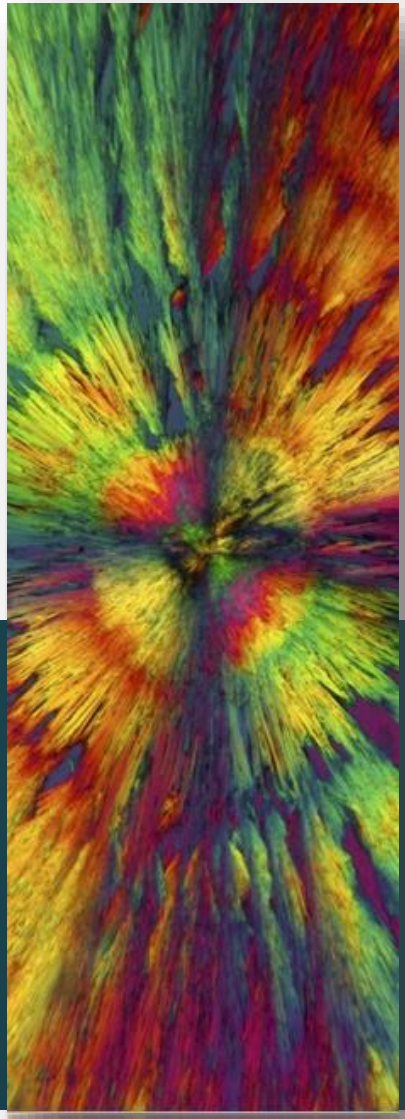


Type 2 Diabetes

A complex disease of gene and environment interactions

UWGSEO

GENOME SCIENCES EDUCATION OUTREACH

Type 2 Diabetes: A complex disease of gene and environment interactions

 This curriculum was created by Genome Sciences Education Outreach (GSEO) and is supported by a Science Education Partnership Award (SEPA) from the Office of Research Infrastructure Programs (ORIP) of the National Institutes of Health through Grant Number R25OD010966.

Cover photo: Polarized light micrograph of glucose crystals Stefan Eberhard, Wellcome Images

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
Supported by the National Institutes of Health

UWGSEO
GENOME SCIENCES EDUCATION OUTREACH

Credits

Authors and Contributors

Joan Griswold, MIT
Science Outreach Specialist
Genome Sciences, University of Washington

Maureen Munn, PhD
Director, Education Outreach
Genome Sciences, University of Washington

Jeffrey Shaver, PhD
Course Program Specialist
Charles A. Dana Center
University of Texas, Austin, TX

Peggy O'Neill Skinner, M.S.
Science Educator
POS Consulting, Seattle, WA

Tara Coffin, M.Ed.
PhD Student
Institute for Public Health Genetics
University of Washington, Seattle, WA

Leadership Team

Maureen Munn, PhD
Director, Education Outreach
Genome Sciences, University of Washington

Joan Griswold, MIT
Science Outreach Specialist
Genome Sciences, University of Washington

Helene Starks, PhD, MPH
Associate Professor
University of Washington

Stephanie M. Fullerton, DPhil
Associate Professor, Bioethics and Humanities
University of Washington

Phyllis B. Harvey-Buschell, EdD
Curriculum Director, MESA
University of Washington

Credits

Field Test Teachers	Lisa Marie Garcia	AC Davis High School, Yakima, WA
	Pamela Legg	AC Davis High School, Yakima, WA

Scientific Advisor

Dianne Lattemann, PhD
Senior Research Scientist, Department of Veteran Affairs
Research Professor
University of Washington, Seattle, WA

Funding Source

This project was made possible by "Genes, the Environment, and Me" (GEM) and is supported by a Science Education Partnership Award (SEPA) from the Office of Research Infrastructure Programs (ORIP) of the National Institutes of Health through Grant Number R25OD010966. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NIH.

Table of Contents

Overview

The increase in type 2 diabetes nationally and globally gives meaningful context for learning about the genetic and environmental contributions to this challenging disease. In this project-based unit, students learn about the role of glucose in the body, and how the failure of mechanisms that maintain balance result in chronic high blood glucose levels. Students consider genetic factors that contribute to the disease, as well as environmental factors that influence health, including social, political and economic structures. Throughout the unit, prevention and treatment are emphasized as students learn how good nutrition, exercise, personal choice, public health policies and community engagement can contribute to positive health outcomes. As a summative assignment, students create a *Call to Action* product, in which they implement direct, meaningful, and relevant actions in order to make a contribution towards combatting diabetes within their community.

Goals

The primary goals of the *Genes, the Environment, and Me* (GEM) curriculum are:

- To teach how genes and the environment interact to determine traits in living organisms, from the simplest bacteria to humans
- To teach about homeostasis in living organisms and how body systems interact to maintain internal balance in a changing environment
- To engage students in the scientific practices, crosscutting concepts, and core ideas outlined in the Next Generation Science Standards
- To engage students in applying their understanding of science concepts by developing call to action projects

The GEM curriculum includes two units: *What can we learn from worms*? which introduces students to the model organism soil nematode *Caenorhabditis elegans* (*C. elegans*), and the Type 2 Diabetes unit which focuses on this complex human disease. The units may be used together or independently.

Enduring Understandings

- Type 2 diabetes (t2d), as with most traits, is determined by both genes and environment.
- The increase in t2d nationally and globally appears to be associated with an increase in obesity, changes in diet to highly processed foods, a decrease in physical activity, as well as other factors.
- Type 2 diabetes is the result of chronic high blood glucose and can develop over time as the mechanisms that maintain glucose levels fail. If left untreated, it has devastating effects on many organs of the body and can lead to death.
- Glucose is the major energy source for most living organisms, including humans. Blood glucose levels need to be maintained within a specific range, and body systems work together to maintain this range through homeostasis.

- T2d can be prevented: factors contributing to a person's risk include access to good nutrition and exercise; personal choice; public health policies, community resources, socio-economic status, and stress.
- Students can make a meaningful contribution to the prevention of type 2 diabetes.

Target Level Introductory and advanced high school biology courses

Organization of Curriculum Materials marked **Teacher Pages** include background and procedural information for the teacher. **Student Resource** pages are for students to look at but not write on, so they may be photocopied and re-used with groups of students (or given to individual students at the teacher's discretion). A **Student Sheet** is a lab sheet or worksheet that requires student answers and should be photocopied for each student.

The 5 E Model The unit is designed around the 5E Learning Cycle Model developed by the Biological Sciences Curriculum Study. The 5E model provides a scaffold for guiding and assessing student inquiry and learning through the following stages: Engage; Explore; Explain; Elaborate; and Evaluate.

Assessment Each lesson provides opportunities to assess student learning through closing activities and questions. In addition, a summative assessment for the instructional unit is included.

Project Based Learning Type 2 diabetes is a complex condition that brings together issues of health care, scientific research, environmental influences, personal choice, access to resources, diet and exercise, social justice, public policy and more. The nature of this complex topic lends itself well to a ***Project Based Learning*** approach in the classroom. Using this teaching method, students work for an extended period of time to investigate and respond to this multi-faceted topic by addressing a specific diabetes-related problem and finding ways to contribute to a solution.

As with other project-based units, this curriculum is focused by a *driving question* that is open-ended and allows for students to make choices about which aspects of type 2 diabetes they would most like to explore as they create a project product. The driving question creates a *need to know* for the students, and each lesson contributes to the overall content knowledge and skill base that students will need to rely on as they implement direct, meaningful and relevant actions in order to make a contribution towards combatting diabetes within the students' communities.

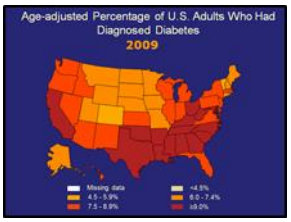
Overview

A helpful resource with background materials and resources for Project Based Learning and can be found at the Buck Institute for Education (www.bie.org).

For teachers who would like to use the curricular unit without a project based learning focus, the lessons can be taught in the traditional manner.

The Driving Question

After students have been exposed to the PowerPoint animation in Lesson One, the question should naturally arise:

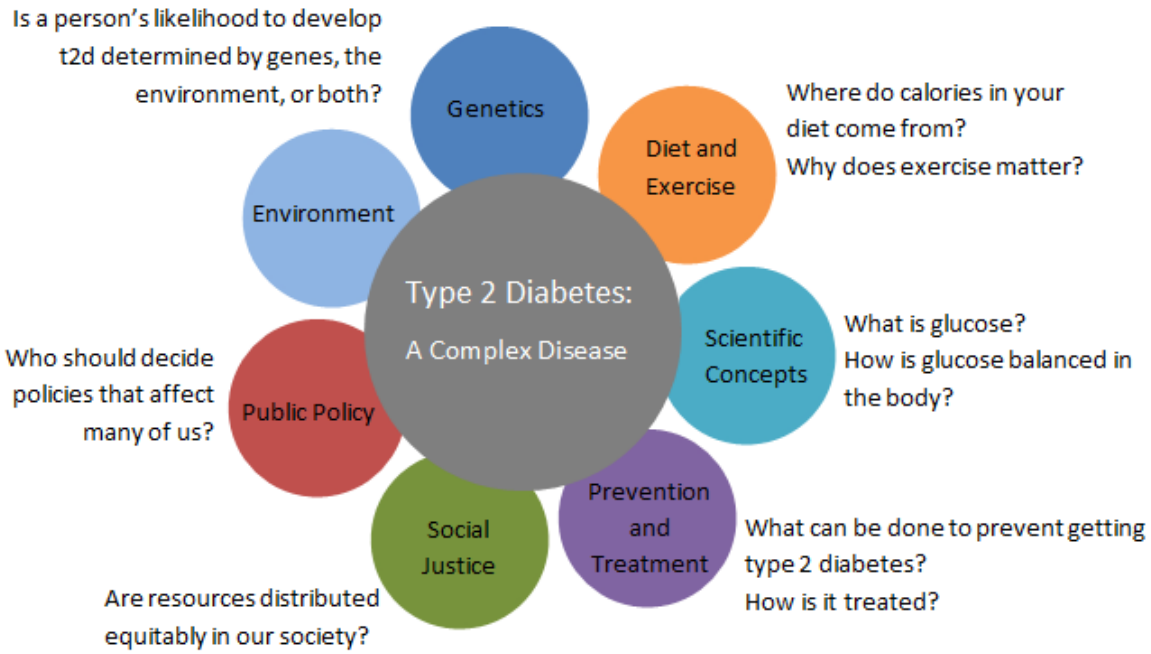


How can the growth of type 2 diabetes [in the Yakima Valley] be slowed?

In order to deeply consider the driving question, students will need to search out answers to a number of other complex questions, including:

- What causes type 2 diabetes?
- How can it be prevented or slowed?
- Why is it growing?
- Are there aspects of my environment (i.e. Yakima Valley) that contribute to this condition?
- Are there social factors in my area that contribute to type 2 diabetes?
- How do we as a society make decisions about policies that affect many of us?

The graphic below illustrates the main areas of focus of the curriculum with additional questions addressed throughout the unit.



Overview

Table 1: Lesson descriptions and time to complete

Lesson	Description	Time	Activities
Lesson 1 Why study type 2 diabetes?	By reviewing data and asking questions, students are challenged to consider how to make a difference in the tremendous growth of type 2 diabetes (t2d) in the last 15 years. Students are introduced to different types of diabetes, risk factors, treatment and prevention options, as well as the Driving Question for the unit.	90 min.	• *Silent Chalk Talk* introduction to unit themes • PowerPoint presentation illustrating the dramatic increase in t2d
Lesson 2 Where is glucose in food?	Students learn that glucose is the major energy source for most living organisms, including humans, and perform an experiment with two digestive enzymes to determine whether glucose is present in three types of milk.	90 min.	• Pencil/paper model of carbohydrates • Lab activity using lactase and sucrase to demonstrate the release of glucose through the breakdown of carbohydrates in foods.
Lesson 3 Where do calories come from in your diet?	Students examine food labels to learn where calories come from, and use an activity calculator to determine durations of physical activity required for balancing calorie intake. Students learn that t2d can be prevented, and that factors contributing to a person's risk include access to good nutrition and exercise.	50 min.	• Food label calculations to determine calories from fat, carbohydrates and protein • Activity calculator to determine the amount of physical activity needed to balance caloric intake
Lesson 4 Glucose in balance	Through a blood glucose homeostasis model using a game board and pasta pieces, students learn that blood glucose levels need to be maintained within specific ranges. Students learn that body systems work together to maintain this range, and t2d can develop over time if the mechanisms that maintain blood glucose levels are challenged and eventually fail.	90 min.	• Game board model of glucose homeostasis with accompanying PowerPoint presentation • Visual demonstration of amounts of sugar in different sized drinks
Lesson 5 Anatomy of type 2 diabetes	Students develop a detailed human body poster that shows how various organs and body systems are impacted by high blood glucose levels that can occur with t2d. Students also learn about classes of medications for t2d and their physiological targets.	50 min.	• Full body posters with organs and body systems represented
Call to Action	*Please provide student groups time to work together on their Call to Action products.*		

Overview

Lesson	Description	Time	Activities
Lesson 6 Introduction to multifactorial traits	Students examine some of their own traits and discuss whether each trait is determined by genes, the environment, or a combination of both. Students are introduced to a variety of both genetic and environmental factors that may contribute to the development of type 2 diabetes.	50 min.	• Revisit *Silent Chalk Talk* posters • Genetic traits inventory and class histogram • Genetic/Environmental factors Venn diagram
Lesson 7 Environmental and genetic risk factors	Students dive more deeply into environmental and genetic risk factors for t2d and consider how these factors interact to reduce or increase risk. Students simulate genetic predisposition to assess risk and weigh how access to resources and personal choice may increase or decrease risk factors over time.	90 min.	• Bean simulation to determine genetic risk • Pencil/paper risk tally to determine environmental risks • Research risk cards
Lesson 8 Who decides?	Students are introduced to a variety of viewpoints concerning the rising rates of t2d and obesity, and consider how public health policies may, or may not, change individual behaviors. Students participate in a *Structured Academic Controversy* about school lunches and learn how to use an ethical framework to help justify their position on an issue.	90 min.	• Stakeholder viewpoint cards • Structured Academic Controversy • Introduction to ethical perspectives of Respect for Persons, Justice, Doing Good, and Doing No Harm
Final Assessment Call to action products	Students synthesize and apply their learning throughout the unit by creating a project that addresses a specific diabetes-related problem and contributes to a solution. Successful *Call to Action* products will implement direct, meaningful, and relevant actions in order to make a contribution towards combatting diabetes within the students' communities.	150 min.	• Final installment of *Silent Chalk Talk* posters • Creation of group or individual projects
Appendix	The appendix to *Type 2 Diabetes* unit contains a mix-and-match set of resources to augment student understanding of this topic and create thoughtful Call to Action products. The resources include additional science content and student support materials.	--	• PPT slide deck with t2d research data • Links to newspaper and research articles • Worksheets to scaffold student reading • Structured discussion strategies

Correlation to the Next Generation Science Standards

	Lesson One	Lesson Two	Lesson Three	Lesson Four	Lesson Five	Lesson Six	Lesson Seven	Lesson Eight
Scientific Practices								
1. Asking Questions	●		●		●	●		
2. Developing and Using Models				●	●		●	●
3. Planning and Carrying out Investigations		●				●		
4. Analyzing and Interpreting Data	●	●	●	●	●	●	●	●
5. Using Mathematics, Information and Computer Technology, and Computational Thinking		●	●	●	●			
6. Constructing Explanations	●	●		●	●	●	●	●
7. Engaging in Argument from Evidence	●	●		●			●	●
8. Obtaining, evaluating, and communicating information	●		●	●	●	●	●	●
Crosscutting Concepts								
1. Patterns	●			●	●	●	●	
2. Cause and Effect: Mechanism and Explanation	●	●	●	●	●	●	●	●
3. Scale, Proportion and Quantity	●		●					
4. Systems and System Models			●	●	●	●	●	●
5. Energy and Matter: Flows, cycles, and conservation		●	●	●				
6. Structure and Function		●		●	●	●		
7. Stability and Change	●			●	●	●	●	●
Core Ideas: Life Sciences								
HS LS1: From Molecules to Organisms: Structure and Processes	●	●	●	●	●			
HS LS2: Ecosystems: Interactions, Energy, and Dynamics		●	●					●
HS LS3: Heredity: Inheritance and Variation of Traits	●					●	●	
HS LS4: Evolution: Unity and Diversity						●	●	

Source:
NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

What is diabetes? Diabetes is a group of diseases marked by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Diabetes can lead to serious complications and premature death, but people with diabetes, working together with their support network and their health care providers, can take steps to control the disease and lower the risk of complications. See http://www.cdc.gov/diabetes/pubs/factsheet11/popup3.htm for the criteria for diagnosing diabetes.

Type 1 diabetes Type 1 diabetes was previously called insulin-dependent diabetes mellitus (IDDM) or juvenile-onset diabetes. Type 1 diabetes develops when the body's immune system destroys pancreatic beta cells, the only cells in the body that make the hormone insulin that regulates blood glucose. To survive, people with type 1 diabetes must have insulin delivered by injection or a pump. This form of diabetes usually strikes children and young adults, although disease onset can occur at any age. In adults, type 1 diabetes accounts for approximately 5% of all diagnosed cases of diabetes. Risk factors for type 1 diabetes may be autoimmune, genetic, or environmental. There is no known way to prevent type 1 diabetes.

Type 2 diabetes Type 2 diabetes was previously called non–insulin-dependent diabetes mellitus (NIDDM) or adult-onset diabetes. In adults, type 2 diabetes accounts for about 90% to 95% of all diagnosed cases of diabetes. It usually begins as insulin resistance, a disorder in which the cells do not use insulin properly. As the need for insulin rises, the pancreas gradually loses its ability to produce it. Type 2 diabetes is associated with older age, obesity, family history of diabetes, history of gestational diabetes, impaired glucose metabolism, physical inactivity, and race/ethnicity. African Americans, Hispanic/Latino Americans, American Indians, and some Asian Americans and Native Hawaiians or Other Pacific Islanders are at particularly high risk for type 2 diabetes and its complications. Type 2 diabetes in children and adolescents, although still rare, is being diagnosed more frequently among American Indians, African Americans, Hispanic/Latino Americans, and Asians/Pacific Islanders.

Gestational Diabetes This is a form of glucose intolerance diagnosed during pregnancy. Gestational diabetes occurs more frequently among African Americans, Hispanic/Latino Americans, and American Indians. It is also more common among obese women and women with a family history of diabetes. During pregnancy, gestational diabetes requires treatment to optimize maternal blood glucose levels to lessen the risk of complications in the infant.

Other types Other types of diabetes result from specific genetic conditions (such as maturity-onset diabetes of youth), surgery, medications, infections, pancreatic disease, and other illnesses. Such types of diabetes account for 1% to 5% of all diagnosed cases.

Fact Sheet

What is type 2 diabetes (t2d)?

It is a chronic condition resulting from the body either not producing enough of the hormone insulin or cells no longer responding to insulin. Normally, insulin is the signal that controls the uptake of glucose by cells. Glucose is the primary energy molecule of the body, and it is formed through the breakdown of the sugars and starches we eat. When glucose builds up in the blood, several complications associated with type 2 diabetes can occur, including damage to the heart and blood vessels, nerve damage, glaucoma (damage to the eye), and kidney disease. Poor circulation and nerve damage cause damage to the feet, including infections that can require amputation.

What are the symptoms of t2d?

Symptoms include thirst and increased urination, hunger, fatigue, weight loss, blurred vision, and slow-healing sores.

What are the causes/risk factors for t2d?

Type 2 diabetes is caused by the body's inability to make insulin or to respond to it. Factors that increase risk for developing it include being overweight, having body fat distributed primarily in the abdomen rather than the hips and thighs, age, family history, having pre-diabetes (increased blood sugar that is greater than normal but not at the level of diabetes), and having gestational diabetes (developing diabetes during pregnancy)

How is it treated?

Treatment can include monitoring blood sugar daily, losing weight, eating a healthy diet, getting daily exercise, and sometimes taking drugs and/or insulin.

Can type 2 diabetes be prevented?

Prevention measures include eating a healthy diet, getting plenty of exercise, and losing weight if overweight.

The points are from the Center for Disease Control (CDC) Fact Sheet found at http://www.nccd.cdc.gov/ddtstrs/FactSheet.aspx

Lesson One

Why study type 2 diabetes?

Overview

This lesson begins with an introduction to the themes explored in the unit through student participation in a *Silent Chalk Talk* conversation. Students are then introduced to diabetes through a CDC power point that shows how the prevalence of diabetes has increased dramatically in the Unites States between 1994 and 2010. Students are challenged to consider how to make a difference in the tremendous growth of this disease in the last 16 years. By asking questions and reviewing data, students are introduced to different types of diabetes, risk factors, treatment and prevention options in order to decide which type is the most common and the most preventable.

Enduring understandings:

- Type 2 diabetes, as with most traits, is determined by both genes and the environment.
- The increase in type 2 diabetes nationally and globally appears to be associated with an increase in obesity, changes in diet to highly processed foods, and decrease in physical activity, as well as other factors.

Essential question:

What is type 2 diabetes and why is it important?

Learning objectives:

Students will be able to:

- Know that type 2 diabetes is an important public health focus in the U.S., due to its prevalence and rapid growth.
- Develop relevant questions based on data and discussion.
- Interpret data.

Time: 90 minutes

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectation

HS LS3-3 Apply concepts of probability to explain the variation and distribution of expressed traits in a population.

HS ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

The lesson highlights the Scientific Practice of **Constructing Explanations and Designing Solutions:** *Design, evaluate and refine a solution to a complex, real-world problem*.

It also highlights **Asking Questions** and **Interpreting Data,** and the Crosscutting Concepts of **Patterns** and **Stability and Change**.

Materials

Materials	Quantity
Chalk Talk poster instructions	1 per class
Chalk Talk Rules of Participation	1 per class
Large pieces of butcher paper or easel pad paper for Chalk Talk	6 per class
Colored markers for writing on Chalk Talk posters (3 x 6 posters)	18
Computer and projector	1 per class
PowerPoint presentation for Lesson 1, found at http://gsoutreach.gs.washington.edu/ (see GEM Instructional Materials)	1 per class
Student Sheet 1: *Why Study Diabetes?* (two-sided)	1 per student
Computers for students	1 per student or group
Access to reliable Type 2 Diabetes websites such as the following American Diabetes Association: http://www.diabetes.org/diabetes-basics/type-2/ Mayo Clinic: Type 2 Diabetes: http://www.mayoclinic.com/health/type-2-diabetes/DS00585 PubMed Health: Type 2 Diabetes: http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001356/ Center for Disease Control (CDC): http://www.nccd.cdc.gov/ddtstrs/FactSheet.aspx Health Outcomes County by County: http://www.countyhealthrankings.org	
Map showing distribution of type 2 diabetes in the US by county http://www.cdc.gov/diabetes/atlas/countydata/atlas.html	

Lesson Preparation

- Create the Chalk Talk posters as instructed and place three markers by each poster.
- Reserve the computer lab or make sure that your students have access to computers in class.
- Make sure that the PowerPoint presentation for lesson one including the slides *Diagnosed Diabetes in US Adults-1994-2010* and *Types of Diabetes* is loaded on your computer and ready to be projected to the class.

Presenting the Unit
Part 1 (Engage): **Silent Chalk Talk** (*15 minutes*)

Teacher Background: In Silent Chalk Talk, students explore and share their thoughts and ideas about how genes and the environment both influence Type 2 Diabetes by silently responding in writing to statements, questions and pictures posted on the classroom walls. The goal for this written (silent) conversation is that all students are given an equal voice, remarks are as anonymous as possible, and students feel safe to express their thoughts and feelings. Through the posters, students will get a sense of the breadth of topics about diabetes this curriculum will address. The posters should remain up around the room for the duration of the unit. Students will get a chance to add to the posters in subsequent lessons, allowing for an evolution of thought.

Create the posters from the Teacher Resource--*Silent Chalk Talk Posters* using large blocks of butcher paper or easel pads. Be sure to leave enough space for students to add their comments over three to four days. If possible, use one color of marker per poster for each day. By doing so, student comments will be more anonymous and different colors will show whether a comment was written early in the unit or later in the unit.

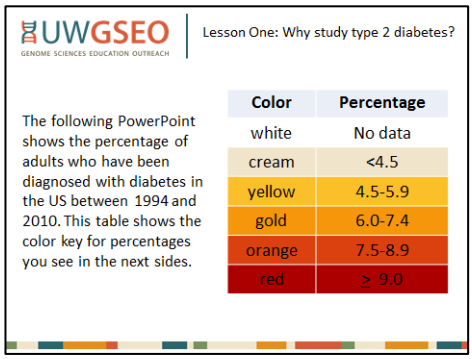
Instructions:

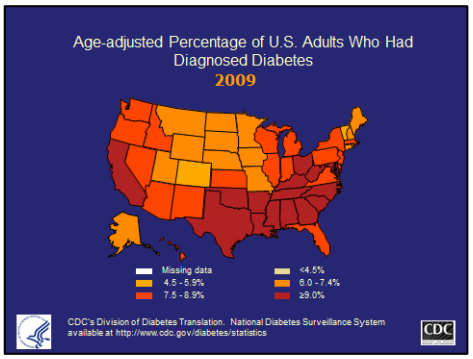
1. Tell students that the class is beginning a unit that explores how both genes and the environment influence our health, and the focus of the unit will be on type 2 diabetes.
2. Show students the six posters placed around the room. Each explores a different aspect of type 2 diabetes, including social factors that contribute to the condition.
3. Before letting the students respond, read through each poster with students and ask for clarifying questions. Be careful to not discuss any opinion or give any information that may change students' responses. Merely ensure that they understand what the questions or statement is addressing. It is important to leave this as vague as possible to allow for students to identify their own preconceived notions and/or misconceptions and to allow for evolution of thought throughout the lessons.
4. Post and review rules of participation in a silent chalk talk from Teacher Resource -- *Silent Chalk Talk Rules of Participation.*
5. Give students 10 minutes to contribute to each poster at least once, either by responding to the primary comment on the poster, or responding to other students' comments.
6. Explain to students that they will be using these posters to continue a conversation over the next few days but are not to discuss it outside of class.

Part 2 (Engage): Diabetes over Time (PPT Presentation; *15 minutes*)

7. Show the PowerPoint, Diagnosed Diabetes in US Adults-1994-2010, which maps the prevalence of type 2 diabetes (t2d) in the United States from 1994-2010. The map is color-coded to indicate the percent prevalence state by state and year by year.

Slide 2 through Slide 19





8. Show the PowerPoint at least three times (by restarting at Slide 3) so that students can absorb the information.

9. Ask the class to brainstorm questions that come up for them as they watch the slide show. Write these questions down on a Question Wall--an area that allows the class to refer back to them throughout the unit.

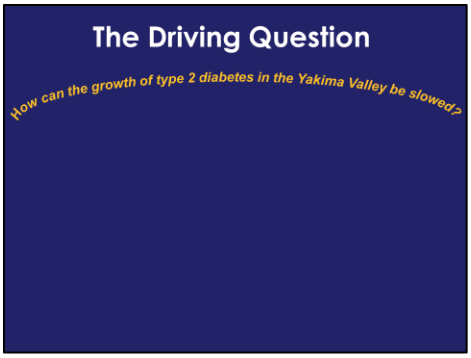
10. Tell students that the Driving Question for this unit will be:

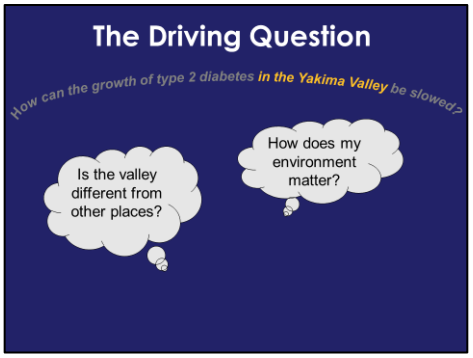
    How can the growth of type 2 diabetes in the Yakima Valley be slowed?

11. Link any questions that the class has already written on the Question Wall back to this question. For example, learning the answers to many of those questions will also lead to the answer to the Driving Question. To fully answer the Driving Question, students will need to know what causes diabetes, what slows or speeds up the condition, and what elements in their local community environment play a part in the acquisition of the disease. Slides 20 – 24 can be used to tie the Driving Question to questions the students have asked.

Note: This curriculum was developed for and piloted by teachers in the Yakima Valley of Washington State. Students should, understandably, research their own communities so that they may be able to learn about local conditions and issues, and potentially address these in their Call to Action products.

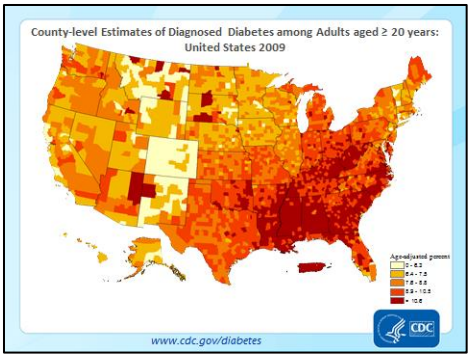
Slide 20 - 24





12. In order to see the ***local connection*** to this nationwide growth, have students view the statistics from their own county by going to the following web page and choosing their state from the dropdown menu near the bottom of the page. It is also possible to see the statistics from earlier years. By choosing the "indicator" dropdown menu near the top of the page, you can also see the county statistics about obesity and physical inactivity.

Slide 25



Another helpful county-by-county resource can be found here: http://www.countyhealthrankings.org

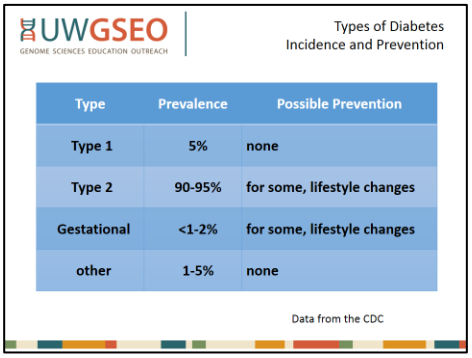
http://www.cdc.gov/diabetes/atlas/countydata/atlas.html

Part 3 (Explore): **Types of Diabetes** *(10 minutes)*

13. After considering the data individually and in pairs, ask students share their ideas about what the data indicate.

14. Show Slide 26 to raise the issue that the data include different types of diabetes, and that it is important to understand the differences for scientific study.

Slide 26



15. Ask students what they know about type 1 and type 2 diabetes, gestational diabetes and the other more general category. You may have to provide some of the background information given in the teacher notes, either as a short reading or direct instruction, to stimulate conversation.

16. Ask students which type of diabetes should be the focus if they want to make a difference in the trend of prevalence in the country. (They should point out that type 2 diabetes is the biggest category and is preventable for some people, so a focus on t2d has the potential to reverse the trend.)

17. Ask students to share what they know about type 2 diabetes.

Part 4 (Elaborate): Going Deeper (*20 minutes*)

18. Provide each student group (3-4 students/group) with access to a computer. Ask them to look for answers to their questions and to write 6-8 advanced questions and ideas that the additional data elicit.

19. Discuss what students learned about their initial questions and have them pose additional questions. What do they know now? What more would they like to learn? Below are a few examples of more sophisticated questions and ideas students may raise after examining the data:

    - What is it about certain parts of the country/world that leads to increased incidence?
    - What changes have occurred worldwide to result in changes in type 2 diabetes incidence?
    - Does the evidence that type 2 diabetes runs in families reflect genetics, culture, society, or all three?
    - Why do some people get type 2 diabetes and others do not?

20. Do not focus on answering the questions, but continue to collect the questions or write a few common questions on the Question Wall.

Closure (Evaluate) *(10 minutes)*

21. Revisit the driving question for the unit:

    How can the growth of type 2 diabetes in the Yakima Valley be slowed?

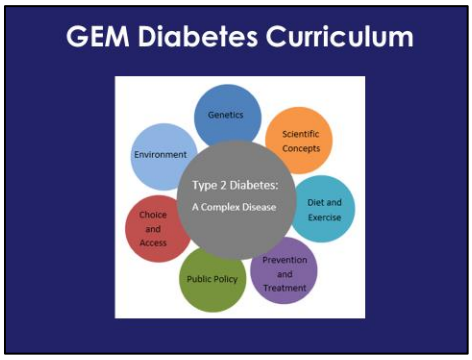
    Have students discuss how what they have just learned helps them answer the question.

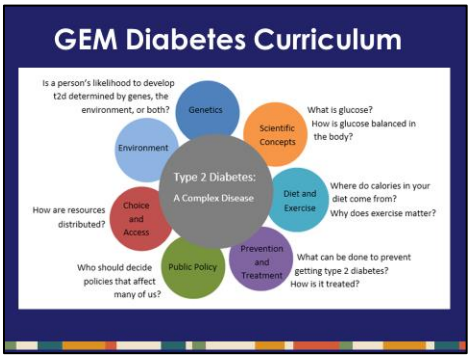
22. Conclude the class by introducing the 'Call to Action' product. Students will be asked to show what they have learned throughout the unit in a way that interests them and answers their unique questions. Products should show that scientific findings

related to type 2 diabetes can be translated into actions on the personal, community, public health policy, and political levels to improve human health.

23. To support students in thinking about their Call to Action products, show slides 27 and 28. These slides give a preview of the entire curriculum so that students can see what topics will be addressed in the next days and weeks. Students can then begin to think about the types of questions that most interest them.

    Slides 27 - 28





24. Ask students to complete Question 9 on Student Sheet 1 to encourage them to begin thinking about their Call to Action product. In the end, a Call to Action product will:
    - Show an understanding of problem(s) associated with type 2 diabetes
    - Contribute to a solution for a problem
    - Have direct and meaningful impact on diabetes in the community (which could include individuals, families, schools, and/or the wider community)
    - Contain accurate information.

25. If time allows, students can sort themselves into groups based on preliminary topic interests.

26. Teachers may choose to share the Grading Rubric for the Call the Action products at this time, which can be found in the Call to Action portion of the curriculum on page 140. This section also contains student worksheets, planning forms, and other resources to support students in their Call to Action products.

Name: _____ Date: _____ Period: _____

Student Sheet 1: Why Study Diabetes?

1. With your class, watch the PowerPoint presentation, Diagnosed Diabetes in US Adults-1994-2010. The table below gives the color key for percentages.

Color	Percentage	Color	Percentage
white	No data	gold	6.0-7.4
cream	<4.5	orange	7.5-8.9
yellow	4.5-5.9	red	≥ 9.0

2. What do the data in this PowerPoint show you in terms of prevalence of diabetes in the United States from 1994-2010? Answer this question by yourself, then discuss with a partner and with the whole class.

3. See Slide 25, Types of Diabetes.

4. Based on the data in the PowerPoint, what type of diabetes would make most sense for public health policies and education to focus on? Why?

5. What do you know about this type of diabetes based on your prior knowledge?

6. a. Write 3-5 initial questions about what you would like to learn about this type of diabetes.

   b. After your class discusses this topic, write down additional questions that were not on your list.

Page 2 What do you want to know about type 2 diabetes?

Answer the questions below:

7. Working in a team of 3-4 students, use the online resources below to answer some questions on your class master list on a separate sheet of paper.

   American Diabetes Association: http://www.diabetes.org/diabetes-basics/type-2/
   Mayo Clinic: Type 2 Diabetes: http://www.mayoclinic.com/health/type-2-diabetes/DS00585
   PubMed Health: Type 2 Diabetes: http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001356/
   Center for Disease Control (CDC): http://www.nccd.cdc.gov/ddtstrs/FactSheet.aspx
   Health Outcomes County by County: http://www.countyhealthrankings.org

8. Write 8-10 questions and ideas that you would like to investigate in more depth based on your exploration of the data package.

9. Call to Action: Highlight two of your team questions from Question 8, and explain how those questions could form the basis of a Call to Action by answering the following for each question:

   a. What is the issue or problem addressed by this question?

   b. Who is affected by this issue or problem?

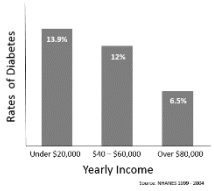
   c. What could be done by individuals, families, communities, health agencies, or others to provide a solution to this problem?

10. Homework: Why is glucose important in type 2 diabetes?

Teacher Resource

Silent Chalk Talk Posters

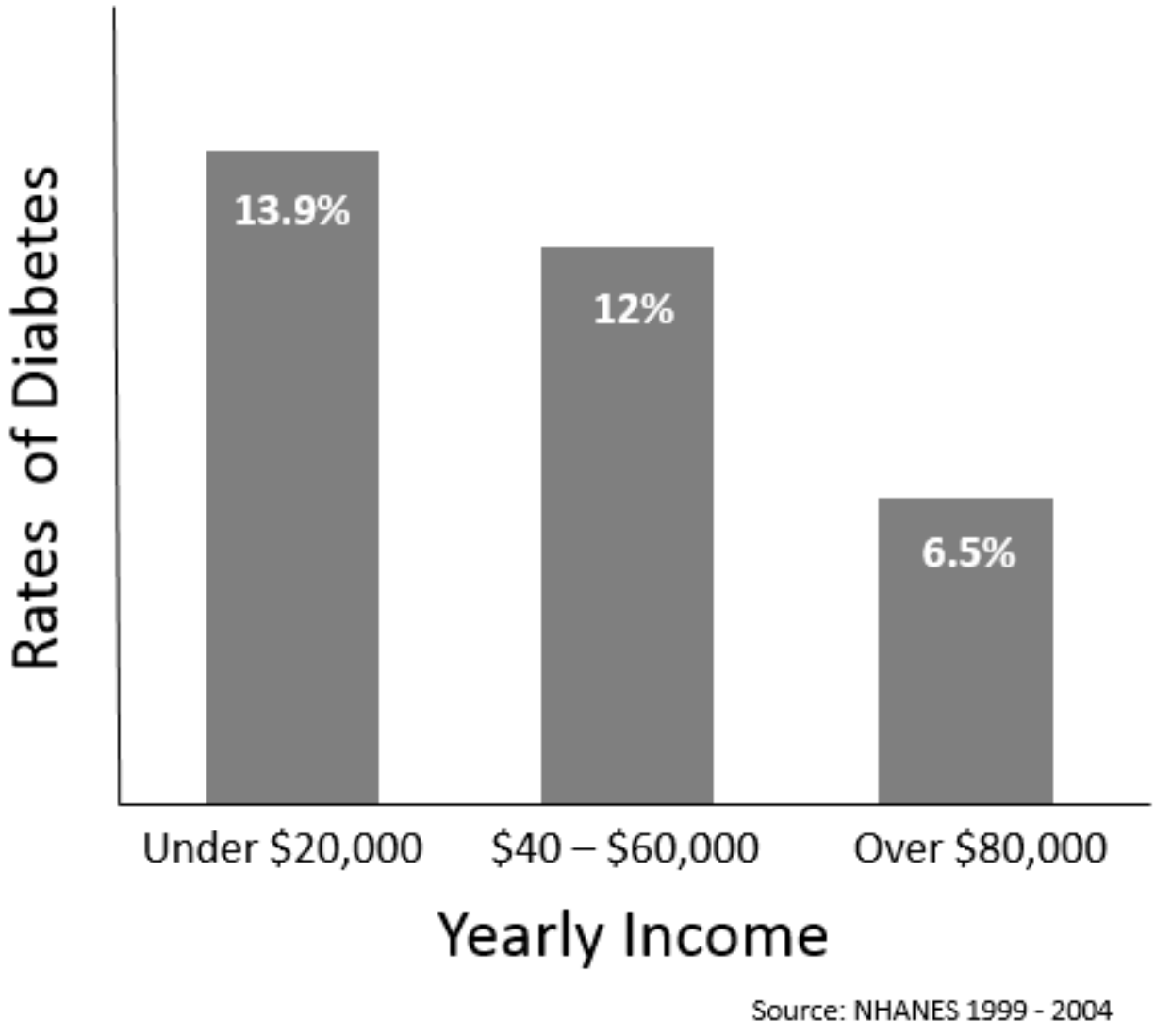
Re-create these posters on large pieces of butcher paper or sticky notes. If possible, provide a different color marker each day students respond to the prompts.

Glucose is…	**I think developing type 2 diabetes is due mostly to:** **Genes** ⟷ **Environment**	**What does this graph mean to you?**  (See teacher resource for copy master)
Type 2 diabetes can be prevented or controlled by…	**Why study diabetes?**	I know **A LOT** about this topic **I have NO personal connection** ⟷ **I have MANY personal connections** I know **LITTLE** about this topic (Have students plot their own position/knowledge point using a different class color each day.)

Silent Chalk Talk Rules of Participation

1. Respond to the main comment anywhere on the poster.
2. Respond to others by drawing an arrow from their comment to yours.
3. If you agree with a comment, add an ! or ★.
4. If you disagree with something, politely explain why.
5. Do not cross out or write over anyone else's comments.
6. Pictures are permissible, just keep them appropriate.
7. Keep all responses respectful.
8. No Talking.

Instructions: Print this graph and attach it to one of the Chalk Talk posters.



Source: NHANES 1999 - 2004

Lesson Two

Where is glucose in food?

Overview
Students learn about different types of sugars and perform an experiment with two digestive enzymes to determine whether glucose is present in three types of milk. Students are introduced to Diastix as a method to measure glucose concentrations, and the use of digestive enzymes lactase and sucrase to demonstrate the release of glucose through the breakdown of carbohydrates in foods.

Enduring understanding:
Glucose is the major energy source for most living organisms, through the process of cellular respiration. The food we eat can either be broken down to glucose, a single-ring sugar, or converted to glucose through the action of enzymes.

Essential question:
Where is glucose in food and what does it have to do with type 2 diabetes?

Learning objectives
Students will be able to:

- Determine the presence of glucose in foods that they consume.
- Model how the enzymes sucrase and lactase act on sugars.

Prerequisite Knowledge
Students should have an understanding of the following terms: enzyme, glucose, digestion, molecule.

Time: Approximately 90 minutes

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectation
HS LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen and oxygen from sugar molecules may combine with other elements to form other large carbon-based molecules [and conversely, how large molecules may be broken down into simple sugar molecules].

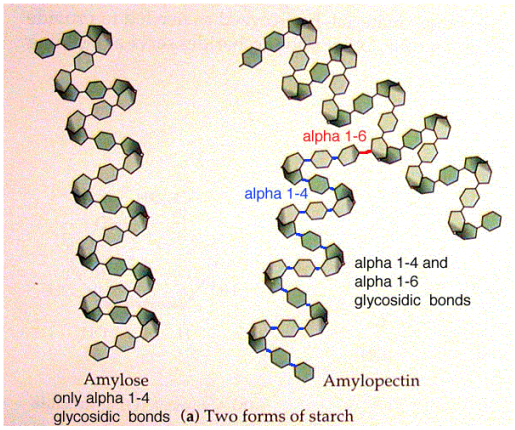
This lesson highlights the Practices of **Carrying out Investigations** and **Constructing Explanations,** and the Crosscutting Concept of **Energy and Matter**.

Background on Carbohydrates

Glucose, a **monosaccharide**, is the primary energy molecule of the body. Surprisingly, much of the food we eat is not in the form of glucose. More commonly, glucose is found as part of **disaccharides** like sucrose (found in fruit) and lactose (in milk) or as a starch. In this lesson, students use readily available digestive enzymes to digest sugars to simple sugars. They use Diastix to detect glucose in milk solutions before and after digestion. Other macromolecules, like amino acids and fats, can be converted to glucose by enzymes in the liver, but this is beyond the scope of this lesson.

How is starch digested to glucose?

Starch, a **polysaccharide**, is a natural **polymer** of glucose, formed in a variety of plants by the chemical linkage of hundreds or even thousands of individual glucose units. Corn, wheat, potatoes and rice are main sources of starch used in the U.S. Other plants with high starch content (*e.g., cassava, milo, sorghum)* are more abundant in other parts of the world. The common starches differ in that they contain different amounts of two types of glucose polymers. One of these polymers is **amylose** (see figure to the right), a linear chain of 500 to 2000 glucose units. The other starch polymer, **amylopectin** (see figure to the right), has a tree-like shape, with linear chains like those in amylose connected at branch points. Each branch contains about 20 to 30 glucose units and the molecule is made up of several hundred branches.



Digestion of carbohydrates begins in the mouth. Saliva contains a large amount of alpha-amylase, an **enzyme** that breaks starch into smaller fragments. With the help of additional digestive enzymes, these fragments are broken down into **glucose.** Glucose molecules are then absorbed from the small intestine into the blood stream. Once in the blood stream, glucose is transported into cells with the help of **insulin**. Insulin is a small **protein hormone** that regulates the amount of glucose in the blood by stimulating cells to transport glucose in from the blood stream. Once in our cells, glucose can be broken down for energy. In addition to alpha-amylase, other digestive enzymes that are responsible for making glucose available to cells for energy include sucrase and lactase. Sucrase (also known as invertase) digests sucrose (*table sugar*; also found in foods containing high fructose corn syrup) to glucose plus fructose, and lactase digests lactose (*milk sugar*) to glucose plus galactose. Also, some foods contain glucose without enzyme digestion.

Starch is broken down to glucose in two stages, each requiring specific enzymes that act upon different portions of the molecule. Due to the size of the starch molecule and the specificity of the enzymes, starchy foods can take longer to digest than foods containing a predominance of mono- or di-saccharides (such as foods containing high fructose corn syrup). Foods that are digested more slowly release glucose into the blood stream more slowly.

Most **fiber** is also a polysaccharide and a natural polymer of glucose. **Fiber** is plant matter such as cellulose that cannot be broken down by human digestive enzymes, though bacteria in the human digestive tract can digest some types of fiber. Fiber is important to the diet because the roughage aids in digestion, and a high fiber meal can provide a feeling of fullness without adding calories. Fiber also slows down the rate of sugar absorption by the body.

Nordqvist, C. (2013, November 4). "What is fiber? What is dietary fiber? Fiber rich foods." *Medical News Today*. Retrieved from http://www.medicalnewstoday.com/articles/146935.

Materials

Materials	Quantity
8.5 x 11 inch sheet of paper	1 per student
Scissors	1 per student
Tape	1 per group
Colored pencils in turquoise and brown to represent Diastix colors	1 per group
Student Resource: *Lesson 2 Student Lab Instructions* (can be re-used)	2 per group (in sleeves)
Student Sheet 2: *Is there glucose in milk?*	1 per student
Consumable materials for the class (enough for 8 lab groups)	
2 Diastix strips for the class demonstration	1 per class
100 ml 1.0 % glucose solution (1 g glucose / 100 ml H_2O)	1 per class
30 ml regular milk (non-fat, 1%, 2% or whole)	1 per class
30 ml chocolate milk	1 per class
30 ml lactose-free milk	1 per class
30 ml 1% sucrose solution (1 g sucrose / 100 ml H_2O)	1 per class
12 ml sucrase (aka invertase) enzyme solution, 1:10 dilution	1 per class
12 ml lactase enzyme solution (1 tablet diluted to 12 mls with H_2O)	1 per class
Lab Materials for each group	
9 x 1.5 ml microfuge tubes:	per group
3 tubes with 1 ml (20 drops) of regular milk in each	
3 tubes with 1 ml (20 drops) of chocolate milk in each	
3 tubes with 1 ml (20 drops) of lactose-free milk in each	
1 x 1.5 ml microfuge tube filled with water	1 per group
1 x 1.5 ml microfuge tube filled with sucrase enzyme solution	1 per group
1 x 1.5 ml microfuge tube filled with lactase enzyme solution	1 per group
9 Diastix glucose test strips	per group
3 x 2 ml plastic transfer pipettes	per group
Diastix container *or* glucose concentration color chart printed in color	1 per group
32^{o}C water bath with microfuge tube floats (optional)	1 per group

Lesson Preparation

- Diastix reagent strips can be purchased from any drugstore. Amazon.com carries containers of 100 strips for $14.00 (as of January, 2014)
- Sucrase is also known as invertase. It can be ordered from a biological supply house in powder form. You may also find it in shops that specialize in cake decoration.
- Lactase tablets can be found over the counter in most drugstores
- Lactose-free milk can be found in the dairy case at grocery stores. One brand name is Lactaid.

Presenting the Lesson

Point out for students some of the questions generated in the previous lesson that had to do with glucose and how elevated glucose levels play an important role in type 2 diabetes. Where does the glucose in our body come from? Tell students that today's lesson asks, *"Where is glucose found in food?"* and involves a lab activity in which students look for glucose and other sugars in three kinds of milk (regular milk, chocolate milk and lactose-free milk). First, students are going to create a paper model of simple and complex sugars.

Procedures

Part 1 (Engage): Modelling Carbohydrates (*15-30 minutes*)

If students do not have any background with macromolecules and/or enzymes, teachers may choose to spend an entire class on this pencil and paper activity before beginning the lab.

1. Hand out a blank 8.5 x 11 inch piece of paper to each student.
2. Have students fold the paper down about an inch along the short side. "Accordion" the paper by folding it back and forth to the end (Figure 1).
3. Once flat, have students cut the paper into squares (Figure 2).
4. Lastly, have students snip the corners off the top and bottom of each square to create connected *6-sided* shapes to represent single-ring sugars such as glucose (Figure 3). ***Be careful*** to leave the midsection intact.

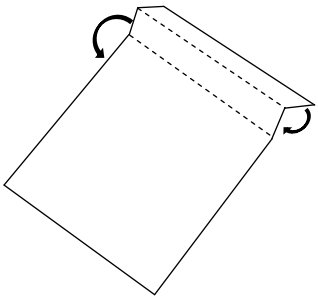


Figure 1

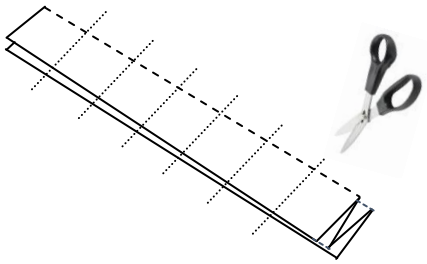


Figure 2

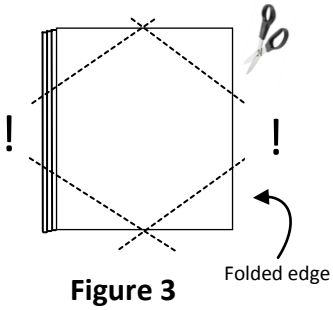


Figure 3

5. Have students unfold their paper models into chains. Tell students that these chains represent ***carbohydrates*** in the form of ***polysaccharides*** (poly = many; saccharide = sugar)**.**

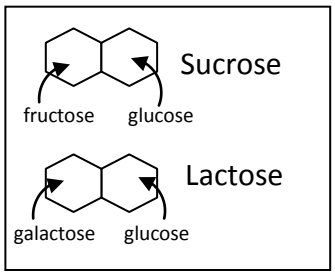
6. Ask each student to take *one* of his or her chains and cut or tear it into individual hexagons. Tell students that each hexagonal piece they just cut represents a single sugar, or ***monosaccharide,*** (mono = one) when detached from the chain. Explain that ***glucose*** is a monosaccharide.

7. Have students label a few monosaccharide pieces as glucose. Students can tape these in their notebooks, if desired.

8. Tell students that *all food* eventually must be digested or converted to ***glucose*** in order for the body to gain energy from the food through the process of cellular respiration. This lab will look at sugars found in a common food—milk—but doesn't address the conversion of proteins and fats into glucose.

9. Ask students to break another chain into groups of two hexagons. Each of these represents a ***disaccharide*** (di = two). ***Sucrose*** (table sugar) and ***lactose*** (the sugar found in milk) are both disaccharides.

10. Have students label a few disaccharides sucrose and lactose.



11. Not all single ring sugars are glucose, however. Sucrose is made of two monosaccharides, ***fructose*** and ***glucose.*** Students can turn over their labeled sucrose molecule and label one monosaccharide as fructose and the other as glucose.

12. Likewise, lactose is made up of the monosaccharides ***galactose*** and ***glucose***. Have students turn over their labeled sucrose molecule and label one monosaccharide as galactose and the other as glucose.

13. Explain that in the body ***enzymes*** are the "molecular scissors" that break the sugars apart. Enzymes often end with the suffix *–ase* and are often named after the molecule they act upon. Ask students to name the enzymes that split sucrose and lactose in to monosaccharides. (***sucrase*** and ***lactase***)

14. Have students tape the remaining chains of sugar together to make longer chains. Encourage them to join chains with other individuals or groups to make both straight chains and branched chains.

15. Choose one group of students to make colored lines using a marker between the glucose molecules of one of the larger chains. (This will represent fiber.)

16. Show students some of the longer, more complex polysaccharide chains. These represent large carbohydrates such as starch and cellulose. The chains without colored lines represent starches in our diets found in foods such as corn, rice, wheat, and potatoes. These can be made up of hundreds or even thousands of individual glucose units, which eventually get broken down through the action of enzymes into glucose.

17. The chains with colored lines between glucose units represent dietary ***fiber***. Fiber is plant matter such as cellulose that cannot be broken down by human digestive enzymes—we don't have the molecular scissors to cut the colored bond—though bacteria in the human digestive tract can digest some types of fiber. Fiber is important to the diet because the roughage aids in digestion, and a high fiber meal can provide a feeling of fullness without adding calories. Fiber also slows down the rate of sugar absorption by the body.

18. Tell students that we will be working with glucose, sucrose and lactose in the upcoming lab, as well as the enzymes that break the disaccharides into monosaccharides. Instruct students to keep their paper models, but put them away.

Part 2 (Explore): Testing glucose with Diastix Demonstration (*5 minutes*)

19. Show students the Diastix container and explain that the Diastix are testing strips used to detect glucose in urine. Explain that type 2 diabetes is the result of chronic high blood sugar, and excess sugar is excreted through the urine. The presence of sugar in the urine has been an indicator for diabetes for thousands of years, long before there was any treatment for the condition.

20. Demonstrate the use of the Diastix by dipping one stick in water, and one stick in the 1.0% glucose solution, and comparing the stick with the scale on the Diastix container shown below. Show students how the color corresponds to the glucose concentration, as measured in mg/dL.

Food or Drink	**Glucose?** *Yes **or** No*	**Diastix: Color***	**Diastix Container: Glucose concentration**
Water	***No***		***0%; 0 mg/dL***
1.0% glucose	***Yes***		***1%; 1,000 mg/dL***

Part 3 (Explore): Testing Milk Types with Diastix *(40 minutes)*

Throughout the curriculum, ***Student Sheets*** are designed to be written on by students and should be copied one per student. ***Student Resources*** are informational and can be reused with groups of students.

21. With students in lab groups, pass out Student Sheet 2: *Is there glucose in milk?* to each student. Make sure that student groups have access to *Lesson Two Lab Instructions*, which can be put in plastic sleeves and re-used with multiple classes.
22. Using the labels from the milk containers (or the Nutrition Fact labels from the lab sheet) have students look for any sugars listed on the labels. Have students write this in the appropriate column in Table 1.
23. Have students follow the procedures found on Student Resource: *Lesson Two Lab Instructions*. Students should record their results on Student Sheet 2 as they proceed.
24. When students have finished the lab, have groups report out on the types of sugar(s) found in each type of milk, using the Diastix results as evidence.

Closure (Elaborate and Evaluate): (*10 minutes*)

25. Return to the paper models students made at the beginning of the class. Using the models, have students explain what they did during the lab to a neighbor, using the correct vocabulary (glucose, lactose, sucrose, monosaccharide, disaccharide, enzyme, lactase, sucrase).
26. Once students have practiced explaining the lab to a neighbor, you may wish to have them glue the paper models and record the steps and in their notebooks for assessment.
27. Using the large, branched carbohydrate chains, make sure that students understand that glucose molecules are the building blocks of carbohydrates such as the starch in corn, potatoes, rice and wheat. These large carbohydrates get broken down into glucose in a number of stages, also involving specific enzymes.
28. Show students the fiber molecule again. It is also a large carbohydrate built of glucose molecules, but the bonds between glucose molecules in fiber are different than those found in starch. Humans do not have the specific enzymes to break the bonds between glucose units that occur in fiber.

Note: Even though humans do not have the needed enzymes to digest fiber, bacteria which live in our guts do. When bacteria digest fiber using their own enzymes, we gain some nutritional benefit. We also end up with the gas the bacteria produce.

29. Ask students:
"If you needed quick energy during a soccer game, what sort of food would be best?"

Students might say that foods with simple sugars will provide quicker energy since they are more easily broken down or converted into glucose. Foods like fruit (with the monosaccharides fructose), milk, soda or candy can increase blood glucose relatively quickly.

"If you eat an early breakfast, what sort of food might keep you satisfied until lunch?"

Students might say that foods containing starches such as potatoes or rice will take longer to break down than foods containing mono- and disaccharides, supplying you with a steadier supply of glucose throughout the morning. They may also say that food containing fiber will be broken down more slowly. Students may mention non-carbohydrates, such as fat and proteins, which add to a feeling of fullness. Fats and proteins will be addressed in the next lesson.

"Why is fiber important to a diet?"

Fiber adds to a feeling of "fullness" after a meal, but does not add calories. It also slows down the rate of sugar absorption by the body.

30. Ask students if this lesson has helped them answer any part of the driving question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?,*** and check the Question Wall to see if any questions have been answered by today's lesson. Ask students if they have any new questions to add to the wall.

31. Remind students of the *Call to Action* product and have them write down any ideas they might have about incorporating concepts from this lesson into a final project. Lab-oriented students may be interested in exploring the extensions below.

Extensions

This lesson lends itself to numerous extensions and further study, such as exploring the following ideas and lab resources:

- Having students bring in their own liquids to test, such as soda or fruit juice.
- Having students compare sugars and rates of digestion for different types of sugars. For example, fructose is often marketed as a "healthy" or "natural" sugar found in fruit juices. How does fructose compare to high fructose corn syrup found in many sodas?
- Using yeast to detect the presence or absence of certain sugars; if yeast can metabolize the sugar, CO_2 will be produced and can be measured.
- Detecting Sugar: An Everyday Problem When Facing Diabetes. http://www.scienceinschool.org/print/597
- How Sweet It Is! Measuring Glucose in Your Food. http://www.sciencebuddies.org/science-fair-projects/project_ideas/FoodSci_p049.shtml

- Sucrose & Glucose & Fructose, Oh My! Uncovering Hidden Sugar in Your Food. http://www.sciencebuddies.org/science-fair-projects/project_ideas/HumBio_p035.shtml

Preparing for Lesson Three

Lesson Three requires having a selection of food labels on hand for students to use. Ask students to bring in food labels from home, or prepare to provide the labels for them. Food labels can also be found online at Super Tracker (https://www.supertracker.usda.gov/default.aspx).

Glossary

Carbohydrate: Types of sugar, starch, and cellulose that are made of carbon, hydrogen and oxygen, usually in a ratio of 1:2:1

Disaccharide: di- (two) + saccharide (sugar). A sugar composed of two single sugars (monosaccharides). Examples are sucrose, lactose and maltose.

Dietary Fiber: A carbohydrate found in plant matter (such as cellulose) that cannot be broken down by human digestive enzymes. Fiber can be soluble and insoluble in water, and is sometimes referred to as roughage.

Enzyme: A biological molecule (a protein) that speeds up the rate of a chemical reaction.

Fructose: A simple, single-ringed sugar found in many plants that often bonds with glucose to make up the two-ringed sugar sucrose (table sugar).

Galactose: A simple, single-ringed sugar often found bonded with glucose to make up the two-ringed sugar lactose, found in milk.

Glucose: A simple, single-ring sugar that is the main source of energy for living organisms through the process of cellular respiration. It also is the building block of many carbohydrates.

Lactose: A two-ringed (disaccharide) sugar made of glucose + galactose sugars. It is the major sugar in milk. It can be broken down by the enzyme lactase.

Monosaccharide: mono- (one) + saccharide (sugar). A simple, one-ring sugar such as glucose or fructose. Monosaccharides are the building blocks of more complex sugars.

Polysaccharide: poly- (many) + saccharide (sugar). A carbohydrate made by repeating units; a complex sugar made of a chain of monosaccharides joined together by bonds.

Starch: A carbohydrate made of many glucose units joined together.

Sucrose: A two-ringed sugar (disaccharide) that is made up of glucose + fructose. It is used widely as a sweetener and made from sugar beets and sugar cane. It can be broken down by the enzyme sucrase.

POSSIBLE ANSWERS

Student Sheet 2: *Where is glucose found in milk?*

1. Fill in the sugars listed on the food labels, if any, for each type of milk on Table 1.

Table 1 – Types of sugars

Sample	Type of sugar(s) Listed on Label	Do you think the Diastix strip will turn a color with no enzyme? Why or why not?
Milk (regular)	Sugars in Nutritional Facts section, but none under ingredients	***Predictions will vary***
Chocolate Milk	Sugar (sucrose) Sugars	
Lactose-free milk	Sugars in Nutritional Facts section, but none under ingredients	

2. Proceed with the lab, as instructed on *Lesson Two Student Lab Instructions*. After completing the first part of the lab (mixing the milk and enzymes), make predictions about which solutions will test positive for glucose after incubation. If you think the solution will test positive, darken the corresponding rectangle on Table 2.

Table 2 – Prediction

Sample	No Enzyme	+ Sucrase	+ Lactase
Milk (regular)	***Predictions will vary***		
Chocolate Milk			
Lactose-free milk			

3. Complete the lab and record your results on Table 3. Using the Diastix results as evidence, record which types of sugar(s) were present in each milk.

Table 3 – Results

Sample	**Diastix Color / Glucose Concentration**			**Sugar(s) Present**
	No Enzyme	+ Sucrase	+ Lactase	
Milk (regular)				Lactose
Chocolate Milk				Sucrose and Lactose
Lactose-free milk				Glucose

Page 2

Answer the following questions:

1. How did your results compare to your prediction?
   Answers will vary.

2. Which solutions contained glucose before adding either of the two enzymes?
   Only lactose-free milk.

3. What is glucose?
   Glucose is a monosaccharide (simple, single-ring sugar). It is the only type of sugar the body can digest for energy.

4. Do you have to eat pure glucose to raise glucose levels in your blood? Why or why not?
   No. Glucose is the building block of sugars and carbohydrates such as starch. Since starches are made of hundreds or thousands of glucose units, eating these will release glucose into the blood after the starch has been broken down with enzymes.

5. What are examples of other carbohydrates you could eat? Are they all sweet?
   Any kind of sugar (such as sucrose or fructose) or starch such as rice, potatoes, corn or wheat. Not all food that contain glucose taste sweet.

6. Based on your experimental results and the sugars listed the food labels, are there any surprises or unexpected differences (e.g., lactose is milk sugar, but is lactose listed on the food label for milk)? If so, please explain.
   One thing that is very misleading about the labeling of sugar within product ingredients labels is how to determine the type of "sugar" that is contained within a product. For example, some sodas that have "sugar" listed in the ingredients contain sucrose, but for others contain high fructose corn syrup. Therefore, it can be difficult to predict the outcome of glucose testing before and after enzyme treatment. Note, this may raise some very interesting questions by students, and may trigger some potentially interesting and rewarding class discussions. In addition, the marketing of sugar in foods may interest some students for their "call to action" products.

Name: _____ **Date:** _____ **Period:** _____

Student Sheet 2: *Is there glucose in milk?*

1. Fill in the sugars listed on the food labels, if any, for each type of milk on Table 1.

Table 1 – Types of sugars

Sample	Type of sugar(s) Listed on Label	Do you think the Diastix strip will turn a dark with no enzyme? Why or why not?
Milk (regular)		
Chocolate Milk		
Lactose-free milk		

2. Proceed with the lab, as instructed on *Lesson Two Student Lab Instructions*. After completing the first part of the lab (mixing the milk and enzymes), make predictions about which solutions will test positive for glucose after incubation. If you think the solution will test positive, darken the corresponding rectangle on Table 2.

Table 2 – Prediction

Sample	No Enzyme	+ Sucrase	+ Lactase
Milk (regular)			
Chocolate Milk			
Lactose-free milk			

3. Complete the lab and record your results on Table 3. Using the Diastix results as evidence, record which types of sugar(s) were present in each milk.

Table 3 – Results

Sample	**Diastix Color / Glucose Concentration**			**Sugar(s) Present**
	No Enzyme	+ Sucrase	+ Lactase	
Milk (regular)				
Chocolate Milk				
Lactose-free milk				

Page 2

Answer the following questions:

1. How did your results compare to your prediction?

2. Which solutions contained glucose before adding either of the two enzymes?

3. What is glucose?

4. Do you have to eat pure glucose to raise glucose levels in your blood? Why or why not?

5. What are examples of other carbohydrates you could eat? Are they all sweet?

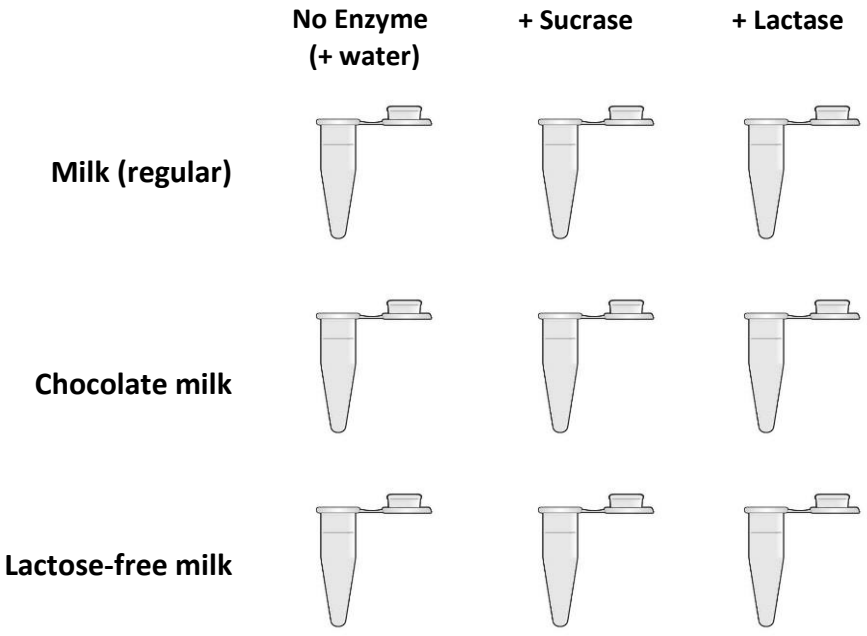
6. Based on your experimental results and the sugars listed on the food labels, are there any surprises or unexpected differences (e.g., lactose is milk sugar, but is lactose listed on the food label for milk)? If so, please explain.

Lesson Two Student Lab Instructions

Testing foods with Diastix before and after enzyme digestion

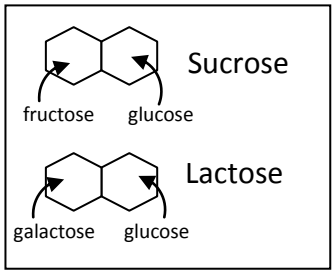
Materials for each group
9 x 1.5 ml microfuge tubes:
3 tubes with 1 ml (20 drops) of regular milk in each
3 tubes with 1 ml (20 drops) of chocolate milk in each
3 tubes with 1 ml (20 drops) of lactose-free milk in each
1 x 1.5 ml microfuge tube filled with water
1 x 1.5 ml microfuge tube filled with sucrase enzyme solution
1 x 1.5 ml microfuge tube filled with lactase enzyme solution
9 Diastix glucose test strips
3 x 2 ml plastic transfer pipettes
Diastix container *or* glucose concentration color chart printed in color
32°C water bath with microfuge tube floats

1. As shown in diagram below, transfer 1 ml (20 drops) of milk, chocolate milk, and your assigned solution into three separate microfuge tubes. Make sure to label your tubes.



2. For each of the solutions (using a different transfer pipette for each enzyme):
   - Add **10 drops of water (*no enzyme*)** to the first set of tubes (***left***)
   - Add **10 drops of sucrase** enzyme solution to the second set of tubes (***center***)
   - Add **10 drops of lactase** enzyme solution to the third set of tubes (***right***)

3. Mix samples by closing lids, and inverting the tubes several times.
4. Incubate samples for **15-20 minutes** at **32°C (*sucrase samples*)** and **room temperature (*lactase samples*)**.
5. While samples are incubating, use Table 2 on Student Sheet 2 to make predictions about the outcome.



Remember, *sucrose* (table sugar) is made up of one fructose and one glucose molecule.

Lactose (milk sugar) is made up of one galactose and one glucose molecule.

6. After incubation, test each of the samples with a Diastix by dipping the Diastix into the sample and removing immediately. Place the Diastix on a paper towel, and wait 30 seconds before recording the color change in the results table on Student Sheet 2.
7. In addition, check the food labels for each sample, and list all sugars present in each sample in the far-right column labeled "Sugars listed on food label."
8. After obtaining your results, prepare to share your results with the rest of the class.

1% HALF GALLON LABEL

Nutrition Facts
Serving Size 1 cup (240mL)
Servings Per Container about 8

Amount Per Serving	
Calories 110	Fat Cal 20
	% Daily Values
Total Fat 2.5g	4%
Saturated Fat 1.5g	8%
rans Fat 0g	
Cholesterol 15mg	5%
Sodium 130mg	5%
Potassium 410mg	12%
Total Carbohydrates 13g	4%
Dietary Fiber 0g	0%
Sugars 12g	
Protein 9g	
Vitamin A 10% •	Vitamin C 0%
Calcium 35% •	Iron 0%
Vitamin D 25%	

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

INGREDIENTS: LOWFAT MILK, VITAMIN A PALMITATE, VITAMIN D3.

A GLUTEN FREE PRODUCT.

CHOC CARTON - Regular

Nutrition Facts
Serving Size 1 cup (240mL)
Servings Per Container about 4

Amount Per Serving	
Calories 190	Fat Cal 25
	% Daily Values
Total Fat 2.5g	4%
Saturated Fat 1.5g	9%
Trans Fat 0g	
Cholesterol 15mg	4%
Sodium 230mg	10%
Potassium 460mg	13%
Total Carbohydrates 31g	10%
Dietary Fiber 1g	3%
Sugars 29g	
Protein 10g	
Vitamin A 10% •	Vitamin C 0%
Calcium 35% •	Iron 4%
Vitamin D 25%	

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

INGREDIENTS: LOWFAT MILK, SUGAR, NONFAT MILK, COCOA PROCESSED WITH ALKALI, SALT, CARRAGEENAN, VANILLIN, VITAMIN A PALMITATE, VITAMIN D3.

A GLUTEN FREE PRODUCT

LACTOSE FREE - 1%

Nutrition Facts
Serving Size 1 cup (240ml)
Servings Per Container 8

Amount Per Serving	
Calories 110	Calories from Fat 20
	% Daily Value*
Total Fat 2.5g	4%
Saturated Fat 1.5g	8%
Trans Fat 0g	
Cholesterol 15mg	5%
Sodium 130mg	5%
Potassium 410mg	12%
Total Carbohydrate 13g	4%
Dietary Fiber 0g	0%
Sugars 12g	
Protein 9g	
Vitamin A 10% •	Vitamin C 0%
Calcium 30% •	Iron 0%
Vitamin D 25%	

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

INGREDIENTS: LOWFAT MILK, VITAMIN A PALMITATE, VITAMIN D3, LACTASE ENZYME*.

*NOT FOUND IN REGULAR MILK.

*Half Gallon

According to FDA regulations:

Sugar (singular) listed in the INGREDIENTS specifically refers to sucrose.

Sugars (plural) listed in the Nutrition Facts section are the total amounts of *any* type of sugar present.

Lesson Three

Where do calories come from in your diet??

Overview
Students examine food labels, calculate the percentage of calories from macromolecules (protein, fat, and carbohydrates), and determine durations of physical activity required for balancing calories consumed and calories burned. Students will also consider factors that contribute to a balanced diet for people with, and without, type 2 diabetes.

Enduring understandings:
- Type 2 diabetes can be prevented: factors contributing to a person's risk include good nutrition and exercise.
- In is important to balance energy consumed with energy burned, as well as knowing the relative value of the calories consumed.

Essential question:
Where do calories come from in your diet and what does this have to do with type 2 diabetes?

Learning objectives
Students will be able to:
- Calculate from food labels the percentage of calories derived from fat, carbohydrates and proteins in that food.
- Display the relative caloric percentages on a graph.
- Use on-line tools to analyze food labels and quantify exercise.

Prerequisite Knowledge
Prior understanding of macromolecules such as carbohydrates, proteins, and fats is helpful, but not necessary.

Time: One 50-minute period

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectation
HS LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy.

This lesson highlights the Practices of **Using Mathematics, Information, and Computer Technology, and Computational Thinking,** and the Crosscutting Concepts of **Scale, Proportion and Quantity**.

Materials

Materials	Quantity
Teacher *Copy Master* of blank bar graphs	1 per class
Computers for students with access to: • **SuperTracker**: www.supertracker.usda.gov/foodapedia.aspx • **Activity Calculator**: www.caloriecontrol.org/healthy-weight-tool-kit/lighten-up-and-get-moving	1 per student or group
A variety of food labels, including nutritional content	4 per student
Calculator	1 per student
Tape or glue	1 per group
Green, red, and purple markers	1 each per student
Student Resource Part A: *Calculating food labels* (can be copied back to back with Part B)	1 per group
Student Resource Part B: *Calculating physical activity*	1 per group
Student Sheet 3: *Balancing calories and exercise*	1 per student

Lesson Background and Preparation

- This lesson requires having a selection of food labels with nutritional information on hand for students to use. Ask students to bring in food labels from home, provide the labels for them, or make sure students have access to on-line nutritional information, such as through www.SuperTracker.usda.gov.

- This lesson focuses on the caloric contribution of different macromolecules in food and asks students to consider how much physical activity is needed to balance the caloric intake. If students haven't already learned about macromolecules in previous units, teachers may wish to teach about fats, proteins and carbohydrates, and their contributions to diet, role in the body, and how these macromolecules are stored. While helpful for the lesson, prior information about macromolecules is not crucial.

- While the balancing of "calories in = calories out" is a useful concept for students, it is helpful for students to know that not all calories are created equally. For example, 140 calories from a handful of nuts will digest slowly due to the fiber content, provide protein, and contribute to a feeling of fullness. 140 calories from a 12-oz can of sugared soda will dump 39 g of sugar into the blood stream without providing fiber or protein.

Presenting the Lesson

Remind students of the prior lesson which focused on carbohydrates. Tell students that carbohydrates are one type of ***macromolecule*** used by the body for fuel. Fats and proteins are also macromolecules that make up our food.

Procedures

Part 1 (Engage and Explain): Calories and Exercise (*10 minutes*)

Part A

1. Show students the collection of labels or food containers to be used in this lesson. Ask students, *"How can you tell what ingredients, nutrients and macromolecules foods contain?"* or *"How can you tell which foods are healthiest?"*

2. Pass out Student Resource Part A: *Calculating Food Labels.* This may be photocopied with Part B: *Calculating Exercise* on the back and reused from class to classes.

3. Tell students that they will be assessing the nutritional labels from different foods, and calculating the total number of calories from fats, carbohydrates, and proteins. They will then figure out how much physical activity is needed to balance the caloric intake from different foods.

4. Using the Student Resource as a guide, demonstrate for students how to convert the number of grams of fats, carbohydrates and proteins from a food label into calories.

   Grams of Fat x **9** cal/gram = _____ calories from fat

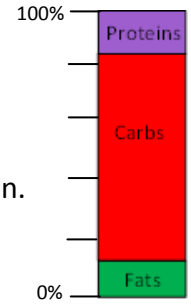
   Grams of Carbohydrate x **4** cal/gram = _____ calories from carbohydrates

   Grams of Protein x **4** cal/gram = _____ calories from proteins

   Total Calories: _____

5. Next, demonstrate for students how to find the relative percentage of calories that come from either fat, carbohydrates, or protein for that food.

$$\frac{\text{Number of [fat] calories}}{\text{Total calories}} \times 100 = \text{percent calories from [fat]}$$



6. Lastly, show students how to graphically represent the relative percentages of calories using the bar graph. Make sure that students know to use green for fat, red for carbohydrates and purple for protein.

Part B

7. Ask students, "How would you find out how many calories are in a McDonald's grilled chicken sandwich vs a McDonald's Big Mac?

8. Using Student Resource Part B: *Calculating Exercise,* demonstrate for students how to find the calories of each sandwich using the USDA's Food-A-Pedia section of the SuperTracker website (www.supertracker.usda.gov), as explained on the Student Resource.

Food-A-Pedia is useful for looking up nutritional values of foods that do not come packaged, such as fruits and vegetables. Encourage students to research these foods, too.

9. Next, demonstrate the Activity Calculator at www.caloriecontrol.org/healthy-weight-tool-kit/lighten-up-and-get-moving.

Note: Using the Activity Calculator, students may notice that a heavier person burns more calories than does a lighter person doing the same activity for the same amount of time. This is due to differences in ***basal metabolic rates***, or the number of calories required to sustain cellular respiration and bodily functions of a person when at rest. A heavier person requires more calories to maintain their weight, and burns more calories when exercising. As a person loses weight, their caloric needs decrease.

Part II (Explore): Balancing Calories and Exercise *(25 minutes)*

10. Pass out Student Sheet 3: *Balancing calories and exercise*. Let students work independently or in groups to record information from four different foods and calculate the amount of activity needed to burn off calories from various foods.

11. Using the copy master, provide additional bar graphs for each student to represent a different type of food they research. Challenge students to find foods that seem noteworthy or interesting (e.g., evenly distributed percentages, heavily unbalanced percentages, or particularly high or low caloric values).

12. After students have completed one bar graph to share with the class, have them fold back the bottom portion of the graph so that the name and calorie content of the food are not displayed. Have students post their graphs in a central location in the classroom.

13. Have students complete the questions on Student Sheet 3 as they proceed.

Part III (Evaluate): What food is that? *(10 minutes)*

14. As a class, consider all of the bar graphs posted in a central location. Find one with a predominant percentage of protein, for example, and ask student to predict what type of food it is.

15. Highlight a few more bar graph examples from which to make predictions before looking at the food name. It might be helpful to group similar-looking graphs into the same area, and then checking the food name to see how similar the types of foods are.

16. As a class, go over the answers to the questions on Student Sheet 3: *Balancing calories and exercise*.

    Part A: Do all calories in foods come from carbohydrates? If not, where else do calories in our food come from?

    No, not all calories in your diet come from carbohydrates. Fats and proteins also contribute calories. Each also contributes varying amounts of nutrients such as vitamins and minerals.

Part B:

4. What do you think happens to excess calories in all forms (i.e., carbohydrates fats, or protein) that are not burned during daily physical activity and metabolism?

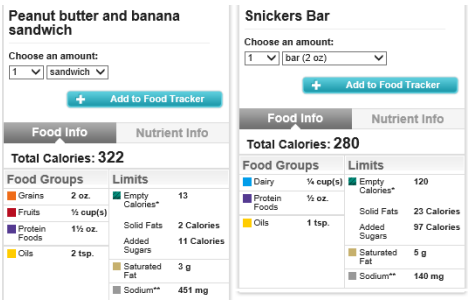
   Excess calories from carbohydrates that are consumed but not burned during metabolism of additional physical activity can be stored as glycogen in the liver or muscles, or stored in adipose tissue as fat. Excess fat could be stored in adipose tissue as fat. Excess protein is often eliminated from the body.

5. Based on your answer to the previous question, do you think it is important to be aware of the number of calories that you consume on a daily basis and whether you are getting a balanced diet of carbohydrates, fats and proteins? Why or why not?

   It is important to know your balance of calories consumed versus burned, and to be aware that excess calories in the form of carbohydrates, fat and proteins are not stored in the same way. It may also be important to know that different forms of exercise (e.g., exercise intensities) burn different energy storages (e.g., fat versus glycogen).

6. Explain the importance of balancing calorie intake and calories burned for someone who is pre-diabetic or has type 2 diabetes

7. Which snack would be a better choice? Give three reasons to support your answer.



While students might choose the Snickers Bar since it has fewer calories, it is important to note that the peanut butter sandwich 1) offers grains and fruit, both of which provide fiber which slows digestion and contributes to a feeling of fullness, 2) The sandwich has by far fewer empty calories, 3) The sandwich provides more protein. If students dig a bit deeper on Food-A-Pedia, the will find that the sandwich also provides more minerals and vitamins. However, the sandwich is much higher in sodium which could be noteworthy for certain groups of people, including diabetics.

Teacher Resource

A great resource for the role of micro-nutrients can be found at *The Linus Pauling Institute* at the University of Oregon: http://lpi.oregonstate.edu/

Part IV Closure *(8 minutes)*

17. Ask students how this lesson contributes to their understanding of the Driving Question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?***

18. Revisit the Question Wall to see if any questions have been answered or more questions need to be added.

19. Have students consider possible Call to Action product that might grow from this lesson. For example, students could:
    - Explore various dietary or food claims for accuracy.
    - Research important nutritional habits for maintaining glucose levels for people with diabetes and create a specialized nutritional map.
    - Track their own diet and exercise over time in order to evaluate their own health status and potential risk for type 2 diabetes.
    - Chart a change in diet over time for a specific cultural or ethnic group and resulting impacts on health.

    Resources to support students in their Call to Action can be found in the *Assessment* section at the end of the curriculum.

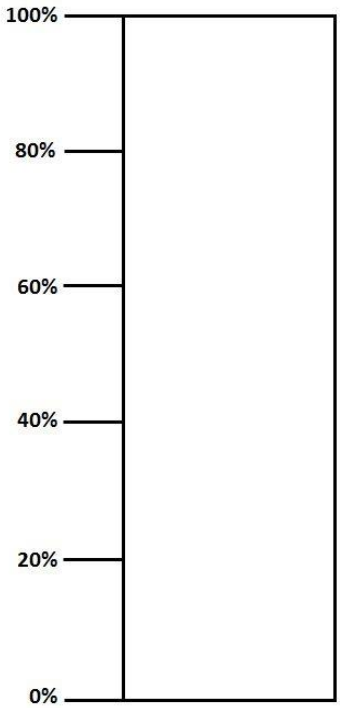
> ***Note:*** Students might also be interested to research where food labels come from, how food labels will change in the near future, who monitors them for accuracy, and what the acceptable margin of error is for the labels. It is interesting to note that although the labels are mandated by the FDA, the food company itself, not the FDA, is responsible for their accuracy. The law allows up to a 20% margin of error on food labels.

Glossary

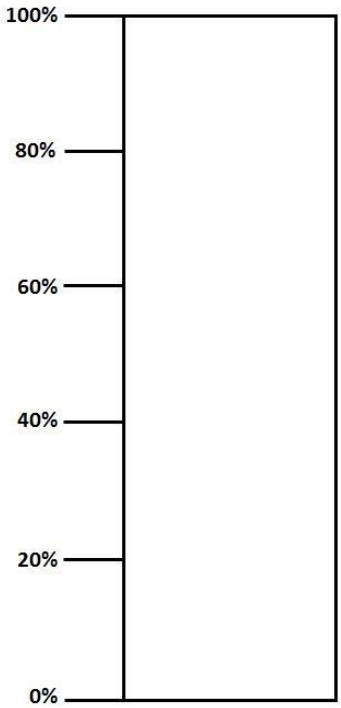
Basal metabolic rate: The rate at which an organism uses energy (burns calories) when at complete rest.

Copy Master

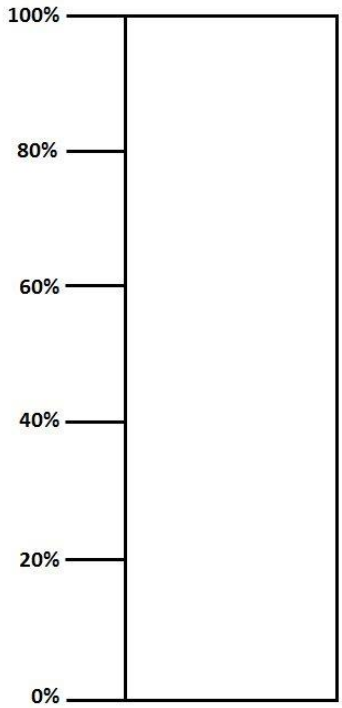
Additional bar graphs for representing percentages of food calories



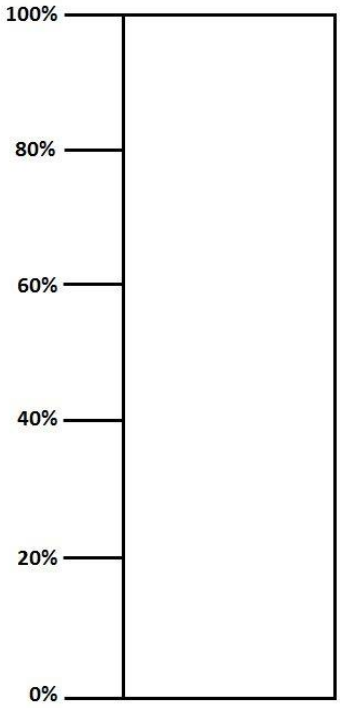
Name:
Total cal:



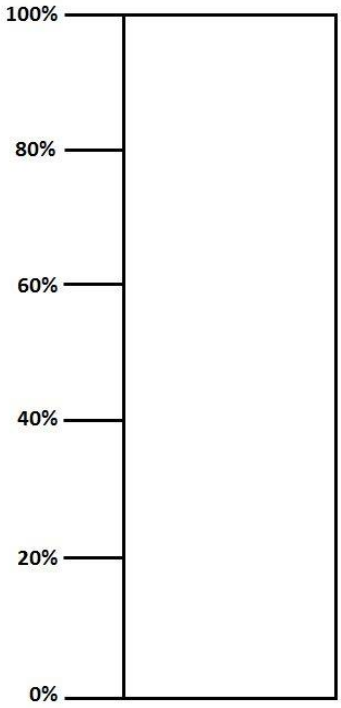
Name:
Total cal:



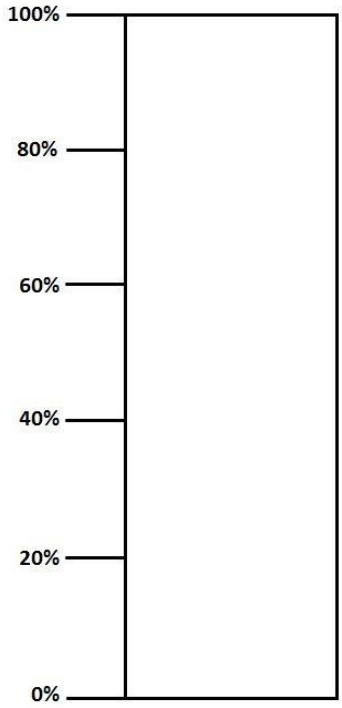
Name:
Total cal:



Name:
Total cal:



Name:
Total cal:



Name:
Total cal:

Part A Example: Calculating Food Labels

1. Using the above label, calculate the total calories in Green Giant Whole Kernel Sweet Corn

   a. Grams of Fat __1__ x 9 calories/gram = __9__ calories

   b. Grams of Carbohydrates __20__ x 4 calories/gram = __80__ calories

   c. Grams of Protein __2__ x 4 calories/gram = __8__ calories

   d. Total calories: __97__ calories

   Note: *the total calculated calories may not be identical to the label because grams of nutrients are rounded for label printing. Use your calculated number of calories to find the percentages of calories for each type of food, not the number from the label.*

2. Calculate the percent calories of each of the food types (fat, carbs, and protein):

   Remember: $\frac{\text{Part of calories}}{\text{Whole (total) calories}}$ X 100 = percentage

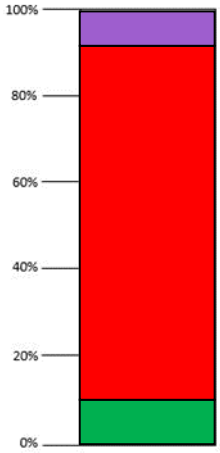
   a. % calories from fat = __9/97__ fat calories/total calories x 100 = __9.3__ %

   b. % calories from carbs = __80/97__ carb calories/total calories x 100 = __82.5__ %

   c. % calories from protein = __8/97__ protein calories/total calories x 100= __8.2__ %

3. Represent the percentages from Step 2 as a bar, as you see here. Label the name of the food and provide the total calories per serving. ***Note:*** make sure to use the following colors: fat (green), carbohydrates (red) and protein (purple).

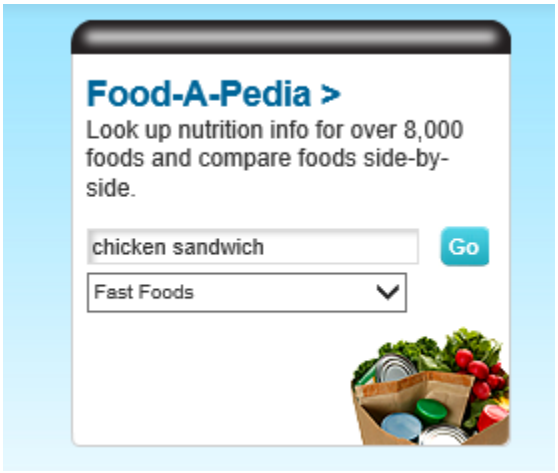
   Name: Sweet corn kernels, canned
   Calories: 97

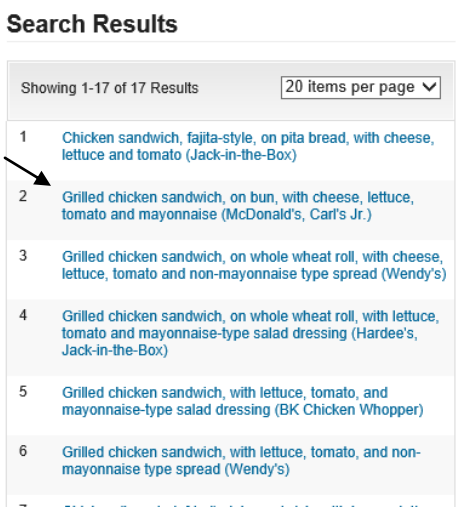


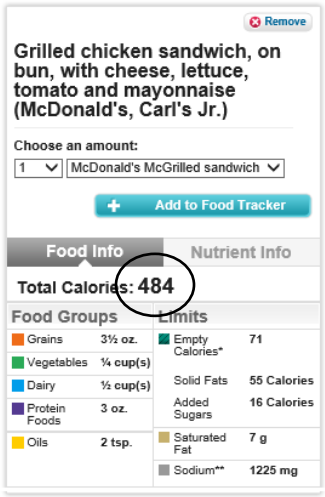
Part B Example: Calculating Physical Activity

1. How many calories are in a McDonald's Grilled Chicken Sandwich vs. a McDonald's Big Mac?

   Go to: www.supertracker.usda.gov and enter the food category and type into Food-A-Pedia. Enter the type of food from the drop-down menu, and then enter the type of food. Next, choose the correct food from the search results:



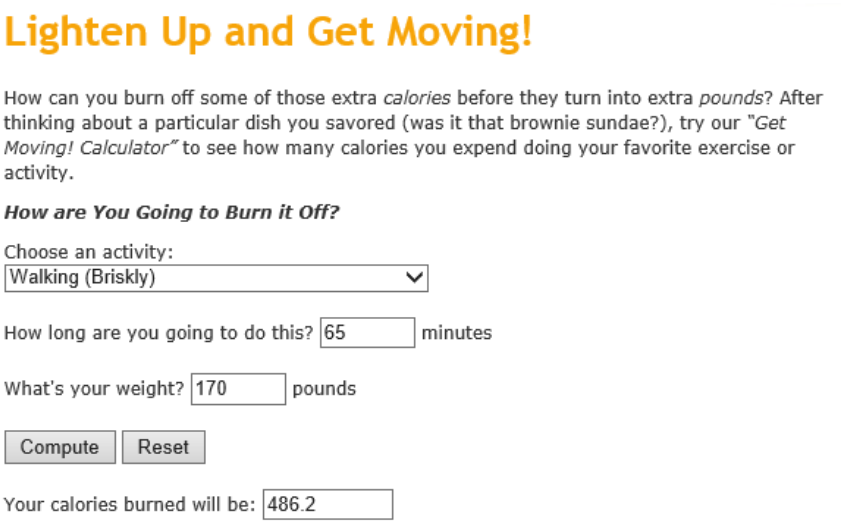




   - McDonald's Grilled Chicken Sandwich: 484 calories
   - McDonald's Big Mac: 585 calories

2. How long you would need to burn off the calories in the McDonald's Grilled Chicken Sandwich vs. the McDonald's Big Mac?

   Go to the Activity Calculator at: www.caloriecontrol.org/healthy-weight-tool-kit/lighten-up-and-get-moving: Choose your favorite physical activity, and determine the duration of activity needed to burn off the calories for each meal.



For example, a 170-pound person would need to walk briskly for just over an hour to burn 486 calories—enough for the Grilled Chicken Sandwich.

Name: _____ **Date:** _____ **Period:** _____

Part A: Using food labels or Food-A-Pedia (www.supertracker.usda.gov/foodapedia.aspx) choose four different foods to compare. Complete the calculations and fill out the bar graph.

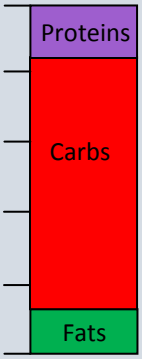
Things to remember…

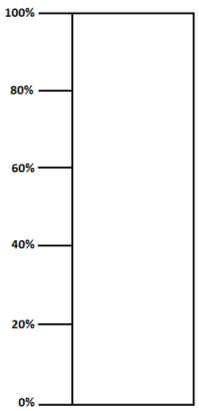
Grams of Fat x **9** cal/gram = _____ calories from Fat

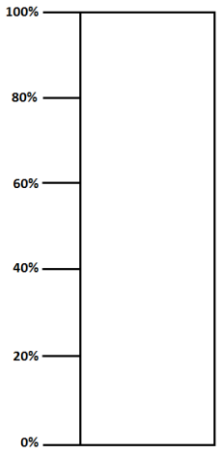
Grams of Carbohydrate x **4** cal/gram = _____ calories from Carbohydrates

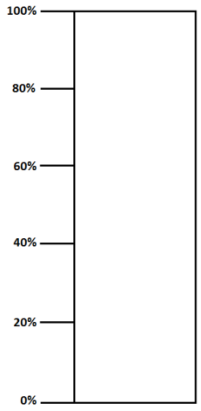
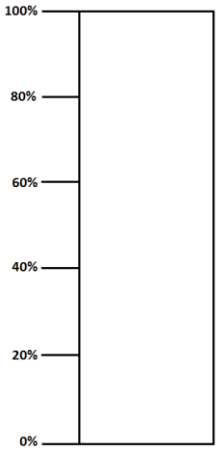
Grams of Protein x **4** cal/gram = _____ calories from Proteins

$$\frac{\text{Part of calories}}{\text{Total calories}} \times 100 = \text{percent calories}$$



Food #1:		**Total Calories:**	
From the label…	*Calculate the…*	*Calculate the…*	
Grams of Fat:	Calories From Fat:	% calories from Fat:	
Grams of Carbs:	Calories from Carbs:	% calories from Carbs:	
Grams of Protein:	Calories from Protein:	% calories from Protein:	
	Total calories:		

Food #2:		**Total Calories:**	
From the label…	*Calculate the…*	*Calculate the…*	
Grams of Fat:	Calories From Fat:	% calories from Fat:	
Grams of Carbs:	Calories from Carbs:	% calories from Carbs:	
Grams of Protein:	Calories from Protein:	% calories from Protein:	
	Total calories:		

Food #3:		**Total Calories:**	
From the label… Grams of Fat: Grams of Carbs: Grams of Protein:	*Calculate the…* Calories From Fat: Calories from Carbs: Calories from Protein: Total calories:	*Calculate the…* % calories from Fat: % calories from Carbs: % calories from Protein:	
Food #4:		**Total Calories:**	
From the label… Grams of Fat: Grams of Carbs: Grams of Protein:	*Calculate the…* Calories From Fat: Calories from Carbs: Calories from Protein: Total calories:	*Calculate the…* % calories from Fat: % calories from Carbs: % calories from Protein:	

Do all calories in foods come from carbohydrates (e.g., glucose)? If not, where else do calories in our food come from?

Name: _____ **Date:** _____ **Period:** _____

Part B:

1. Using the Activity Calculator found at www.caloriecontrol.org/healthy-weight-tool-kit/lighten-up-and-get-moving, choose your favorite physical activity, and determine how long you would need to participate in this activity to burn off the calories from one of the foods you chose in Part A.

    - Name of food:
    - Activity chosen:
    - Duration of activity needed to burn of the calories in the food:

2. Choose two snacks from the vending machine or from your home, and use Food-A-Pedia: www.supertracker.usda.gov/foodapedia.aspx or the labels to determine how many calories are in each of these snacks.

    Food-A-Pedia is useful for looking up nutritional values of unprocessed foods that do not come packaged, such as fruits and vegetables. How about including a piece of fruit or vegetable as a snack?

    - Snack #1 _____: _____ calories
    - Snack #2 _____: _____ calories

3. Using the Activity Calculator: www.caloriecontrol.org/healthy-weight-tool-kit/lighten-up-and-get-moving: Choose a physical activity, and determine how long you would need to participate in this activity to burn off the calories from each of the two snacks.

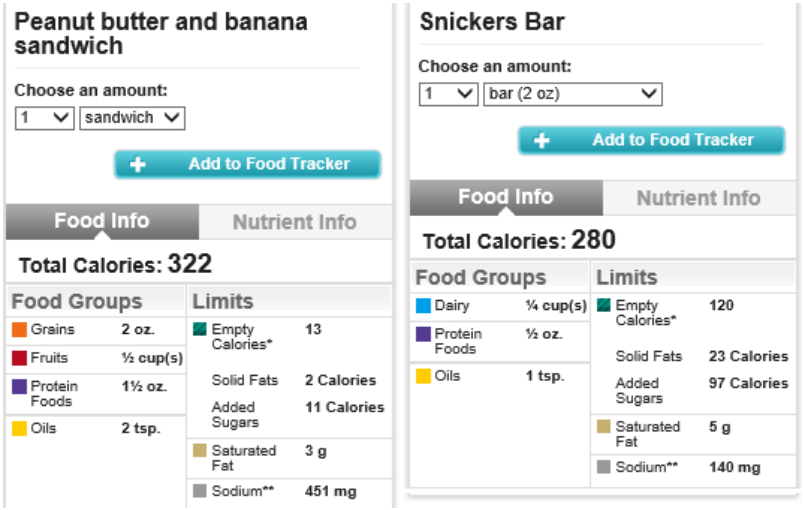
    - Activity chosen: _____
    - Duration of activity needed to burn of the calories in:
        - Snack #1 _____: _____
        - Snack #2 _____: _____

4. What do you think happens to excess calories (i.e., carbohydrates fats, or protein) that are not consumed (i.e., burned) during daily physical activity and metabolism?

5. Based on your answer to question 4, do you think it is important to be aware of the number of calories that you consume on a daily basis and whether you are getting a balanced diet of carbohydrates, fats and proteins? Why or why not?

6. Explain the importance of balancing calorie intake and calories burned for someone who is pre-diabetic or has type 2 diabetes

7. Which snack would be a better choice? Give three reasons to support your answer.



Peanut butter and banana sandwich

Choose an amount: 1 sandwich

+ Add to Food Tracker

Food Info | Nutrient Info

Total Calories: 322

Food Groups		Limits	
Grains	2 oz.	Empty Calories*	13
Fruits	½ cup(s)	Solid Fats	2 Calories
Protein Foods	1½ oz.	Added Sugars	11 Calories
Oils	2 tsp.	Saturated Fat	3 g
		Sodium**	451 mg

Snickers Bar

Choose an amount: 1 bar (2 oz)

+ Add to Food Tracker

Food Info | Nutrient Info

Total Calories: 280

Food Groups		Limits	
Dairy	¼ cup(s)	Empty Calories*	120
Protein Foods	½ oz.	Solid Fats	23 Calories
Oils	1 tsp.	Added Sugars	97 Calories
		Saturated Fat	5 g
		Sodium**	140 mg

* Calories from food components such as added sugars and solid fats that provide little nutritional value. Empty Calories are part of Total Calories.

Lesson Four

Glucose in balance

Overview
Students model blood glucose homeostasis using a game board and pasta pieces to simulate how blood glucose levels are regulated by the hormones insulin and glucagon, and how the liver, fat cells, muscle and brain play a role in blood glucose homeostasis. Using their models, students first explore how blood glucose levels in healthy individuals are affected by eating and fasting. They then model how insulin resistance leads to elevated blood glucose levels, and predict the effects of β cell damage, exercise, and medication on blood glucose levels. Students also discuss the limitations of using a model to show relationships and connections within complex systems.

Enduring understanding: Blood glucose levels need to be maintained within specific ranges, and body systems work together to maintain this range through the process of homeostasis. Type 2 diabetes can develop over time if the mechanisms that maintain blood glucose levels are challenged and eventually fail.

Essential question: How do our body systems work together to maintain balanced glucose levels, and how does type 2 diabetes develop when this balance is upset?

Learning objectives
Students will be able to:
- Model the mechanism for maintaining glucose balance.
- Predict how insulin resistance, exercise, medication and β cell damage may affect type 2 diabetes.

Prerequisite Knowledge
Students should have an understanding of the following terms: cell, tissue, organ, glucose, fat, protein, hormone.

Time: Approximately 90 minutes

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectations
HS LS1-3 Conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
HS LS1-2 Use a model to illustrate the hierarchical organizations of interacting systems that provide specific functions.

HS LS1.A Disciplinary Core Idea
Structure and Function: Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range.

This lesson highlights the Practices of **Using Models, Interpreting Data** and the Crosscutting Concept of **System Models**.

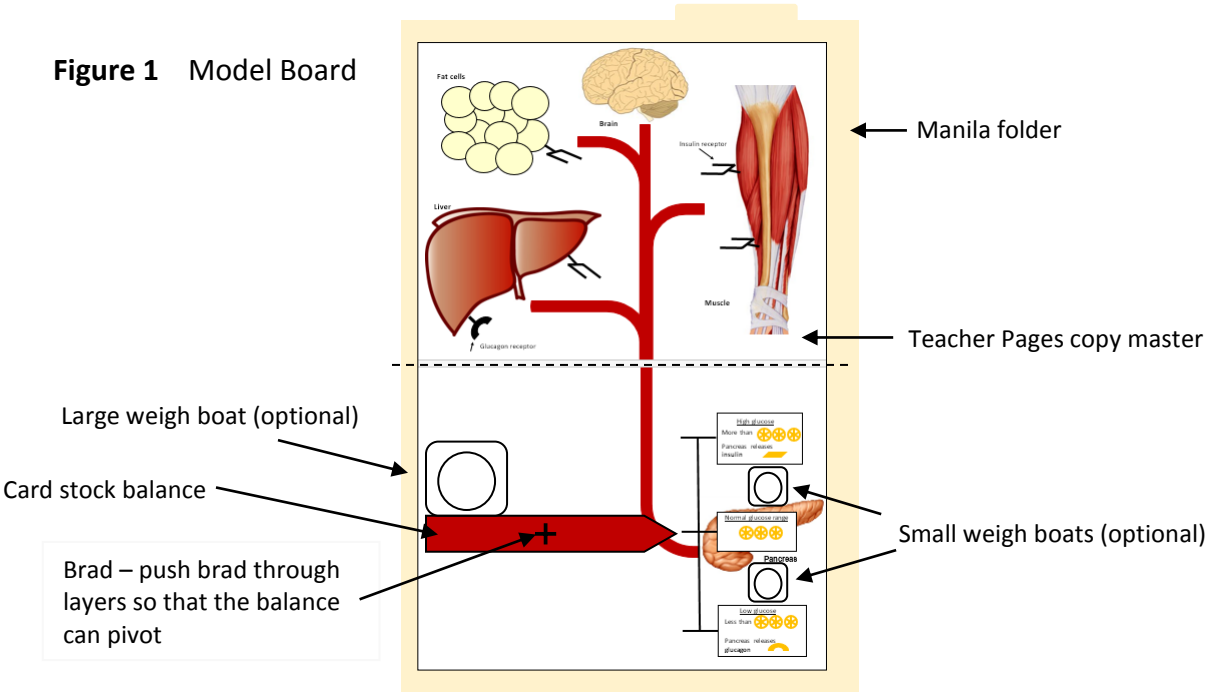
Materials

Materials	Quantity
Computer and projector, or 1 computer per student pair	1 per class or pair
PowerPoint presentation found at http://gsoutreach.gs.washington.edu/ (see GEM Instructional Materials)	1 per class
Model set (see Figure 1) Each set contains: 1 Manila folder 1 2-page photocopy of model board 1 brad 1 balance made from red card stock, approximately 7.5 in x 1 in, and pointed at one end. Teachers may wish to write the word "homeostasis" on the balance to underscore the concept. 20 pieces of wheel-shaped (rotelle) pasta to represent glucose 20 pieces of I-shaped (penne) pasta to represent insulin 10 pieces of curvy-shaped (macaroni) pasta to represent glucagon 1 small sticky note cut into 4 strips, each with a sticky end Optional: 2 small weigh boats, and 1 large weigh boats to hold pasta	1 per group
Student Sheet 4	1 per student
Optional: A helpful, and surprising, visual for this lesson includes: • Container(s) to hold 5 liters of liquid, preferably red, representing the approximate amount of blood adults have in their bodies. • 1 baggie with 4 g of sugar in it, representing the approximate amount of blood glucose a healthy adult would have when waking in the morning (80 mg/dl). • 1 baggie with 16 g of sugar in it, representing very high blood glucose levels of a person with diabetes (320 mg/dl). • 1 baggie with 65 g of sugar in it, representing the amount of sugar in one 20 ounce Coca-Cola.	1 per class

Lesson Preparation

- The PowerPoint presentation for this lesson is integral to the lesson. If possible, the PPT should be loaded onto student computers so that student groups can proceed at their own pace, with stopping points built in for teachers to check for understanding. If student computers are not available, the teacher may direct the lesson with the whole class.
- Photocopy Student Sheet 4 for each student.
- Make enough model boards for each group, as shown in Figure 1. Add the correct number of pasta pieces and sticky notes.
- Make up the baggies containing sugar and containers with liquid, if showing the optional visual model for this lesson.

Figure 1 Model Board



Presenting the Lesson

Tell students that they will be learning about the biological mechanism of type 2 diabetes in this lesson by working with a model. Models can be useful to show relationships and connections within complex systems. However, every model has limitations, especially a model that works to simplify a very complex system. Some limitations of this model are, for example, that it focuses on only a few cell types even though every cell can use glucose for energy. In addition, the role of fats and triglycerides is not well-addressed, nor are the model pieces to scale. Tell students that they will have a chance to address any other limitations of the model at the end of the lesson.

Procedures

Part 1 (Engage): Life in Balance (*5 minutes*)

1. If the concept of ***homeostasis*** is new for students, begin the class with a discussion about balance.

2. Have a student volunteer stand up and stand on one leg. Ask students to make observations about the student. What does it take to stay in balance?

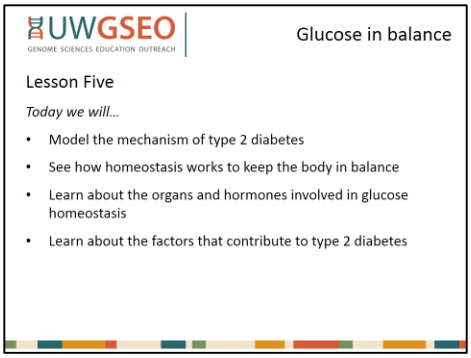
3. Throw the student a tennis ball. Ask students to think about all of the different cells, organs and body systems working to keep the student upright.

4. Tell students that all living things have feedback mechanisms that allow them to cope with changing environmental conditions. ***Homeostasis*** is the ability of an organism to adjust its internal environment to maintain stability, or balance, even as the external environment changes.

Part 2 (Explain): Who's who of diabetes (*20 minutes*)

5. Show students the first slide of the PowerPoint presentation and go over the goals of the lesson.

Slide 1

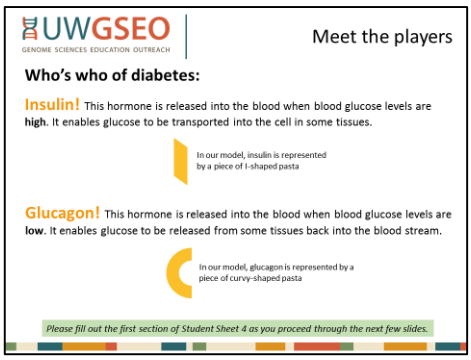


6. Pass out *Student Sheet 4* for students to take notes on during the lesson

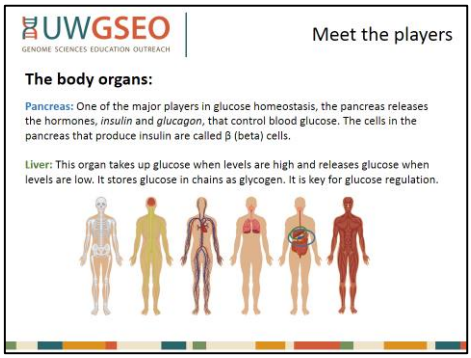
7. Let students proceed through slides 2 through 9.

Slide 2

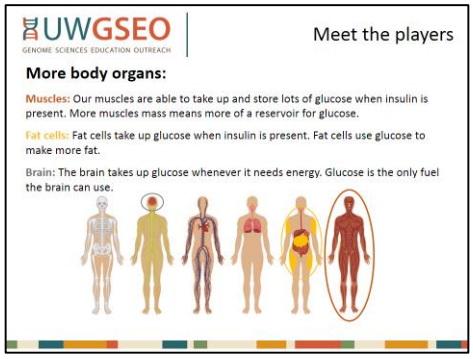
Slide 3



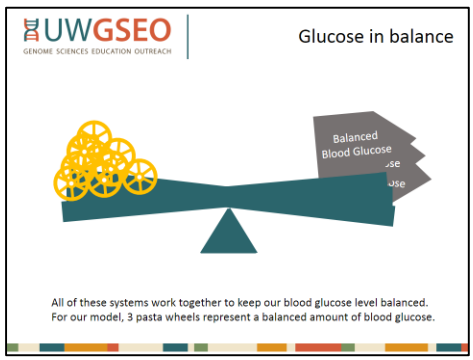
Slide 4



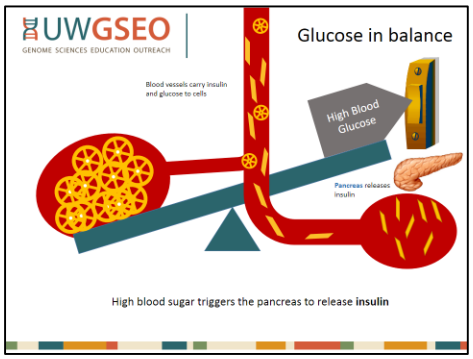
Slide 5

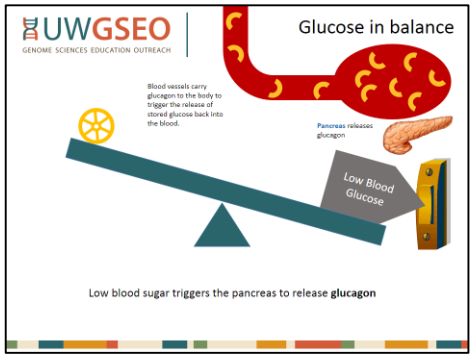


Slide 6

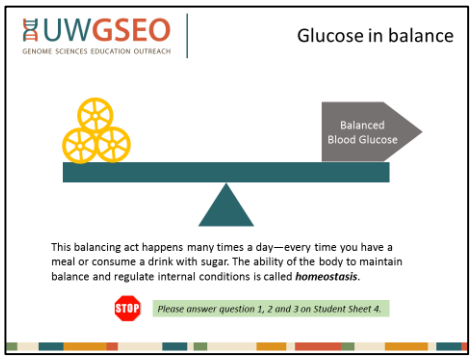


Slide 7





Slide 8



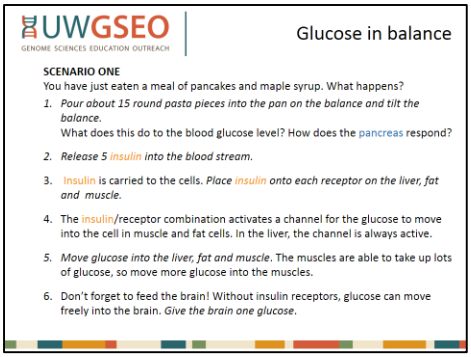
Slide 9

Part 3 (Explore): Glucose in and out of balance (*30 minutes*)

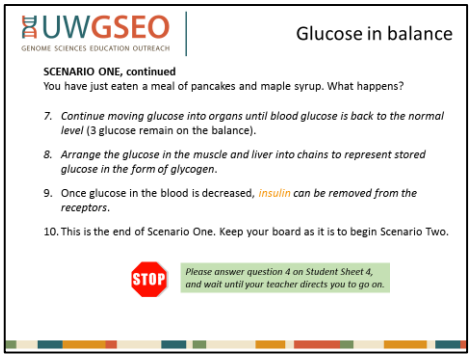
8. Hand out the model boards to each student group of 2-3 students. Make sure that students have a supply of the three types of pasta (rotelle, penne and macaroni).

9. Check for student understanding of the previous slides and let students explore the balance mechanism of their game boards.

10. Have students progress through Scenario One using Slides 10 and 11.

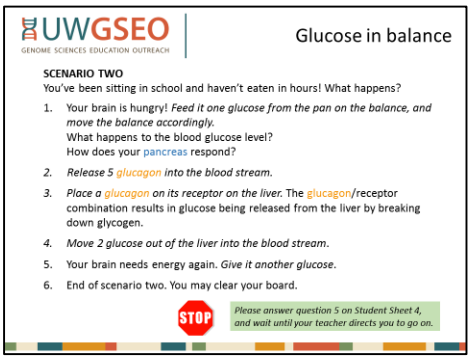


Slide 10



Slide 11

11. Check for understanding of Scenario One and proceed to Scenario Two on Slide 12.



Slide 12

12. Show students the *first step* of Slide 13 (black line only), which illustrates the normal fluctuations in glucose. Use the following prompts to have students make predictions (in pencil) on *Student Sheet 4* about how insulin and glucagon might respond after a healthy individual eats a meal.

    - For the blood glucose line, in **black**:
      What are normal levels of fasting blood glucose? *Between 80 – 90 mg/dL.*
      About how long are glucose levels elevated after a meal? *About two hours.*

      The next line will show insulin. What do you predict the line will look like?
      It should go up when blood glucose goes up, and go down when blood glucose goes down.

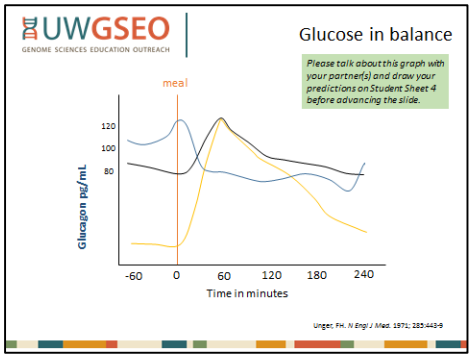
    - For the insulin level line, in **gold**:
      Does the line show what you predicted it would? Why or why not?

      The next line will show glucagon. What do you predict the line will look like?
      It should go up when blood glucose in low, and go down when blood glucose is high (i.e. inverse relationship).

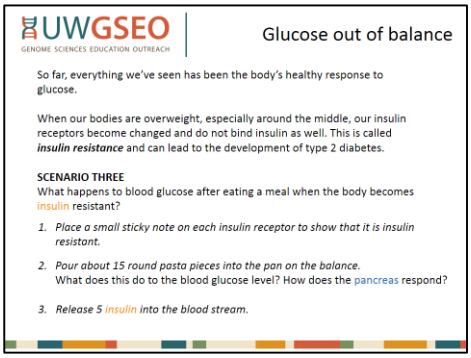
    - For the glucagon level line, in **blue:**
      Does the line show what you predicted it would? Why or why not?

    If student predictions are not very accurate, have them re-draw the three lines on *Student Sheet 4* to show the correct relationships. Point out for students that the even though glucose, insulin and glucagon are shown on the same graph at the same scale, they are all measured in different units.

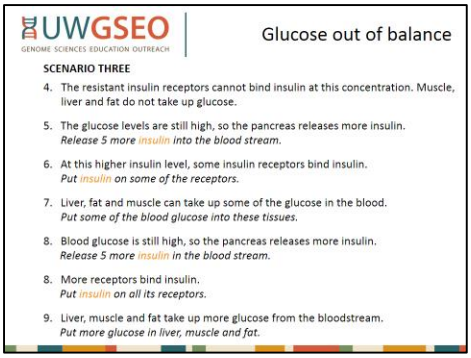
Slide 13



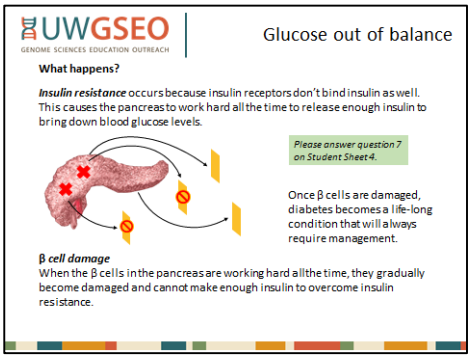
13. Go through Slides 14 through 18, either as a class or in small groups, discussing Scenario Three, insulin resistance and β cell damage, and the ways in which prediabetes and diabetes are defined and diagnosed.



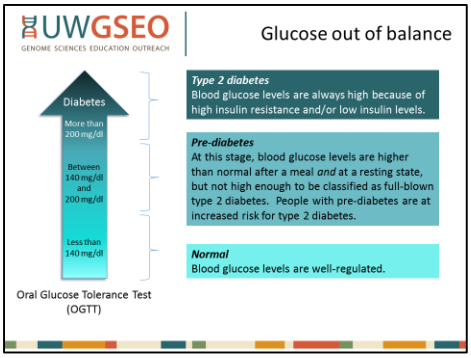
Slide 14



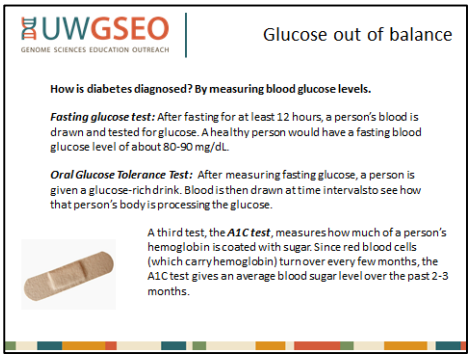
Slide 15



Slide 16

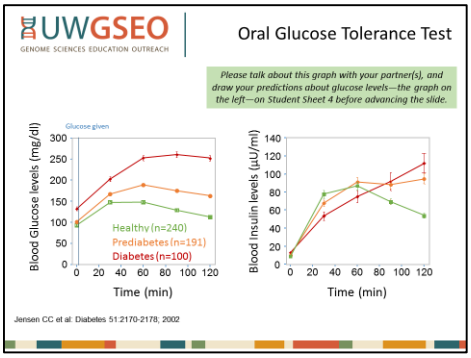


Slide 17



Slide 18

14. For Slide 19, again make sure students pause between each step of the animation to predict blood glucose levels for individuals who are healthy, have prediabetes, and have diabetes. Students can make predictions using *Student Sheet 4*. If their predictions are incorrect, make sure that they correct their graphs in order to have accurate information.

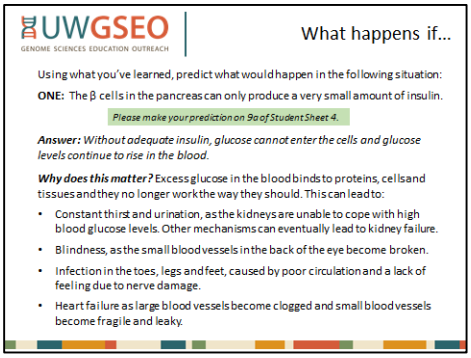


Slide 19

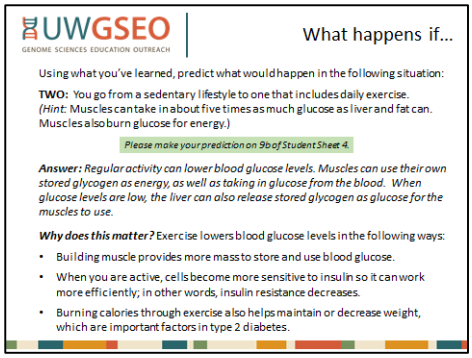
Note: This is a good place to show students the visual representation of normal and high levels of blood sugar using the baggies and 5 L of liquid (see the ***Materials*** section). 80 mg/dl translates to 4 grams of sugar in 5 liters of liquid (the approximate amount of blood in an adult). Students can also compare this to the amount of sugar in a 20-oz Coca-Cola.

Part 4 (Elaborate/Evaluate): What happens if…? (*25 minutes*)

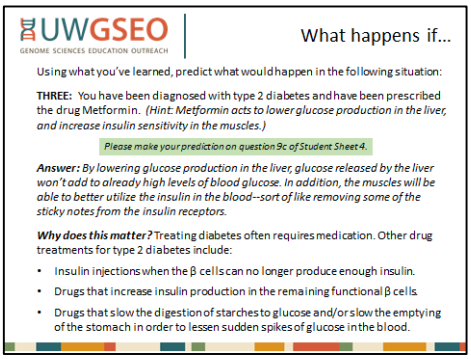
15. Slides 20 through 23 can be used in a number of ways (see note below). They challenge students to use what they have learned to predict how the body would react in three different situations— if β cells are damaged, if a person exercises, or if a person is put on diabetes medication. Additional information about symptoms of type 2 diabetes for each circumstance is provided for each situation.



Slide 20



Slide 21



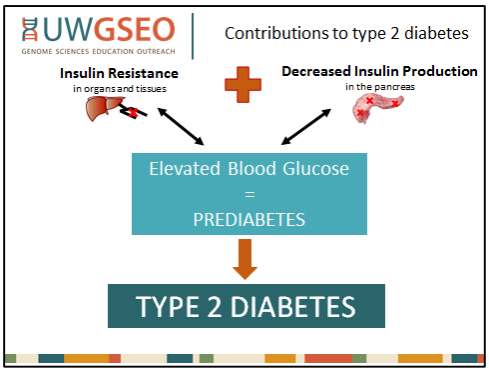
Slide 22

Note: Teachers could use these scenarios in a number of ways, such as going through each slide as a class, assigning scenarios to different groups and having them report back to the class, or assigning scenario(s) for homework with follow up the next class period.

Closure The Big Picture (*5 minutes*)

16. Close the class by showing Slide 23. Some important points to make are:
    - *Insulin resistance* and *decreased insulin production* are interconnected processes that lead to type 2 diabetes.
    - Both processes can be affected by environmental and genetic influences. For example, a person may be genetically predisposed to have β cell damage.
    - Lifestyle changes that lead to increased exercise and/or weight control can have a major impact in reversing prediabetes (point out reversible arrows).
    - Once type 2 diabetes is diagnosed, it can be controlled and managed, but not "cured" as yet (point out the one-way arrow).
    - Especially if caught early, prediabetes and type 2 diabetes are preventable and/or treatable.

Slide 23



17. Give students a chance identify any limitations to the model they used today.

Call to Action Product

17. Ask students how this lesson contributes to their understanding of the Driving Question**: How can the growth of type 2 diabetes in the Yakima Valley be slowed?**

18. Look through the questions currently on the Question Wall to identify questions that have been answered by today's lesson and can help students in their Call to Action product.

19. Ask students if they have any new questions to add to the Question Wall.

20. Let students know that no matter the specific topic or focus of their Call to Action product, each student will need to have a solid understanding of the roles of glucose, insulin, glucagon in blood glucose homeostasis.

Glossary

Glucose: A simple, single-ring sugar that serves as the main source of energy for most living things.

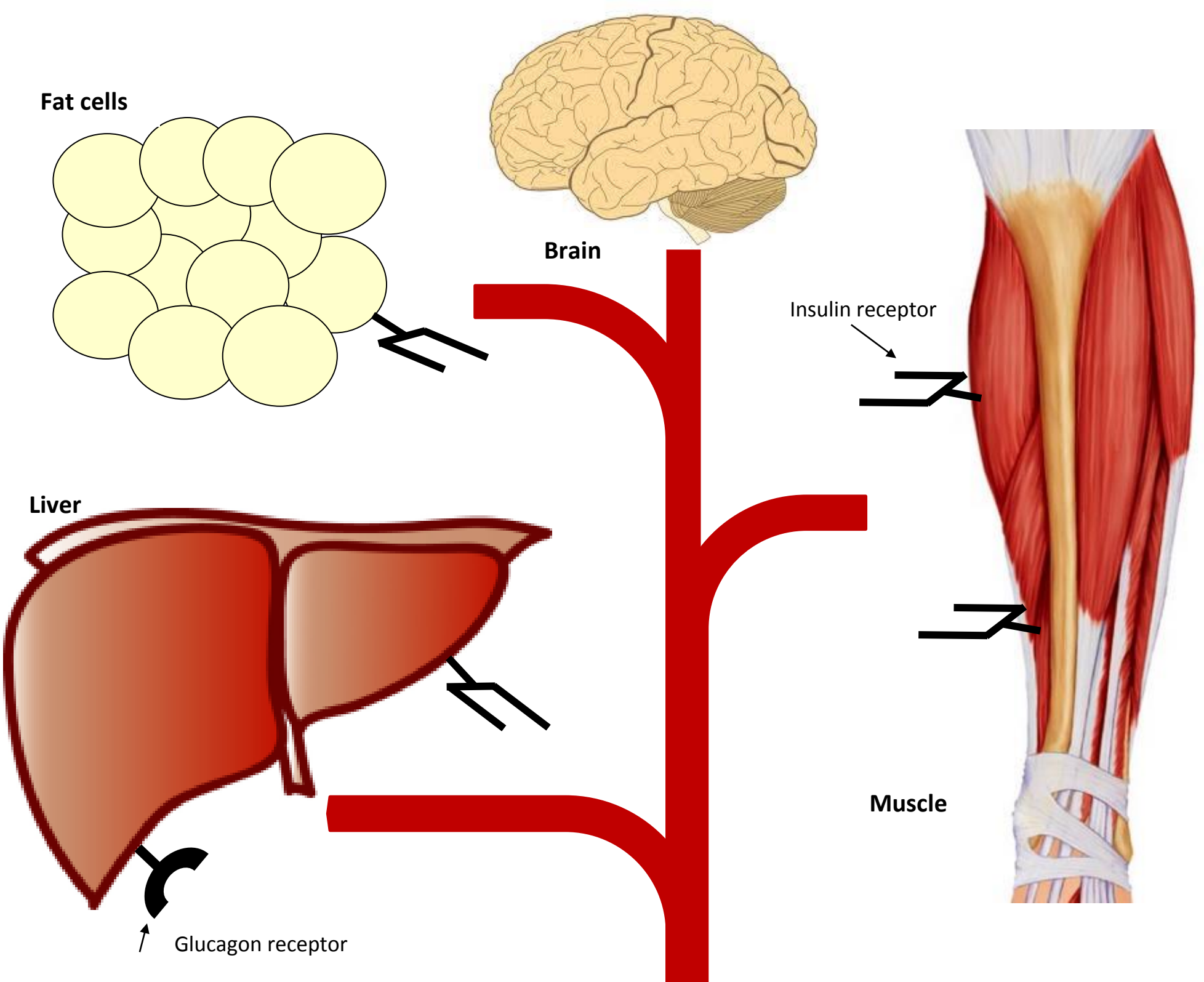
Insulin: A hormone made by the beta cells of the pancreas to regulate the amount of glucose in the blood.

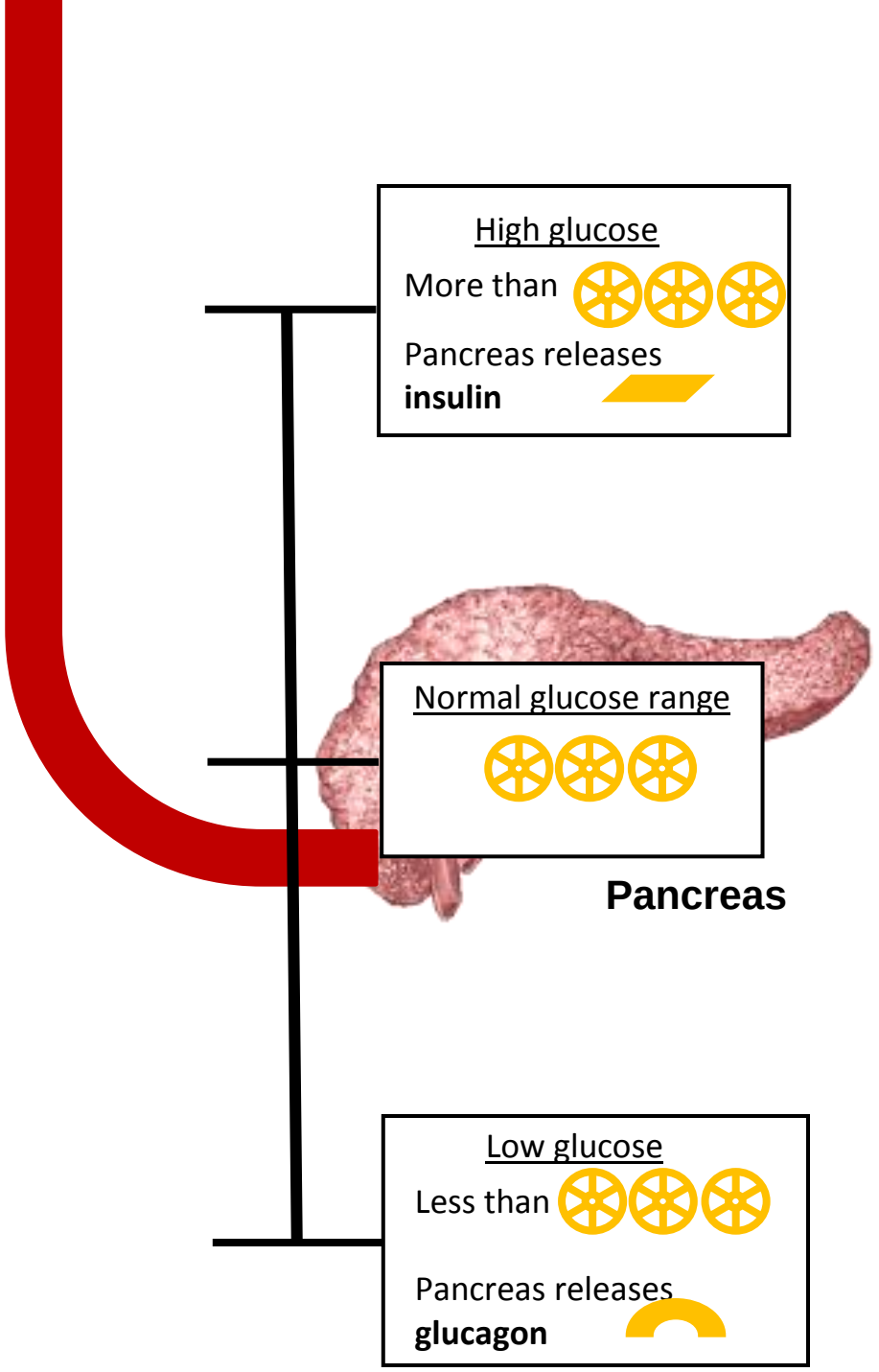
Glycogen: A storage form of glucose produced mainly in the liver and muscle cells.

Glucagon: A hormone made by the pancreas in response to a fall in blood glucose levels.

Beta cell (β cell): A type of cell in the pancreas that makes and secretes insulin.

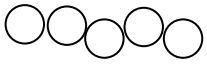
Homeostasis: The ability to maintain a living system's internal conditions within certain limits even as external conditions change within some range, often involving feedback mechanisms.


Fat cells
Brain
Insulin receptor
Liver
Muscle
Glucagon receptor


High glucose
More than
Pancreas releases
insulin
Normal glucose range
Pancreas
Low glucose
Less than
Pancreas releases
glucagon

POSSIBLE ANSWERS to Student Sheet 4

Meet the Players:

Player	Game piece	Function
Glucose		*Blood sugar, used as energy*
Glycogen		*Stored glucose, made of many units of glucose*
Insulin		*Hormone allows glucose storage*
Glucagon		*Hormone allows glucose to be released*

Organ	Role
Pancreas	*Makes and releases insulin and glucagon. Has β cells, which make insulin.*
Liver	*Regulates glucose levels in blood by both taking up and releasing glucose*
Muscles	*Can take up lots of glucose from the blood, use glucose, and store glucose*
Fat cells	*Can take glucose into the fat cell when glucose in present*
Brain	*Uses glucose for fuel; does not need insulin*

Glucose in Balance

1. When our blood glucose is high, the ___***pancreas***___ releases ____***insulin***_____.

2. When our blood glucose is low, the ___***pancreas***____ releases ____***glucagon*** ____.

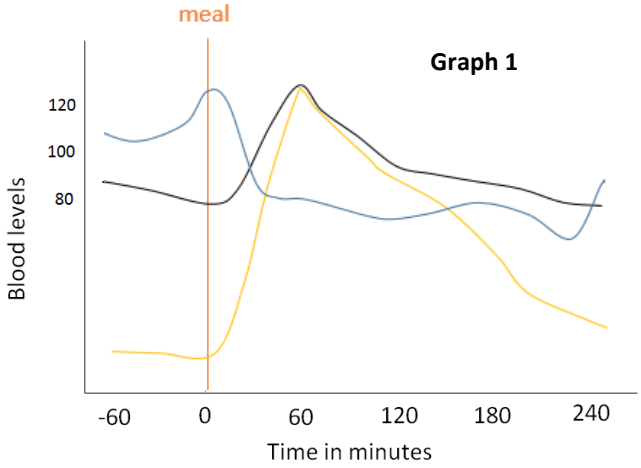
3. Define homeostasis:
The ability of the body to maintain balance and regulate internal conditions.

4. Summarize what happens in the body in scenario **one** (after a meal).
Digestion releases glucose into the blood stream. Glucose levels become high, so the pancreas releases insulin. Insulin in receptors allows muscle, liver and fat to take up and store glucose.

5. Summarize what happens in scenario **two** (after not eating).
Low blood glucose levels trigger the release of glucagon from the pancreas. The liver receives the glucagon message and releases stored glucose into the blood.

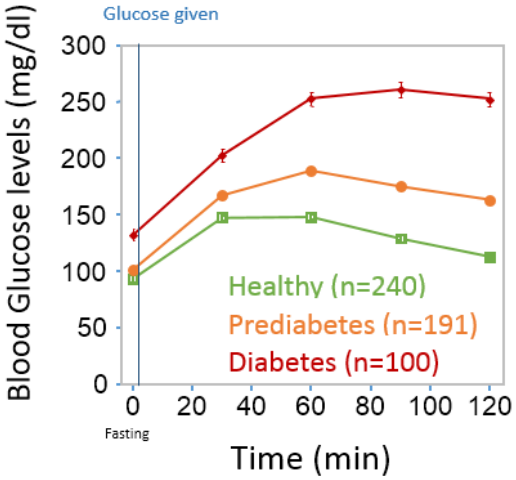
Teacher Pages

6. On the **Graph 1** to the right, blood glucose levels are shown.
   a) Draw in the line you think will best represent ***insulin*** levels
   b) Draw in the line you think will best represent ***glucagon*** levels for a healthy person.



Glucose out of balance

7. Why does one develop type 2 diabetes?
   Insulin resistance (body requires higher levels of insulin to trigger receptors to take up glucose) and beta cell damage (the pancreas cannot produce adequate levels of insulin).



Graph 2

8. 8. On the **Graph 2** to the left, draw the line that best represents ***blood glucose*** levels after eating for:
   a) a person who is healthy
   b) a person who is prediabetic
   c) a person who is diabetic.

9. What happens if…
   a) **ONE:** The β cells in the pancreas can only produce a very small amount of insulin.
   Blood glucose stays high, which leads to complications like blindness, heart disease, amputations, and constant thirst and urination.

   b) **TWO:** You go from a sedentary lifestyle to one that includes daily exercise.
   Exercise decreases blood glucose levels because muscles use blood glucose to work, plus muscles can store lots of glucose so building muscle builds places for glucose storage. Exercise also helps burn calories which can control weight.

   c) **THREE:** You have been diagnosed with type 2 diabetes and have been prescribed the drug Metformin
   Metformin controls blood sugar by not allowing as much stored glucose to be released by the liver. It also allows muscles to take up more glucose.

Name: _____ Date: _____ Period: _____

Meet the Players:

Player	Game piece	Function
Glucose		
Glycogen		
Insulin		
Glucagon		
Organ	**Role**	
Pancreas		
Liver		
Muscles		
Fat cells		
Brain		

Glucose in Balance

1. When our blood glucose is high, the _____ releases _____.

2. When our blood glucose is low, the _____ releases _____.

3. Define homeostasis:

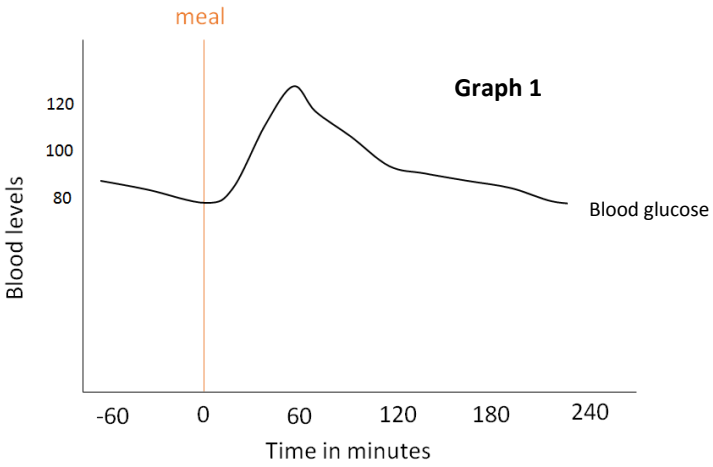
4. Summarize what happens in the body in scenario **one** (after a meal).

5. Summarize what happens in scenario **two** (after not eating).

Lesson Four: *Glucose in balance*

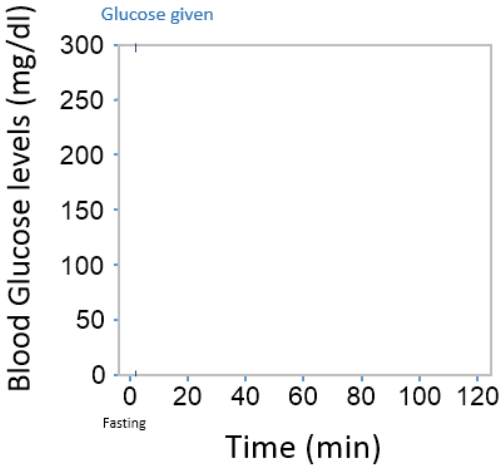
6. On the **Graph 1** to the right, blood glucose levels are shown.
   a) Draw in the line you think will best represent ***insulin*** levels

   b) Draw in the line you think will best represent ***glucagon*** levels for a healthy person.



Glucose out of balance

7. Why does one develop type 2 diabetes?



Graph 2

8. 8. On the **Graph 2** to the left, draw the line that best represents ***blood glucose*** levels after eating for:

   a) a person who is healthy

   b) a person who is prediabetic

   c) a person who is diabetic.

9. What happens if…
   a) **ONE:** The β cells in the pancreas can only produce a very small amount of insulin.

   b) **TWO:** You go from a sedentary lifestyle to one that includes daily exercise.

   c) **THREE:** You have been diagnosed with type 2 diabetes and have been prescribed the drug Metformin

Continue on another sheet of paper, if needed

Lesson Five

Anatomy and physiology of type 2 diabetes

Overview
Students develop a detailed human body poster that shows the many organs and body systems impacted by type 2 diabetes and learn about the damage done to each of those organs. They also learn about treatments for type 2 diabetes and their physiological targets.

Enduring understanding: If left untreated, type 2 diabetes (chronic elevated blood glucose) has devastating effects on many organs of the body and can lead to death. In the face of the growing epidemic, it is critical that we address ways to treat and prevent type 2 diabetes.

Essential question: What are the effects of type 2 diabetes on the body, and how can we treat these effects?

Learning objectives
Students will be able to:

- Create a human body poster that shows organs affected and damaged by type 2 diabetes.
- Explain treatment/prevention options for type 2 diabetes
- Evaluate the relative costs of diabetes prevention and diabetes treatment

Prerequisite Knowledge
Students should be familiar with the human body systems (circulatory, digestive, nervous) and body organs (heart, eye, kidney, stomach, intestines, pancreas, liver)

Time: Two 50 minute periods

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectation
HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Disciplinary Core Idea LS1.A: Structure and Function
Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.

This lesson uses the Scientific Practices of **Developing and Using Models** and **Obtaining, Evaluating and Communicating Information**. It also highlights the Crosscutting Concept of **Cause and Effect**, and **Structure and Function**.

Materials

Materials	Quantity
Computer and projector	1 per class
Lesson 5 PowerPoint presentation, found at: https://gsoutreach.gs.washington.edu/	1 per class
Computer and internet access	Per group
Large piece of butcher block paper, big enough to make a life-sized body outline of a student	1 per class
5 colors of construction paper, one for each body group (heart, brain, eyes, kidneys, and limbs)	1 color per group
Student Sheet 5: *Organs affected by type 2 diabetes* (two-sided)	1 per student
Student Resource: *On-line Reference Guide* (this could be cut into strips)	1 per group

Lesson Preparation

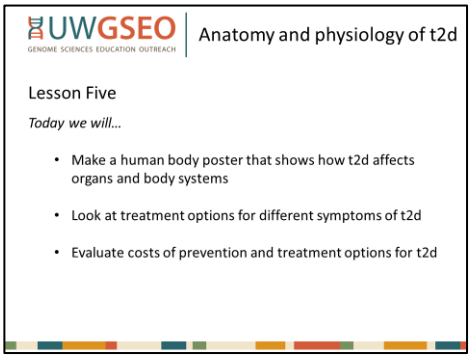
- Prepare a life-sized body outline before class, or have butcher paper available to do so at the beginning of class by tracing a student.
- Make sure that students have access to computers and the internet.
- Have Lesson 5 PowerPoint presentation ready to be projected.

Presenting the Lesson

Part 1 (Engage): Type 2 diabetes: a growing epidemic (*10 minutes*)

1. Show students PowerPoint Slide 1 to introduce the lesson to students.

Slide 1



2. Read the statement below to your class, or project slide 2 of the PowerPoint.

If current trends continue, 1 in 3 U.S. adults will have diabetes by 2050.

Source: Center for Disease Control and Prevention, http://www.cdc.gov/chronicdisease/resources/publications/aag/ddt.htm

Slide 2

3. Ask students to work in pairs to briefly discuss:
    - What do you know about the effects of type 2 diabetes on the body?
    - How are these symptoms treated?
    - What would happen if 1 in 3 adults in the U.S. had type 2 diabetes?

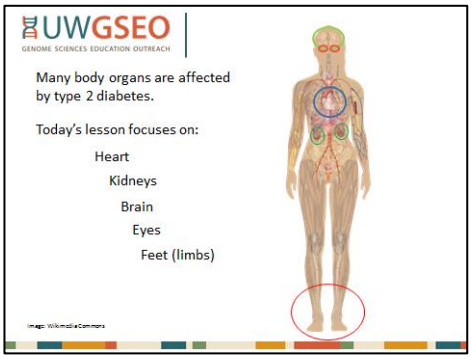
4. As a class, discuss and record student responses to the three prompts. Ask students what aspects of the symptoms/effects of t2d they would like to learn more about, and record these questions.

Part 2 (Explore): Organs affected by type 2 diabetes (*30 minutes*)

5. Make (or show) one full-sized body poster made of butcher paper for the class to use. Hang the poster in a place that is accessible to students. Ideally, the poster could be left up for the duration of the unit, so that the class could continue to add information to the poster.

6. Use Slide 3 to give a body overview and discuss the body organs and systems affected by type 2 diabetes. Refer back to the symptoms/effects students mentioned earlier, when possible.

Slide 3



Note: Teachers may wish to have class teams research and report back on more than five organs affected by type 2 diabetes. The Teacher Resource at the end of this lesson suggests additional organs or organ systems that are affected, such as the pancreas, skin, lungs, stomach, intestines, and others.

7. Hand out Student Sheet 5: *Organs affected by type 2 diabetes*. Tell student that they will be working in teams to learn more about each organ listed on Table 1 and on the slide.

8. Split the class into 5 groups and assign each group an organ to research in more detail. Alternately, the class could be split into 10 or more groups, with two groups finding information about the same organ.

9. Hand out the Student Resource: *On-line Reference Guide* to each group (or hand out the strip of paper pertaining to their organ). This will be used to further research the effects of type 2 diabetes on that organ. Ideally, the links could also be provided in electronic form.

10. Hand out a piece of colored paper to each group. This will be used to draw and cut out a life-sized organ to be attached to the life-sized poster.

11. Have students begin researching in groups and record their findings for their organ on the front side of Student Sheet 5: *Organs affected by type 2 diabetes*.

12. When students have had enough time, students can report back to their classmates on what they have learned. Presenting students should come to the human body poster, attach their organ, and report back on their findings. The rest of the class can take notes on the organs other students have researched as they listen to their presentations.

> ***Note:*** This portion of the lesson can also be run as a jigsaw activity, in which students who have chosen the same organ first meet together to fully fill out the information for that organ on their tables on Student Resource 5. Students then regroup into mixed organ groups in order to teach each other about the other organs. Organs can be attached to the human body poster after the jigsaw is complete.

Part 3 (Explore/Explain): **How high blood glucose causes damage** *(20 minutes)*

13. After student groups have presented to each other, ask if there are any common themes about treatment and prevention (last column) across the different organs.

    Students may notice that damage to many of the organs can be prevented by lowering chronic high blood glucose level (controlling blood sugar) through lifestyle interventions like diet and exercise. Careful screening and medication may also play a part after diabetes has developed.

14. Point out for students the first column of their data table. Why does it say *Chronic High Blood Glucose*?

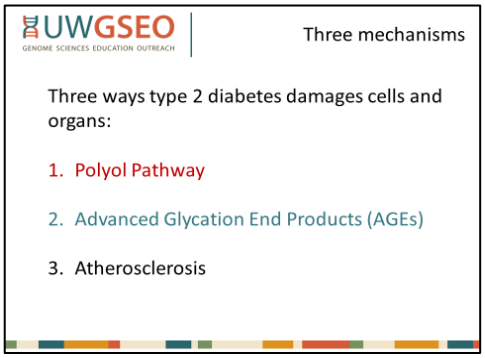
    Although different organs may sustain different types of damage, the root cause of type 2 diabetes is chronic high blood glucose levels. By controlling that, each organ can be affected.

15. Ask students to look at the column that asks *What causes the symptom*? Do they see any common pathway to damage among the organs they have studied? What damaged body systems contribute to the damage in the organ they studied?

    Student may notice that damage to blood vessels is a common theme. They may also notice that damage to nerves (neuropathy) contributes to damage in other organs.

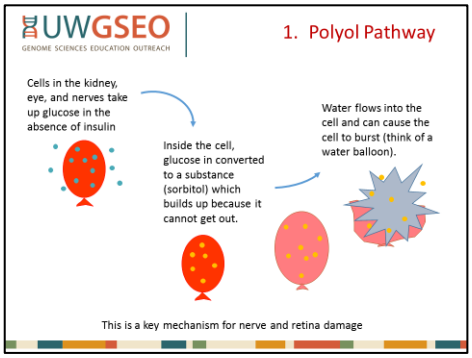
16. Use Slides 4 through 7 to discuss three major ways that high blood glucose and other changes in type 2 diabetes cause damage to cells, organs, and body systems. Slide 4 shows three types of primary damage that have a cascade effect on many organs.

Slide 4

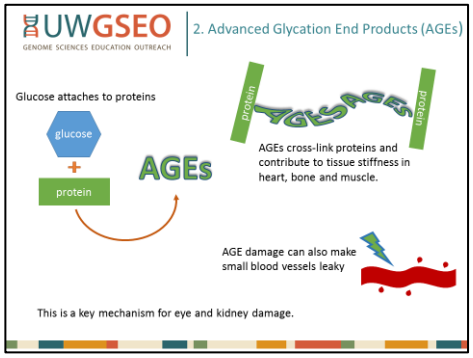


17. Slides 5 – 7 describe each of the mechanisms in more detail.

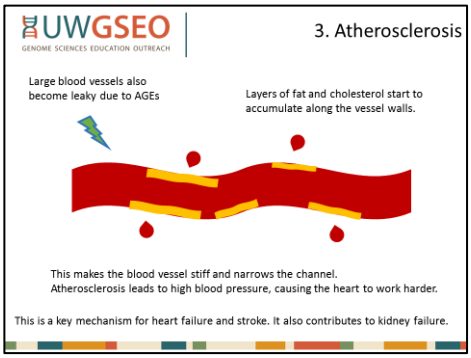
Slide 5



Slide 6



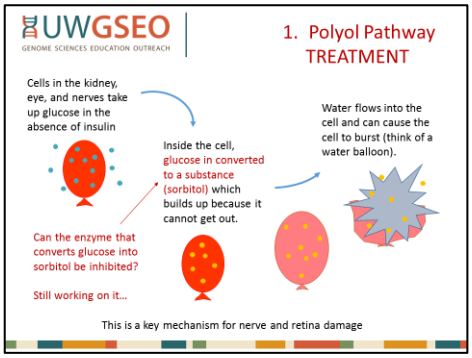
Slide 7



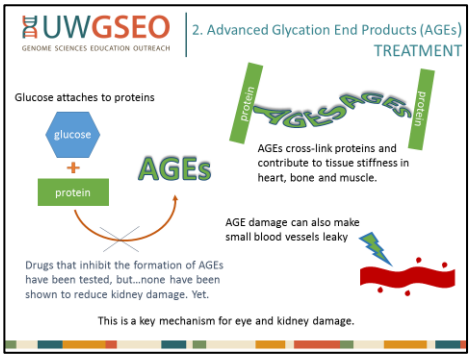
18. Ask students to work with their groups to relate these mechanisms to the organ they studied. If time allows, students could add this to the human body poster.

19. Show students slides 8 through 10. While treatments of all three of these mechanisms are being studied, none provides a perfect, or even good, solution.

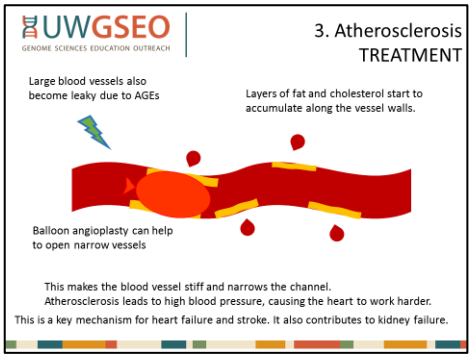
Slide 8



Slide 9



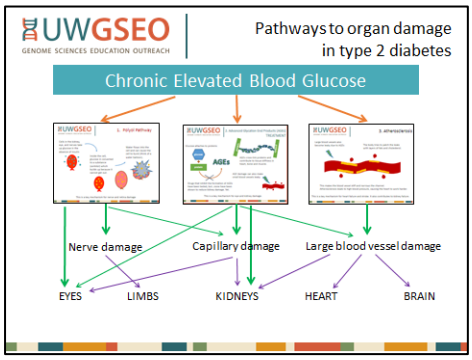
Slide 10



Part 4 (Elaborate): Treatment and cost (*20 minutes*)

20. Show students Slide 11. Underscore for students that the physiological mechanisms they have seen in this lesson are complex and interrelated, which makes treatment difficult and expensive. The green arrows show primary damage caused by the three mechanisms, and the purple arrows show the effects of damage to nerves, capillaries, and large blood vessels to other organs.

Slide 11

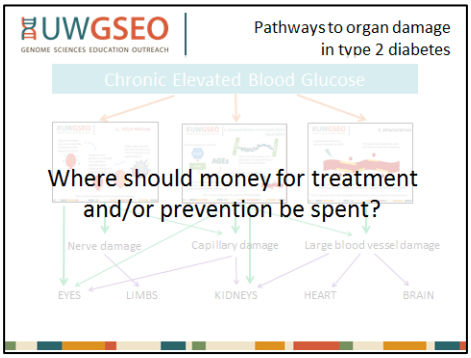


21. Share with students some of the financial costs of type 2 diabetes, per year. These statistics are from the year 2007, which was the latest year this information was available:
    - Direct medical costs for t2d: $116 billion
    - Indirect costs (related to disability, work loss, premature death): $58 billion
    - Total costs (direct and indirect): $174 billion
    - On average, medical expenses for a person with diagnosed diabetes are more than twice as much as the expenses of a person without diabetes.

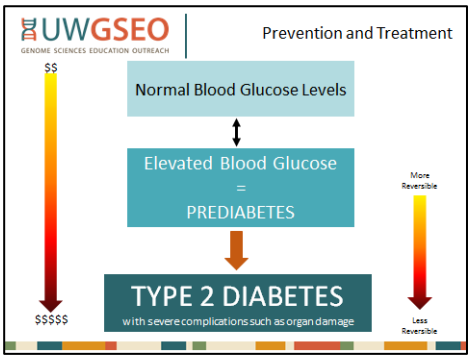
    Source: CDC, http://www.cdc.gov/chronicdisease/resources/publications/aag/ddt.htm

22. Show students Slides 12 and 13. Discuss the question, and point out that both prevention and treatment can start with the control of chronic elevated levels of blood glucose, through diet, exercise, and medication to help reduce insulin resistance.

Slide 13



Slide 12



23. Type 2 diabetes puts a financial burden on individuals, families, communities, and health care systems. Money needs to be invested in treatment options for people living with type 2 diabetes and, at the same time, money needs to be invested in prevention so that people do not become diabetic. ***Prevention, in the long run, is more cost effective than treating the effects of type 2 diabetes.***

Closure (Evaluate) *(10 minutes)*

24. Revisit the statement made at the beginning of the class:

    If current trends continue, 1 in 3 U.S. adults will have diabetes by 2050.

25. Ask students how old they will be in 2050. If prevention is more desirable than treatment, and they will be about 50 years old in 2050, at what point in time should their 50 year-old self take steps to prevent diabetes?

26. Ask students how this lesson contributes to their understanding of the Driving Question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?*** and revisit the Question Wall to see if questions have been answered or more questions need to be added.

Please allow students time to work in groups on their Call to Action products. It will take a class period or two for groups to assimilate and integrate new information into their product, as well as refine their Call to Action plan. A *Group Planning Worksheet* and other resources can be found in the *Assessment* section at the end of this unit.

Heart

National Heart, Lung, and Blood Institute: http://www.nhlbi.nih.gov/health/health-topics/topics/dhd/

National Diabetes Information Clearinghouse (NDIC): http://diabetes.niddk.nih.gov/dm/pubs/stroke/#occur

American Diabetes Association: http://www.diabetes.org/living-with-diabetes/complications/heart-disease/

WebMD: Risks and complications in heart and blood vessels: http://www.webmd.com/diabetes/risks-complications-uncontrolled-diabetes

Genetic Health http://www.geneticheath.com/DBTS_Diabetes_Controlling_Type_2_Diabetes.shtml#Anchor2

Brain

National Diabetes Information Clearinghouse (NDIC): http://diabetes.niddk.nih.gov/dm/pubs/stroke/#occur

American Diabetes Association: http://www.diabetes.org/living-with-diabetes/complications/stroke.html

http://www.diabetes.org/research-and-practice/we-are-research-leaders/recent-advances/type-2-diabetes-deteriorates-brain-function.html

The Final Frontier: How Does Diabetes Affect the Brain? (advanced content): http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2797942/

Eyes

American Diabetes Association http://www.diabetes.org/living-with-diabetes/complications/eye-complications/

WebMD: Risks and complications in heart and blood vessels, eyes: http://www.webmd.com/diabetes/risks-complications-uncontrolled-diabetes

Genetic Health: http://www.geneticheath.com/DBTS_Diabetes_Controlling_Type_2_Diabetes.shtml#Anchor2

Kidneys

American Diabetes Association: http://www.diabetes.org/living-with-diabetes/complications/kidney-disease-nephropathy.html

Diabetic kidney disease: http://www.patient.co.uk/health/diabetic-kidney-disease-leaflet

Diabetes and kidney disease: http://www.kidney.org/atoz/content/diabetes.cfm

Diabetes and kidney failure:
http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Diabetes_and_kidney_failure

Genetic Health: http://www.geneticheath.com/DBTS_Diabetes_Controlling_Type_2_Diabetes.shtml#Anchor2

Feet (e.g. limbs)

American Diabetes Association http://www.diabetes.org/living-with-diabetes/complications/foot-complications/

Group Health Cooperative:
http://www.ghc.org/healthAndWellness/?item=/common/healthAndWellness/conditions/diabetes/nerveDamage.html&print=true

Pictures of organs and organ systems can be found at: **www.diabetes.co.uk/body/** and **http://commons.wikimedia.org/wiki/Human_body_diagrams**

Instructions: Make a life-sized organ using the colored paper. Reseach the organ using the sources on the other side of this handout, and fill in the correct columns.

Chronic High Blood Glucose	**Organ**	**Function** *(what does it do?)*	**What are some symptoms of type 2 diabetes in this organ?** *(stroke, ulcers, blindness…)*	**What causes the symptom?** *(leaky blood vessels, decreased circulation…)*	**How can the organ damage be treated or prevented?** *(screening, lifestyle changes, surgery, medicine…)*
	Heart				
	Brain				
	Eyes				
	Kidneys				
	Limbs (e.g. feet)				

Use the back of the sheet for additional space if needed.

Question:

Given a hypothetical 1 million dollars that you must spend to benefit the community in regards to type 2 diabetes, how would you spend the money? Why? Make sure to mention both prevention and treatment in your answer.

(Since it is difficult to know exactly how much things cost, you may use percentages, such as: *I would spend 50% of the money on prevention by building play grounds in elementary school so that school kids can get exercise, and 50% of the money on treatment by making sure that people without health insurance have the medication they need.)*

Additional notes:

Teacher Resource: Effect of Diabetes on Human Body Systems and Organs

Organ / Structure	Body System	Function	Effect of diabetes
Heart	Cardiovascular	The function of the heart, a grapefruit-sized organ, is to pump oxygen-rich blood throughout your body and oxygen-poor blood to your lungs.	**High Blood Pressure (Hypertension):** • As many as 2 out of 3 adults with diabetes have high blood pressure (***hypertension***). • Because of the risks of high blood pressure to people with diabetes, the American Diabetes Association and the National Institutes of Health recommend a lower blood pressure target than the general public (less than 130/80 mmHg). • Hypertension raises risk for heart attack, stroke, eye problems, and kidney disease. • Blood pressure can be controlled with lifestyle changes, such as diet and exercise, and medication.
Brain	Nervous	With information in the form of nerve impulses, the brain is able to monitor and regulate unconscious body processes, such as digestion and breathing and to coordinate most voluntary movements of your body.	**Dementia:** From large epidemiological studies, it has been demonstrated that both ***vascular*** and ***Alzheimer's dementia*** are more common in patients with type 2 diabetes. **Stroke:** • 2 out of 3 people with diabetes die from stroke or heart disease. • A stroke occurs when blood supply to part of your brain is interrupted and brain tissue is damaged, resulting in paralysis, problems with thinking or speaking, or emotional problems.
Eye	Nervous System	Your eyes are connected to your brain and are dependent upon the brain to interpret what we see. It consists of the cornea, iris, lens, macula, optic nerve, pupil, retina, and other structures.	**Blindness:** Most blindness in U.S. adults is caused by diabetes (***diabetic retinopathy)***. Diabetic retinopathy happens when diabetes damages the tiny blood vessels inside your retina, the light sensitive tissue at the back of the eye.
Kidneys	Urinary	The kidneys, a pair of dark red bean-shaped, fist-sized organs, make urine from waste products and excess water in the blood, and keep your blood composition constant (e.g. water, pH and salt).	**Kidney Disease:** • High blood sugar can overwork kidneys, causing them to stop working properly, and can result in excess sugar and proteins leaking into the urine. • When diagnosed later, kidney failure usually results.

Feet	Appendage (*contains structures from various different body systems*)	Your feet allow for mobility.	Nerve damage, as a result of high blood sugar, from diabetes can cause you to lose feeling in your feet. You may not feel a cut, a blister or a sore. Foot injuries such as these can cause ulcers and infections. Serious cases may even lead to amputation. Damage to the blood vessels can also mean that your feet do not get enough blood and oxygen. It is harder for your foot to heal, if you do get a sore or infection.
Pancreas	Digestive/ Endocrine	The function of the pancreas is to secrete enzymes (digest fats, proteins, and carbohydrates) and hormones (**insulin** and **glucagon**) that control blood sugar levels. Insulin lowers blood sugar by increasing the intake of glucose to cells (fat, muscle and liver cells). Glucagon increases blood sugar by triggering the liver to release glucose into the blood.	Sustained high blood sugar (***hyperglycemia***), occurring in all types of diabetes, increases blood fats. Constant exposure of the ***beta cells*** (insulin-producing cells in the pancreas) to blood fats is thought to prompt an inflammatory effect. Though not well understood, sustained inflammation appears to reduce insulin production (by the pancreas) and possibly destroy the insulin-producing beta cells completely.
Skin	Integumentary	Skin, the largest organ, is flat, pliable and tough, between 0.5 and 4m thick. Its function is to protect your body from damage, infection and drying out.	**Effect of Diabetes on Skin:** At least 33% of people with diabetes will have a skin disorder caused or affected by diabetes at some time in their lives, which is often the first sign of diabetes.
Lungs	Respiratory	Your lungs are a pair of large sponge-like organs that almost fill your chest cavity, and deliver oxygen to and remove carbon dioxide from your blood.	**Effect of Diabetes on the Lungs:** It has been shown that lung damage, caused by type 1 and 2 diabetes, is the result of ***diabetic microangiopathy*** (damage to small blood vessels).
Blood vessels	Cardiovascular	Blood vessels (arteries, veins and capillaries) carry blood to and from the body.	**Effect of Diabetes on Blood Vessels:** High blood glucose levels cause the endothelial cells lining the blood vessels to take in more glucose than normal. As a result, these cells form more *glycoproteins* on their surface than normal, and cause the basement membrane to grow thicker and weaker, causing them to bleed, leak protein, and slow the flow of blood through the body.

Stomach	Digestive	The function of the stomach, a J-shaped elastic organ, is storing food, breaking food down and mixing it with juices secreted by its lining.	**Gastroparesis:** • ***Gastroparesis*** is a type of ***neuropathy*** (nerve damage) in which food is delayed from leaving the stomach, due specifically to damage to the ***vagus nerve***, and is caused by long periods of high blood sugar. • Delayed digestion makes the management of diabetes more difficult. • It can be treated with insulin management, drugs, diet, or in severe cases, a feeding tube. • This disorder affects people with both type 1 and 2 diabetes.
Liver	Digestive	The liver (largest internal organ), a wedge-shaped, spongy organ, gets rid of toxins, regulates your blood sugar levels and to produces bile. The liver regulates blood sugar by responding to a hormone, **glucagon**, by breaking down glycogen to glucose in liver cells, and releasing the glucose to the blood. Liver storage cells store glucose and glycogen (as do muscle cells).	***Hemochromatosis***, an autosomal recessive inherited condition, characterized by elevated absorption of iron from the small intestine and excessive accumulation of iron in the liver and other tissues. Patients with untreated hemochromatosis develop progressive liver disease, ***cirrhosis*** (hardening of the liver), and diabetes and are at high risk for developing ***hepatocellular carcinoma*** (liver cancer). ***Note:*** *The liver can also convert amino acids (building blocks of proteins) into glucose (gluconeogenesis) and fat into ketones for energy when blood glucose is low.*
Bladder	Urinary	The bladder stores urine. When this organ stretches beyond a certain point, nerves in its wall send a message to your brain telling it that this organ is getting full and needs to be emptied.	**Effect of Diabetes on the Bladder:** • Diabetes can affect the nerves that control the bladder, making it difficult for a person to empty his or her bladder completely. • Incomplete emptying of the bladder can result in the growth of bacteria in the bladder and the tubes leading from it, eventually causing infection. • Without prompt examination and treatment by a doctor, the infection can reach the kidneys, causing pain, fever, and possibly kidney damage.

Muscle	Muscular-Skeletal	Muscle accounts for about half of a person's weight. There are 3 types of these in your body: voluntary, smooth and cardiac.	**Effect of Diabetes on Muscles:** • Research has shown that "known and newly diagnosed diabetic older men have significantly weaker muscle strength and higher odds of impaired physical function than those without diabetes". • From this study, there appears to be a relationship between raised glucose levels, weaker muscle strength, and impaired physical function.
Nerve	Nervous	1. Receive information from the sensory receptors, 2. Transfer and interpret impulses, and 3. Send impulses to the muscles and glands.	If you have diabetes, your blood sugar levels are too high. Over time, this can damage the covering on your nerves or the blood vessels that bring oxygen to your nerves. Damaged nerves may stop sending messages, or may send messages slowly or at the wrong times. This damage is called ***diabetic neuropathy***. ***What is Diabetic Neuropathy?*** • ***Diabetic neuropathy*** is a ***peripheral*** (near the surface) nerve disorder caused by diabetes or poor blood sugar control. • The most common types of diabetic neuropathy result in problems with sensation in the feet. It can develop slowly after many years of diabetes or may occur early in the disease. • The loss of sensation in the feet may also increase the possibility that foot injuries will go unnoticed and develop into ulcers or lesions that become infected, and can be associated with weakness in the foot muscles. • Diabetes can also affect the ***autonomic nerves*** that control blood pressure, the digestive tract, bladder function, and sexual organs. • Problems with the autonomic nerves may cause lightheadedness, indigestion, diarrhea or constipation, difficulty with bladder control, and impotence.
Small and large intestine	Digestive	The small intestine, an organ, is a five meter long narrow tube that functions in the chemical digestion of food and the absorption of nutrients into your blood. The large intestine, an organ, is a 1.5 meter-long tube that functions in converting food waste products into feces. It is the final part of your digestive tract.	Longstanding diabetes can diminish the function the ***enteric nerves*** to the small intestine, leading to abnormal motility, secretion, or absorption. This can lead to bacterial overgrowth syndromes, resulting in diarrhea and abdominal pain. Though limited information is available, it is known that ***enteric neuropathy*** may affect the nerves of the colon, decreasing in colon motility and resulting in constipation.

Lesson Six

Introduction to multifactorial traits

Overview
Students explore human diversity by examining some of their own traits and discuss whether each trait is determined by genes, the environment, or a combination of both genes and environment. Students graph their class data for mid-digital finger hair and height onto two histograms and discuss the distribution of these two traits in their classroom population. They discuss what factors contribute to the development of type 2 diabetes and develop an expanded understanding of what is considered an environmental factor for diseases like diabetes.

Enduring understanding:
Most traits are determined by a combination of genetic and environmental factors, including complex diseases like type 2 diabetes.

Essential question:
What is a multifactorial trait and how might this apply to type 2 diabetes?

Learning objectives
Students will be able to:

- Interpret histograms they make showing the distributions of two different traits
- Identify traits that are determined by genes only, by the environment only, or by a combination of genes and environment
- Write a definition for multifactorial trait and provide an example

Prerequisite Knowledge
Students should have an understanding of the following terms: trait, gene, genetic factor, environmental factor

Time: 50 minutes

This lesson connects to the Next Generation Science Standards in the following ways:
Performance Expectations
HS LS3-3 Apply concepts of probability to explain the variation and distribution of expressed traits in a population.

HS LS3.B Disciplinary Core Idea
Variation of Traits: Through sexual reproduction, new genetic combinations result in genetic variation. Environmental factors also affect expression of traits. Thus variation and distribution of traits observed depend on both genetic and environmental factors.

This lesson highlights the Scientific Practices of **Analyzing and Interpreting Data** and the Crosscutting Concept of **Cause and Effect**

Materials

Materials	Quantity
Two histograms drawn on white board or poster paper to record student data on mid-digital finger hair and height (Figure 6.1)	1 per class
Venn diagram drawn on white board or poster paper (Figure 6.2)	1 per class
2"x 3" sticky notes	2 per student
Student Resource: *Genetic traits images*	1 per group
Student Sheet 6: *Exploring diversity in the classroom* (2-sided)	1 per student

Lesson Preparation

- Make two histograms like the ones shown in Figure 6.1 by drawing them on a board or making them on poster paper. Make sure that the spacing along the x and y axes is the right size for the corresponding size and number of sticky notes.
- Draw a Venn diagram on the board or poster paper as shown in Figure 6.2

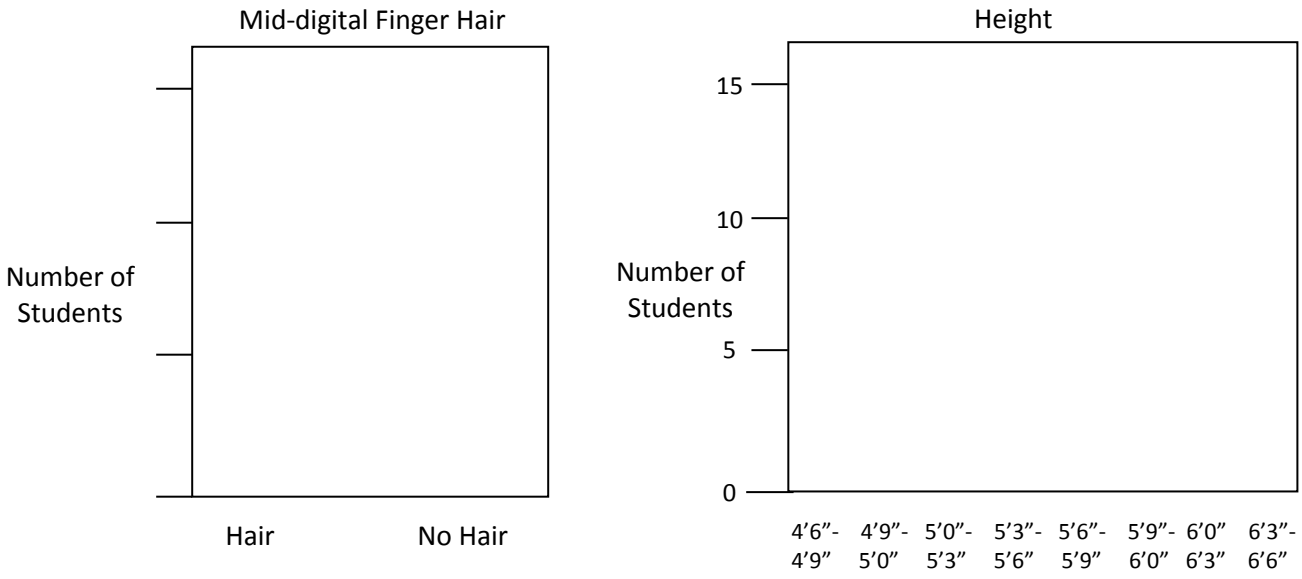


Figure 6.1. Histograms showing distributions of two traits among students in classroom

Procedures

Part 1 (Engage): Trait Assessment (*15 minutes*)

1. Tell students that in today's lesson they will be assessing some of their physical characteristics, or ***traits***. The lesson focuses on traits that can be seen, such as height and hair color. Remind students, however, that many traits cannot be seen by looking at a person, such as how well their body breaks down lactose or gluten, or how adept their red blood cells are at transporting oxygen.

2. Hand out the Student Resource: *Genetic Traits Images* to groups of students and review the traits. Show students the two class histograms, and demonstrate how each student will record their data for mid-digital finger hair and height on the two histograms by placing a sticky note along the x-axis at the position for their trait. When/if there is more than one sticky note at a single position, students should place sticky notes one above the other in a straight column.

3. Hand out Student Sheet 6: *Exploring diversity in the classroom* and two sticky notes to each student. Ask students to complete Parts A and B of the sheet (the front page) using the images in the Student Resource to help them score the traits. They may want to work in pairs, but each student should fill out a sheet based on their own traits. Students should not fill in the right column at this time. Ask them to record their data on the two class histograms, and then record the class data on their handouts.

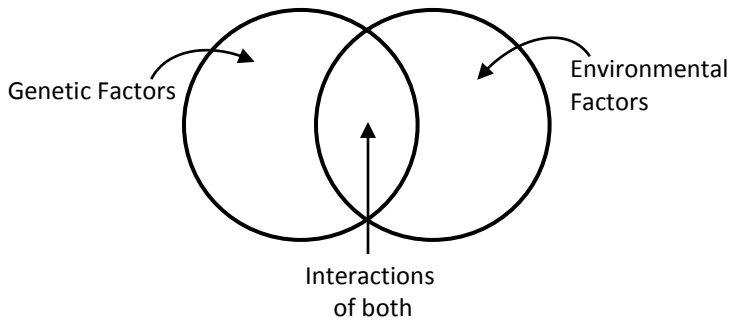
> ***Note:*** Be sensitive to any students who may not wish to share their information with the class for whatever reason. Encourage them to participate as they feel comfortable.

Part 2 (Explore and Explain): Exploring Diversity in the Classroom (*15 minutes*)

4. Gather the class back together, and ask students what they notice about the distribution of traits on the two histograms. Students should notice that finger hair come in two versions, while there is a wide range of heights distributed roughly in a bell curve. Depending on your class population, the distribution of heights may be bimodal, with a peak of shorter heights corresponding to females and higher heights for males. This is not always the case.

5. Ask students what determines whether or not a person has mid-digital finger hair. Finger hair is determined by a gene. Depending on the versions of the gene (people have 2 copies of each gene), the person may or may not have hair on the middle joint of their fingers. While most traits result from the interaction of many genes, mid-digital finger hair is relatively easy to identify as a single genetic trait since it is a Yes/No trait.

6. Using the Venn diagram (see Figure 6.2) write "mid-digital hair" in the circle labeled "Genetic Factors.



Note: Some teachers recommend not labeling the Venn diagram at the beginning of the lesson. Start the discussion with examples of traits that can be clearly categorized, such as mid-digital hair (genetic), hair length (environmental), and height (both). Elicit the labels for the Venn diagram from the students, then move on to characteristics that are more difficult to categorize.

Figure 6.2 Venn diagram showing factors that determine traits

7. Next, ask students to suggest what factors determine a person's height. Students will probably recognize that height is determined by genes, because people who are tall usually have tall parents. However, they should also recognize that environmental factors like nutrition, childhood diseases, and general health also contribute to a person's height.

8. Height is an example of a ***multifactorial*** trait. Use this example to develop a definition of multifactorial traits. Here is one possible definition: Multifactorial traits are traits that are determined by the interaction of genetic and environmental factors. The genetic contribution usually involves multiple genes. Many environmental factors can also contribute.

9. Using the Venn diagram, write "height" at the intersection of the two circles, showing that the trait is the result of a combination of interactions between genes and the environment.

10. Ask students to reconsider each of the traits they assessed using Student Sheet 6: *Exploring diversity in the classroom.* Using the right-hand column of Part A, have students mark each trait on a scale of 1 to 5, with 1 being *all genetic factors*, 5 being *all environmental factors*, and 3 being an even interaction of both genetic and environmental factors.

G ⟷ E
1 2 3 4 5

11. As a class, discuss the placement of each trait on the Venn diagram and write each one on the appropriate part of the diagram as students come to consensus. Make sure students understand that there are few right and wrong answers—there is much current research about the relative contributions of both genes and environment to human traits, including health and behavior, and still much to be discovered. As such, how a student supports his or her claim about the placement of a trait may be more important than the actual placement.

Part 3 (Elaborate): Diabetes as a multifactorial trait (*15 minutes*)

12. Ask students to think about where type 2 diabetes would be placed on the Venn diagram. Before placing t2d in the middle intersection, challenge each person to think of at least one genetic factor and one environmental factor that contributes to t2d. For environmental factors, you may need to encourage students to consider things that are not part of their physical environment but that none-the-less are considered as environmental, such as access to healthy food options, or having access to areas to exercise safely. Examples of each may include:

Some genetic factors influencing t2d:

- Inheritance: T2d runs in families, which suggests a genetic link
- Identical twins have a high correlation of t2d
- Variation by ethnicity: Certain ethnicities are have higher incidences of t2d, which points to genetics
- Gene variants: Variations in certain specific genes that increase susceptibility to t2d have been identified
- Weight gain: A person's tendency to become overweight or obese has a genetic component, and this increases a person's risk for t2d.

Some environmental factors influencing type 2 diabetes:

- Nutrition: This varies from excellent to poor depending on the quality and amount of food a person eats
- Health care: Access to health care; whether there are barriers preventing people from receiving appropriate care and prevention
- Exercise: Whether or not a person gets routine exercise
- Food access: A person's access to healthy food options within their communities
- Public spaces: Access or lack of access to sidewalks, parks, bike lanes
- Air quality: This includes poor air quality due to pollution for cars, dust storms, chemical sprays, etc., as well as good air quality that is free from these contaminants
- Toxins: Environmental toxins, naturally occurring and those occurring from manufacturing
- Sanitation: Access to sewage and garbage disposal systems within the community, clean water supply, clean toilets
- Stress levels: Higher levels of stress contribute to type 2 diabetes
- Sleep: Getting fewer than 5 hours of sleep per night has been significantly associated with type 2 diabetes

> ***Note:*** Factors that can lead to the development of a disease condition are called **risk factors**, and factors that help prevent the disease are called **protective factors**. Lesson Six will explore this more deeply.

Closure (Evaluate) (*10 minutes*)

13. Ask students:

"We saw in Lesson One how quickly this disease is spreading across the nation. How does one go about understanding a complex, multifactorial condition like type 2 diabetes in order to treat it, prevent it or research the disease?"

Make sure that students understand that multifactorial diseases like type 2 diabetes are very complex to both treat and investigate. Scientists must look for both genetic and environmental factors that may contribute to disease susceptibility.

"How does this relate to our Driving Question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?"***

"Which is easier to influence and change—genetic factors or environmental factors?"

While the symptoms of some genetic conditions or diseases may be treated with medications, making changes to the genes themselves is not yet an option for t2d—in fact, scientists are still working on identifying which genes are involved.

Changing environmental factors may seem easier on the surface, but often involve changing large economic, social, and political structures which influence health, as well as those involving issues of poverty and race. Personal behavioral changes may be some of the most controllable environmental factors.

14. As closure and evaluation, students can finish questions 1 – 5 on the Student Sheet 6 either in class or as homework, depending on remaining class time and teacher preference.

Extensions:

- A description of the connection between diabetes and environmental pollution can be found in a May, 2013 BBC article titled: *Diabetes: dirty air 'may raise' insulin resistance risk.* http://www.bbc.co.uk/news/health-22465389
- Challenge students to bring in current new articles that detail possible genetic contribution(s) to a certain behavior or condition.
- Optional discussion: When discussing environmental factors and how they may influence traits, consider introducing the following discussion in class: Is age an environmental factor or a genetic factor, in the development of traits? Age as a risk factor is introduced more completely in Lesson Six in reference to being a risk factor mentioned by a risk test published by the ADA, so this would be a great time to get students thinking about it. Have students consider age as a risk factor, in regards to their general understanding about aging, but also thinking about how different stages in life are accompanied by different life styles, such as puberty which is accompanied typically by an increase in calorie consumption, or the early 20's

which is often accompanied by a decrease in physical activity (going from high school sports to not being as active/"freshman 15")

Glossary

Trait: A characteristic or attribute of an individual.

Multifactorial traits: Traits that are determined by the interaction of genetic and environmental factors.

POSSIBLE ANSWERS

For Student Sheet 6: *Exploring diversity in the classroom*

1. What do you notice about the distribution of your class traits for mid-digital finger hair and height? What does this tell you about the kinds of traits these are?

   Finger hair has two possible forms, having it and not having it, while height has a wide range of options. This is because mid-digital finger hair is a single gene trait, while height is determined by more than one gene (and environment as well).

2. Name two multifactorial traits, and explain how both genetic and environmental factors contribute to each trait.

Multifactorial Trait 1: *athletic ability*	
Genetic Factor	Environmental Factor
Many genes, such as those that code for fast-acting muscles, good coordination, strength	*Physical training, healthy diet, adequate sleep*
Multifactorial Trait 2: *skin color*	
Genetic Factor	Environmental Factor
Genes for skin pigments (melanins)	*Amount of UV exposure, wind exposure, state of health*

3. Which category do you think most human traits fall into, genetic, environmental, or multifactorial? *Most human traits are multifactorial.*

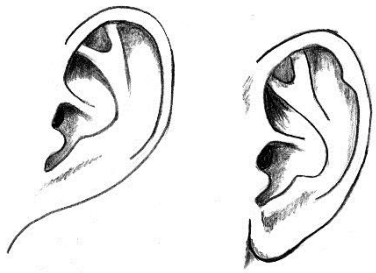
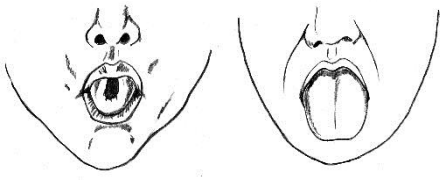
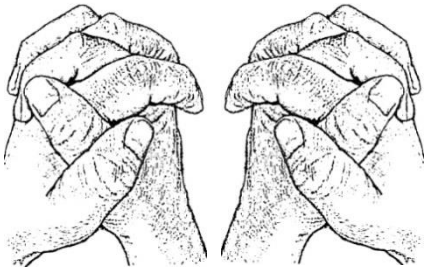
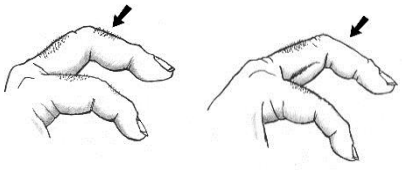
4. What category does type 2 diabetes fall into? Justify your answer.

   Type 2 diabetes is multifactorial because many genetic and environmental factors contribute to whether someone will develop it.

5. What are the implications of your answer to the previous question on the study of diseases like type 2 diabetes?

   Multifactorial diseases like type 2 diabetes are very complex to investigate. Scientists must look for genetic and environmental factors that may contribute to disease susceptibility. On the plus side, conditions with an environmental component can sometimes be prevented or treated through modification of environmental factors.

Genetic Traits Images

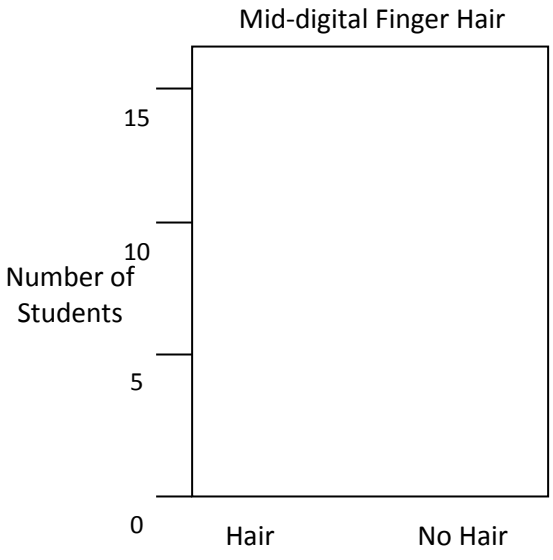
Earlobes	**Tongue Rolling**
	
Attached Free	Rolls tongue Can't roll tongue
Earlobes are attached if the bottom lobe is attached directly to the head. Earlobes are free if the lobe hangs free.	Tongue rolling is the ability to roll your tongue upwards to form a closed tube. The sides of your tongue will meet at the top of the tube if you can roll your tongue. Tongue rolling is an example of a "motor skill" that is inherited.
Thumbs	**Mid-digital Finger Hair**
	
Left over Right over	Hair No hair
When you interlock your fingers, which thumb goes on top? Try interlocking your fingers without thinking about how you are doing it, and look at which thumb is on top, left or right. Although you can probably force yourself to do it with the opposite finger on top, one way usually feels more natural.	Your fingers have 3 segments, top, middle, and bottom. If hair is present on the middle segment of any finger, even just one hair or one finger, you have mid-digital hair. Do not score the bottom finger segment for hair, just the middle segment. Look closely, as it can be difficult to score, and hair may be fair, especially on children.

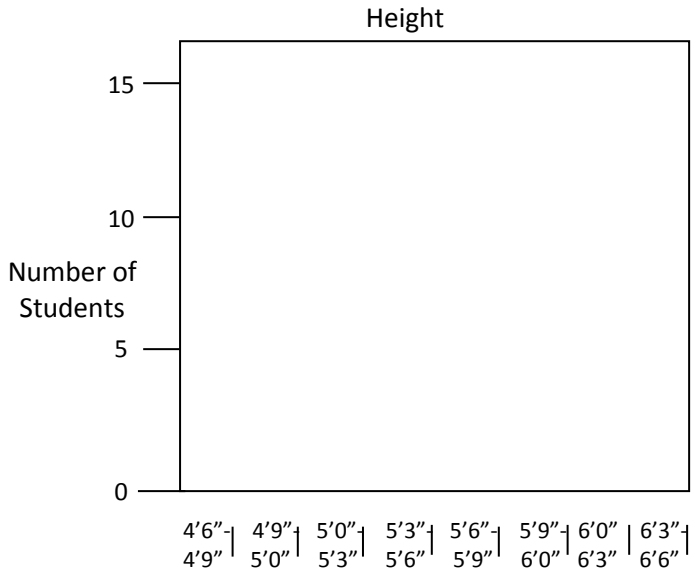
Name: _____ **Date:** _____ **Period:** _____

A. Answer the following questions about your traits by circling or writing in the correct answer. Do not fill in the last column at this time.

Traits				G ⟷ E 1 2 3 4 5
Do you have free earlobes?	Yes	No		
When you clasp your hands, which thumb is on top?	Left	Right		
Do you have mid-digital finger hair?	Yes	No		
Do you have any allergies?	Yes	No		
Can you roll your tongue?	Yes	No		
Do you have any body piercings?	Yes	No		
What is your height in feet and inches?				
What is your hair color?				
What is your hair length?				
How do you rate your athletic ability?	High	Moderate	Low	
How do you rate your artistic ability (e.g. musical, drawing, painting)?	High	Moderate	Low	

B. Add your data to each of the two class histograms of mid-digital finger hair and height by placing a sticky note at the correct position. Stack sticky notes at the same position in a neat column. After everyone has posted his or her data, draw the class results on the figure below.





C. Work with a partner to fill in the right-hand column of Part A. You can also list additional traits that are not on the survey.

Questions

1. What do you notice about the distribution of your class traits for mid-digital finger hair and height? What does this tell you about the kinds of traits these are?

2. Name two multifactorial traits, and explain how both genetic and environmental factors contribute to each trait.

Multifactorial Trait 1:	
Genetic Factor	Environmental Factor
Multifactorial Trait 2:	
Genetic Factor	Environmental Factor

3. Which category do you think most human traits fall into, genetic, environmental, or multifactorial?

4. What category does type 2 diabetes fall into? Justify your answer.

5. What are the implications of your answer to the previous question on the study of diseases like type 2 diabetes?

Lesson Seven Environmental and genetic risk factors

Overview
Students dive more deeply into environmental and genetic risk factors for type 2 diabetes and consider how these factors interact to reduce or increase risk. Students simulate genetic predisposition by drawing colored beans to represent alleles, and weigh environmental risk by assessing how access to resources and personal choice may increase or decrease risk factors over time.

Enduring understandings:
- The increase in type 2 diabetes nationally and globally appears to be associated with an increase in obesity, changes in diet to highly processed foods, a decrease in physical activity, as well as other factors.
- Type 2 diabetes can be prevented: factors contributing to a person's risk include good nutrition and exercise; personal choice; public health policies, access to resources, socio-economic status, and stress.

Essential question:
How do environmental and genetic risk factors influence a person's risk of developing type 2 diabetes?

Learning objectives
Students will be able to:
- Identify opportunities to increase or decrease risk for developing type 2 diabetes.
- Interpret genetic information associated with an increased risk for type 2 diabetes.
- Understand that genes do not influence the development of type 2 diabetes as much as behavior and lifestyle do, for the majority of people.

Prerequisite Knowledge
Students should have an understanding of the following terms: gene/genetic factor, environmental factor, inheritance, risk, protein, allele.

Time: Approximately 90 minutes

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectation
HS LS3-3 Apply concepts of probability to explain the variation and distribution of expressed traits in a population.

HS LS3.B Disciplinary Core Idea
Variation of Traits: Variation and distribution of traits observed depend on both genetic and environmental factors.

Nature of Science: Science is influenced by society and society is influenced by science.

Materials

Materials	Quantity
Computer and projector	1 per class
Access to the American Diabetes Association Risk Test found at http://www.diabetes.org/are-you-at-risk/diabetes-risk-test/ Or a paper version of the test, also available at the above address	1 per student
Class stock mixture of dry beans, in the following amounts and colors: 7-8 pounds of blue beans 2-3 pound of green beans 2-3 pound of orange beans Tan beans can be spray painted on one side, if similarly-sized blue, green and orange beans are not available. Pony beads of different colors can also be used.	Per class
Small opaque bag	1 per pair
From class stock mixture (above) make the following combinations: **Standard Mix**: Make most student groups a bag containing: 1 cup of blue beans, 1/3 cup green beans, and 1/3 cup orange beans. **Risk Mix:** Give one or two groups the standard mix, but add more orange beans and remove some green beans. **Protective Mix:** Give one or two groups the standard mix, but remove some orange beans and add some green beans.	1 per pair
Egg carton for 12 eggs	1 per pair
Student Sheet 7.1: *Genetic risk factors*	1 per student
Student Sheet 7.2: *Environmental influences and options*	1 per student
Teacher Resource: *Environmental and genetic risk cards*	1 set per class
Contributions to Type 2 Diabetes Poster, downloaded from https://gsoutreach.gs.washington.edu/ or copied from Teacher Resource	1 per class
Optional: Copy of the film *Unnatural Causes* from California Newsreel. It can be ordered from http://www.unnaturalcauses.org/	1 per class

Lesson Preparation

Prepare the bean bags for each student group, as described above. Make Copies of ADA risk assessment form, or provide student access to computers and the URL. Photocopy Student Sheets 7.1 and 7.2 one per student, and make a class set of the *Environmental and genetic risk cards.* Students will also need access to the *Contribution to Type 2 Diabetes* Poster found at the end of this lesson.

Teacher Note

The term "environment" is used quite broadly in this lesson, and encompasses factors such as access to resources, personal choice, and both the physical environment and the emotional/social environment. The film ***Unnatural Causes***, available from California Newsreel, contains a 29-minute episode called *Bad Sugar* which addresses some of the

social circumstances of health by making connections between diabetes, oppression, and empowerment in two Native American communities. This segment of the film would be ideal to show before this lesson, if possible.

Presenting the Unit

Part 1 (Engage/Explain): ADA risk assessment (*15 minutes*)

1. Remind students of the previous day's discussion and refer to the Venn diagram (if available) showing the intersection of Environmental Factors and Genetic Factors that determine different traits.

2. Tell students that a ***factor*** (genetic *or* environmental) can be positive or negative. A positive factor is considered ***protective***, and a negative factor is considered a ***risk***. Ask students to think of an example of a protective factor and a risk factor for the environment. Answers could include:

Environmental Factors	
Protective	**Risk**
Walking to and from the school bus stop daily	Many hours of screen time daily
Low stress, or well-managed stress levels	High stress levels
Access to healthy, affordable food	Living in a "food desert" where access to healthy, affordable food is not available within a convenient travel distance

3. Tell students that genes can also be protective in nature, or add to a person's risk of acquiring type 2 diabetes.

4. Review the American Diabetes Risk Assessment with students, either using the on line version or the paper version. Both are available at http://www.diabetes.org/are-you-at-risk/diabetes-risk-test/

5. Encourage students to play with the risk numbers in order to see which conditions lead to the highest risk for diabetes, and which conditions lead to the lowest. Allow students to take the test themselves if they choose to, but do not require students to share their results.

Note: The term ***risk*** is used here as it is in the field of public health. A person with an increased risk for t2d will not automatically develop t2d. Rather, risk is a measure that compares an individual to population data. In other words, a person's risk of developing a disease given x, y, and z, is based on how many other people who have x, y, and z actually get the disease of concern.

6. Discuss factors in the risk test over which people have control, or do not have control. Encourage discussion about how choices, access, genetic factors, and environmental factors affect the results of the risk assessment.

Part 2 (Explore): **Simulating genetic risk** (*15 minutes*)

7. Tell students that they will now assess their *simulated* genetic predisposition for type 2 diabetes by doing an activity that will give them a hypothetical genetic risk score. During this exercise, we are assuming that some of the genes associated with type 2 diabetes increase susceptibility to the disease, some offer a protective effect, and some have no effect.

8. Show student the colored beans and egg cartons. Explain that each student will randomly draw two beans from the bag at a time to be placed in one of the egg spaces in the carton. When one person has drawn and recorded a total of 24 beans (2 beans x 12 egg spaces), the next person will draw 24 beans. Although students will be working independently, they will share supplies with a partner.

9. Tell students that students will be working with three different types of beans. Each pair of beans indicates a different pair of alleles.

10. Blue beans indicate alleles that have no effect on t2d. Orange beans increase risk for developing t2d, and green beans offer a protective effect, decreased the risk for developing t2d.

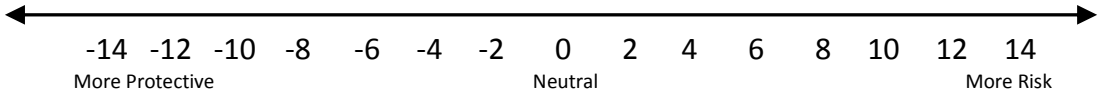
11. Pass out Student Sheet 7.1 *Genetic risk factors*, bean bags and egg cartons to each group. Give most student groups the **Standard Mix**, but give 1-2 groups the **Protective Mix**, and 1-2 groups the **Risk Mix**. Do not tell students which mix they have.

Note: The commonly-used terms *dominant* and *recessive* are not generally used to describe genes related to type 2 diabetes. For many genes of interest, the exact mechanism is not well understood at this time.

12. Let students complete the activity using Student Sheet 7.1: *Genetic risk factors*.

13. Have students tally their genetic risk score and record it on Student Sheet 7.1, as this number will be used at the beginning of the next section.

14. Ask the class to report back on their genetic risk scores, and record these numbers on a common scale, as shown below. Most of the scores should fall in a middle range, as most of the students received the Standard Mix of beans. The scores for the student groups who received either the Protective Mix or the Risk Mix, however, will be lower or higher than the norm.



15. Allow student to open their bags and look at the allele mix from their bags. How did the allele mix contribute to their (simulated) higher or lower risk scores? Will they take any actions based on this information?

Part 3 (Explore): **Assessing environmental access and choices** *(10 minutes)*

16. Tell students that they will be now be assessing their environmental risks for acquiring type 2 diabetes. If students don't feel comfortable assessing their own environmental risks, they may choose a fictional representative character to assess.

17. Pass out Student Sheet 7.2: *Environmental influences and options* for students to fill out. Allow students to tally their scores and answer the questions.

18. Help students determine which environmental factors are issues of *access*, and which are issues of *choice*. For example, students may live in neighborhoods with good parks (providing access to exercise) but choose not visit the park to walk, run, play Frisbee or otherwise exercise (an issue of choice). Conversely, students may not have access to a gym, but choose to run on a road.

19. Be aware that not all of the factors on the sheet are easily sorted into *access* or *choice* and be prepared to discuss areas of gray. If lack of time is a contributing factor to not exercising, is that an issue of choice or access? How does age factor into acquiring type 2 diabetes? Are high levels of stress a matter of access or choice?

Part 4 (Elaborate): Going Deeper (*25 minutes*)

20. Encourage students to ask questions about the specific factors listed and used for the tally. Tell students that each factor is supported by research in the scientific community.

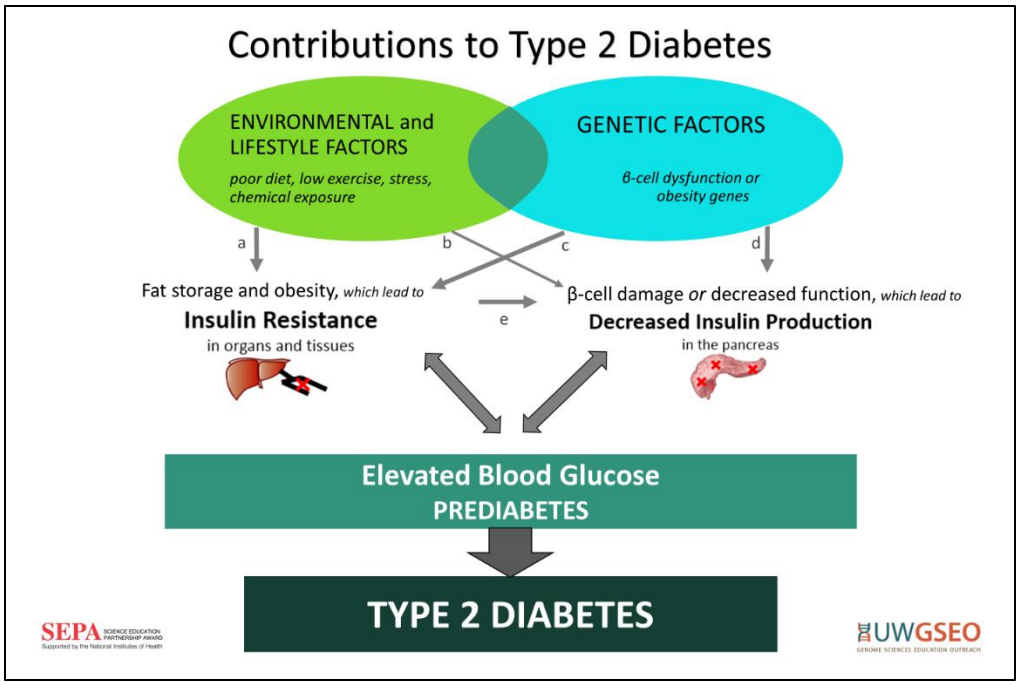
21. Give each student an environmental or genetic risk card from the Teacher Resource: *Environmental and genetic risk cards*, or let students choose cards of interest to them.

22. Tell students that there are 25 environmental risk cards and only 6 genetic risk cards. Explain that the cards are weighted that way for a reason: Although genes may affect the development of type 2 diabetes, for most people they do not exert as much influence on health as behavior and lifestyle.

23. These cards can be used in a variety of ways depending on class time and teacher direction. Some examples include:

    - Each student could be asked to provide more research about his or her card, possibly as a homework assignment, using the source information on the card.
    - Students could share the information on the card in a round-robin exercise.
    - Students could meet in groups of four to share information the cards, and then regroup with new students until students have heard from a range of their peers.

24. Show students the *Contributions to Type 2 Diabetes* poster found at https://gsoutreach.gs.washington.edu/ as a PowerPoint slide, or as a Teacher Resource at the end of this lesson.



25. Spend some time unpacking the content of the slide with the class. For example, students saw the Venn diagram in the previous lesson, and learned about insulin resistance and β cell damage in the pancreas in Lesson Four. This slide puts those two concepts together. Ask students:

    "What two mechanisms in the body lead to elevated blood glucose levels?"

    Insulin resistance due to fat storage and obesity, and/or decreased insulin production, due to β-cell damage.

    "Are these determined by environmental factors or genetic factors?"

    Both. (Point out for students that arrows a, b, c, and d go from each side of the Venn diagram to each mechanism.)

26. Have students re-read their *Environment and genetic risk* card. Have them consider whether their particular card is more likely to be related to arrow *a or c* (*fat storage and obesity*) or arrow *b or d* (*β cell damage)*. Ask students:

    "Who has an Environmental Factor Card that follows arrow *a* (i.e. leads to insulin resistance through fat storage and obesity?)"

    Almost all of the cards will fall into this category, even if it is a protective factor (i.e. getting lots of exercise). Even age as an environmental factor falls into this category.

"Who has an Environmental Factor Card that follows arrow *b* (i.e. leads to decreased insulin production through β cell damage?)"

BPA exposure (Card 21) and Air pollution exposure (card 23) may both contribute directly to β cell damage.

"Why is arrow *b* thinner than the rest?"

Arrow b shows that most environmental factors do not directly damage the pancreas, but rather contribute to diabetes risk through the fat storage and obesity route. Chemical exposure may be one way in which the pancreas is damaged directly through the environment.

27. Likewise, ask about the Gene Cards. Which Gene Cards follow arrow *c* and which follow arrow *d*? See Table 1, below, for answers.

Table 1

	Insulin Resistance (through fat storage and obesity)	**Decreased Insulin Production** (through β cell damage)
Environmental Factor Cards	All cards *except* Cards 21 and 23	BPA exposure (Card 21) and air pollution exposure (Card 23) may both contribute directly to β cell damage
Gene Cards	Gene 4: TC7L2 Gene 6: CDKAL1	Gene 1: Melanocortin-4 (MC4) Receptor Gene 2:Leptin (LEPR) Receptor Gene 3: PPAR Gene Family Gene 5: FTO

28. Ask students to turn to a neighbor and explain their understanding of arrow *e*. What does it mean?

Prolonged insulin resistance itself can lead to β cell damage in the pancreas.

29. Tell students that this poster is a framework, or model, for thinking about factors that contribute to type 2 diabetes. What are some limitations of this model?

The mechanisms for developing type 2 diabetes are very complex and interconnected. This slide simplifies the process to the point that it likely introduces some inaccuracies. Also, there is much that is not known about how the mechanisms work, and how they affect each other.

Closure (Evaluate) *(15 minutes)*

30. Ask students to write down five factors that appear to be associated with an *increase* in type 2 diabetes. Have them then turn to a neighbor and compare lists. If time allows, create a class list on the board.

31. Ask students to write down five factors that contribute to the *prevention* of type 2 diabetes. Again, have students turn to a neighbor and compare lists, and then create a class list if time allows.

32. Review with students that both genetic and environmental exposures may increase an individual's risk of acquiring type 2 diabetes. Likewise, there are genetic and environmental protective factors that influence likelihood of acquiring type 2 diabetes.

33. Ask students how this lesson contributes to their understanding of the Driving Question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?***

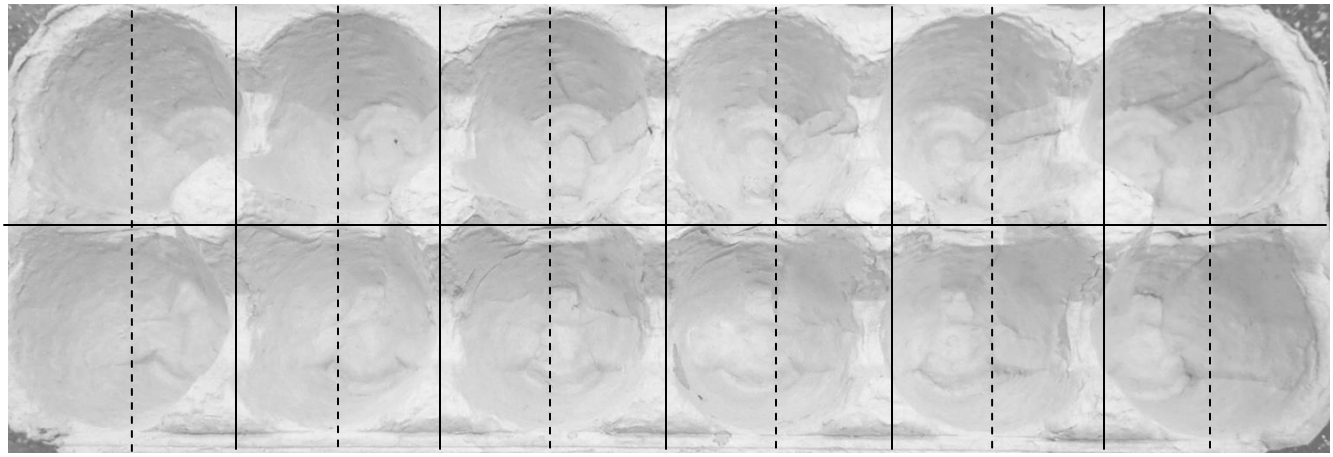
34. Ask students if this lesson has raised any additional questions they would like to put on the Question Wall.

Name: _____ Date:_____ Period:_____

This activity simulates a genetic predisposition for getting type 2 diabetes. A high number indicates an increased risk, a neutral number indicates no change, and a low or negative number indicates the possibility of a protective effect.

Directions:

1. One person selects two beans from the bag and places them in the first egg carton slot.
2. Continue drawing two beans until each egg carton slot has two beans, for a total of 24 beans.
3. Record your bean combinations in the space below using the following symbols:
   - An orange bean is represented by a **+**. This indicates a risk factor.
   - A green bean is represented by a **-**. This indicates a protective factor.
   - A blue bean is represented by a **0**. This indicates a neutral factor.
4. Put the beans back into the bag and let your partner draw beans and record his or her combinations.



5. Tally your genetic risk score by adding 1 for each **+** and subtracting 1 for each **–** . Make no adjustments for each 0.
6. Record your simulated genetic risk score: _____
7. No model is 100% accurate.
   a. What are some strengths of this model?

   b. What are some limitations?

Student Sheet 7.2: *Environmental influences and options*

Student Sheet 7.2

Name: _____ Date: _____ Period: _____

Directions: Fill in the following table to the best of your ability. You will not be required to share your score unless you choose to. "In your community" means the distance you can walk in 15-20 minutes, or the area you drive through frequently.

Environmental Factor	Range	Score	
1. Number of fast food establishments (such as McDonald's or Burger King) or convenience stores that are in your community.	0 – 3 4+	0 +1	
2. Number of times you eat a meal at a fast food restaurant over the course of the week.	0 – 1 2 – 4 5 +	0 +2 +4	
3. Number of servings of fruit juice you drink per day.	0 – 1 2 – 4	0 +2	
4. Number of 12-ounce sugar-sweetened sodas you drink on an average day (one 36 ounce drink = 3 x 12-ounce drinks).	Add 2 points per 12 oz.		
5. Number of grocery stores in your community.	0 1 2+	+1 0 -1	
6. Number of Farmer's Markets, community gardens, or neighbors who share fresh produce in your community.	0 1 2+	+1 0 -1	
7. Number of servings of fruits and vegetables you have on an average day	Subtract 1 pt per serving		
8. Number of times per week you eat red meat (beef, pork, lamb)	0 – 1 2 – 4 5 +	0 +2 +4	
9. Number of times per week you eat whole grains	0 – 1 2 – 4 5 +	+4 0 -4	
10. Number of times per week you eat dessert, cookies and other sweets	0 – 1 2 – 4 5 +	0 +2 +4	
11. Number of local gyms or sports clubs such as the Boys & Girls Club or YMCA in your neighborhood.	0 1 2+	+1 0 -1	
12. Number of times you exercise for 30 minutes or more over the course of the week.	0-1 2-4 5+	+4 0 -4	
13. Number of safe, free places to be physically active, such as parks, trails, skate parks, etc., within walking distance of where you live.	0 1-2 3+	+1 0 -1	
14. Number of days a week you spend more than 2 hours watching TV.	0-1 2-4 5-7	-2 0 +2	
15. Number of days per week you spend more than 4 hours playing video games or being on a computer or on your smart phone.	0-1 2-4 5-7	-2 0 +2	
16. Are the sidewalks in your neighborhood in good repair and/or do you see other people walking?	Yes No	-1 +1	
17. Are there bike lanes, paved shoulders of roads, or other safe places to ride a bike, near where you live?	Yes No	-1 +1	
18. Number of times you bike or walk to a destination over the course of a week, 1/2 a mile or more.	Subtract 1 point per time		

19. Do you have bus access in your neighborhood or within walking distance of where you live?	Yes No	-2 +1	
20. Number of times you drive to a destination less than 2 miles away from your home over the course of a week.	0-5 6+	0 +1	
21. Number of times per day you drink out of an older, hard plastic water bottle that is not BPA-free.	Add 1 point per time		
22. How many hours of sleep do you usually get every night?	Less than 5 5-9 >9	+1 -1 +1	
23. Do you live along a busy road?	Yes No	+1 -1	
24. What is your age?	Up to 45 46-64 65+	0 +2 +4	
25. How are your stress levels, on an average day? 1 2 3 4 5 (Circle a number) Not much Moderate Very stressed	Add the number you circled		

Total Risk Score

Total your *negative* scores here: -

Total your *positive* scores here: +

Add your genetic risk score from Student Sheet 7.1 here:

= Total Risk Score:

Assessment of Risk Score:

1. Do you consider your risk to be high, low, or average? Why?

2. What total risk score would you list as "high risk?" What about "low risk?" Explain your answer.

3. Given your risk score, how would you alter or improve environment risk factors contributing to your risk score?

Access and Choice:

Look back at the environmental factors table. Some of the factors are issues of ***access*** (do you have access to many fast food restaurants in your neighborhood?) and some are issues of ***choice*** (how often do you eat at fast food restaurants?). Put a STAR next to the factors that represent a ***choice.***

Photocopy the following cards back to back, one set per class. Cards can be cut out along the lines.

Environmental Factor 1

Number of fast food establishments (such as McDonald's or Burger King) or convenience stores that are in your community.

Abby G. Ershow, Sc.D. 2009. Environmental Influences on Development of Type 2 Diabetes and Obesity: Challenges in Personalizing Prevention and Management in Journal of Diabetes Science and Technology, Diabetes Technology Society, 3, 727-734.

Environmental Factor 2

Number of times you eat a meal at a fast food restaurant over the course of the week.

Farah Naja, Hwalla N, Itani L, Salem N, Azar ST, Zeidan MN, 2012. Dietary patterns and odds of Type 2 diabetes in Beirut, Lebanon: a case control study. Nutrition and Metabolism 9: 111-122

Environmental Factor 3

Number of servings of fruit juice you drink per day.

Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/

Environmental Factor 4

Number of 12-ounce sugar-sweetened sodas you drink on an average day (one 36 ounce drink = 3 x 12-ounce drinks).

Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/

Environmental Factor 5

Number of grocery stores in your community.

Curry, Andrew. "Bringing Healthy Fare to Big-City 'Food Deserts.'" Diabetes Forecast. December 2009. http://forecast.diabetes.org/magazine/your-ada/bringing-healthy-fare-big-city-food-deserts

Environmental Factor 6

Number of Farmer's Markets, community gardens, or neighbors who share fresh produce in your community.

Curry, Andrew. "Bringing Healthy Fare to Big-City 'Food Deserts.'" Diabetes Forecast. December 2009. http://forecast.diabetes.org/magazine/your-ada/bringing-healthy-fare-big-city-food-deserts

Environmental Factor 7

Number of servings of fruits and vegetables you have on an average day

Harding, AH, Wareham, NJ, Bingham SA et al (2008) Plasma vitamin C level, fruit and vegetable consumption, and the risk of new-onset type 2 diabetes mellitus: the European prospective investigation of cancer—Norfolk prospective study. Arch Intern Med 168:1493-1499.

Environmental Factor 8

Number of times per week you eat red meat (beef, pork, lamb)

Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/

Back of cards

A study from Beirut, Lebanon showed that people with type 2 diabetes are 2.80 times more likely to eat a high fast food diet than people without type 2 diabetes.	A study in Portland, OR showed that an increase in fast food outlets is associated with a 7% increase in being overweight and obese. Li F, Harmer PA, Cardinal BJ, Bosworth M, Acock A, Johnson-Shelton D, Moore JM. Built environment, adiposity, and physical activity in adults aged 50–75. Am J Prev Med. 2008; 35 (1):38–46.
Based on data from several studies, for every 12 oz. serving of a sugary drink per day, diabetes risk increases by 25%. Research on the effects of artificially-sweetened beverages is still unclear about association with t2d, but one large study of men showed that drinking one 12 oz can of diet soda per day does not affect t2d risk.	Drinking 2 or more servings per day of fruit juice is associated with a 31% increase in t2d risk compared to drinking less than 1 serving per month. There is growing evidence that daily drinking of sugary drinks also results in chronic inflammation, high triglycerides, decreased HDL ("good" cholesterol) and increased insulin resistance.
There is a strong correlations between increased rates of type 2 diabetes and people who live in areas without access to affordable, healthy food options within a convenient travelling distance.	A study of Chicago neighborhoods found that people who did not have access to affordable, healthy food options within a convenient travelling distance died from diabetes at twice the rate as people from areas offering access to grocery stores.
Eating red meat (beef, pork, or lamb) or processed red meat daily, even a small serving about the size of a deck of cards, increases diabetes risk by 20%. Replacing red meat with a daily serving of fish, poultry, nuts, or whole grains results in a 35% reduction in diabetes risk.	A 12-year study showed that people with higher levels of vitamin C were less likely to develop diabetes. Vitamin C is a good indicator of fruit and vegetable consumption because fruits and vegetables are the main source of vitamin C in the western diet. Even small amounts of them may be beneficial, and protection against diabetes increases with the amount of fruits and vegetables consumed.

Front of cards

Environmental Factor 9

Number of times per week you eat whole grains.

Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/

Environmental Factor 10

Number of times per week you eat dessert, cookies and other sweets

Farah Naja, Hwalla N, Itani L, Salem N, Azar ST, Zeidan MN, 2012. Dietary patterns and odds of Type 2 diabetes in Beirut, Lebanon: a case control study. Nutrition and Metabolism 9: 111-122

Environmental Factor 11

Number of local gyms or sports clubs such as the Boys & Girls Club or YMCA in your neighborhood.

Auchincloss AH, Roux, A, Mujahid MS, et al. (2009) Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. Arch Intern Med. 12(18):1698-1704.

Environmental Factor 12

Number of times you exercise for 30 minutes or more over the course of the week.

Gill JM and Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. Sports Med. 2008; 38(10):807-24.

Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/

Environmental Factor 13

Number of safe, free places to be physically active, such as parks, trails, skate parks, etc., within walking distance of where you live.

Li F, Harmer PA, Cardinal BJ, Bosworth M, Acock A, Johnson-Shelton D, Moore JM. Built environment, adiposity, and physical activity in adults aged 50–75. Am J Prev Med. 2008; 35 (1):38–46.

Environmental Factor 14

Number of days a week you spend more than 2 hours watching TV.

Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/

Environmental Factor 15

Number of days per week you spend more than 4 hours playing video games, being on a computer or on a phone.

Owen N, Healy GN, Matthews CE, Dunstan DW. Too Much Sitting: The population-Health Science of Sedentary Behavior. Exerc Sport Scien Rev. July 2010; 38(3): 105-113.

Environmental Factor 16

Are the sidewalks in your neighborhood in good repair and/or do you see other people walking?

Auchincloss AH, Roux, A, Mujahid MS, et al. (2009) Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. Arch Intern Med. 12(18):1698-1704.

Back of cards

A study from Beirut, Lebanon showed that people with diabetes are 3.85 times more likely to east a diet high in refined grains and dessert, than people without type 2 diabetes.	In one study of women followed over 18 years, women who ate 3 or more servings of whole grains per day had a 30% lower risk of t2d than those who ate little or no whole grains. Based on several large studies, eating an extra 2 servings of whole grains per day reduces risk by 21%.
Vigorous physical activity is associated with a 20-30% reduction in diabetes risk, and brisk walking for 3.5-5 hours/week can improve risk of not developing type 2 diabetes by 30%. Active muscles involved in physical activity are able to take up increased amounts of glucose. This is balanced by the liver producing more glucose.	A study following people over 5 years found that better neighborhood resources, such as those that offered opportunities to be physically active and access to healthy food, were associated with a 38% lower incidence of type 2 diabetes.
One study found that for every two hours a day spent watching television instead of doing something more active resulted in a 20% increase in diabetes risk.	A Portland, OR study found that a mix of more street intersections interspersed with green spaces and parks was associated with more neighborhood walking. A 10% increase in land-use mix resulted in a 25% reduction in the prevalence of people being overweight and obese, which affects type 2 diabetes.
A study following people over 5 years found that better neighborhood resources, such as those that offered opportunities to be physically active and access to healthy food, were associated with a 38% lower incidence of type 2 diabetes.	One study found that the more time a person sits per day correlates to higher levels of blood glucose and fasting glucose, even in active adults. This study coined the term “Active Couch Potato” to describe adults who got enough physical activity to meet healthy guidelines, but still sat for long periods of time each day

Front of cards

Environmental Factor 17 Are there bike lanes, paved shoulders of roads, or other safe places to ride a bike, near where you live? Auchincloss AH, Roux, A, Mujahid MS, et al. (2009) Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. Arch Intern Med. 12(18):1698-1704.	**Environmental Factor 18** Number of times you bike or walk to a destination over the course of a week, 1/2 a mile or more. Gill JM and Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. Sports Med. 2008; 38(10):807-24.
Environmental Factor 19 Do you have bus access in your neighborhood or within walking distance of where you live? Li F, Harmer PA, Cardinal BJ, Bosworth M, Acock A, Johnson-Shelton D, Moore JM. Built environment, adiposity, and physical activity in adults aged 50–75. Am J Prev Med. 2008; 35 (1):38–46.	**Environmental Factor 20** Number of times you drive to a destination less than 2 miles away from your home over the course of a week. Gill JM and Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. Sports Med. 2008; 38(10):807-24.
Environmental Factor 21 Number of times per day you drink out of an older, hard plastic water bottle that is *not* BPA-free. Alonso-Magdalena P, Morimoto S, Ripoll C , Fuentes E, Nadal A. Effect of Bisphenol A Disrupts Pancreatic B-Cell Function *In Vivo* and Induces Insulin Resistance. Environmental Health Perspectives. 2006; 114(1):106-112.	**Environmental Factor 22** How many hours of sleep do you usually get every night? Gangwisch JE, Heymsfield SB, Boden-Albala B, Buijs RM, Kreier F, Pickering TG, Rundle AG, Zammit GK, Malaspina D. Sleep duration as a risk factor for diabetes incidence in a large US sample. Sleep. 2007; 30(12):1667–1673.
Environmental Factor 23 Do you live along a busy road? Ursula Krämer, Christian Herder, Dorothea Sugiri, Klaus Strassburger, Tamara Schikowski, Ulrich Ranft, Wolfgang Rathmann, 2010. Traffic-Related Air Pollution and Incident Type 2 Diabetes: Results from the SALIA Cohort Study. Environ Health Perspect 118:1273-1279 (2010).	**Environmental Factor 24** What is your age? http://www.diabetes.org/diabetes-basics/statistics/

Back of cards

Vigorous physical activity is associated with a 20-30% reduction in diabetes risk, and brisk walking for 3.5-5 hours/week can improve risk of not developing type 2 diabetes by 30%. Active muscles involved in physical activity are able to take up increased amounts of glucose. This is balanced by the liver producing more glucose.	A study following people over 5 years found that better neighborhood resources, such as those that offered opportunities to be physically active and access to healthy food, were associated with a 38% lower incidence of type 2 diabetes.
Vigorous physical activity is associated with a 20-30% reduction in diabetes risk, and brisk walking for 3.5-5 hours/week can improve risk of not developing type 2 diabetes by 30%. Active muscles involved in physical activity are able to take up increased amounts of glucose. This is balanced by the liver producing more glucose.	A study in Portland, OR found that more public transit stations in an area were associated with people walking more for transportation.
Routinely getting 5 hours or less sleep per night as an adult is associated with developing type 2 diabetes. This effect is attributed to weight gain and chronic stress due to low sleep. There is also an association between getting more than 9 hours sleep per night as an adult and type 2 diabetes. This association may be due to increased release of small proteins which cause sleepiness, and disrupt glucose balance and β cell function.	Bisphenol A (BPA) is used in making polycarbonate plastics and leaches from plastics. BPA is found in the urine of most Americans, and higher levels of BPA in the urine are associated with type 2 diabetes. In studies of mice with higher levels of BPA, beta cells produced and released more insulin, which increased insulin resistance.
As people get older, their risk for type 2 diabetes goes up. About 11% of the people between the ages of 20 and 64 have diabetes. After the age of 65, almost 27% of people in this age group have diabetes. As in other age groups, type 2 diabetes is associated with obesity.	In a longitudinal study of women in an industrialized section of Germany, risk of type 2 diabetes was increased by 15% for each doubling in exposure to particulate matter such as that found in air pollution near busy roads.

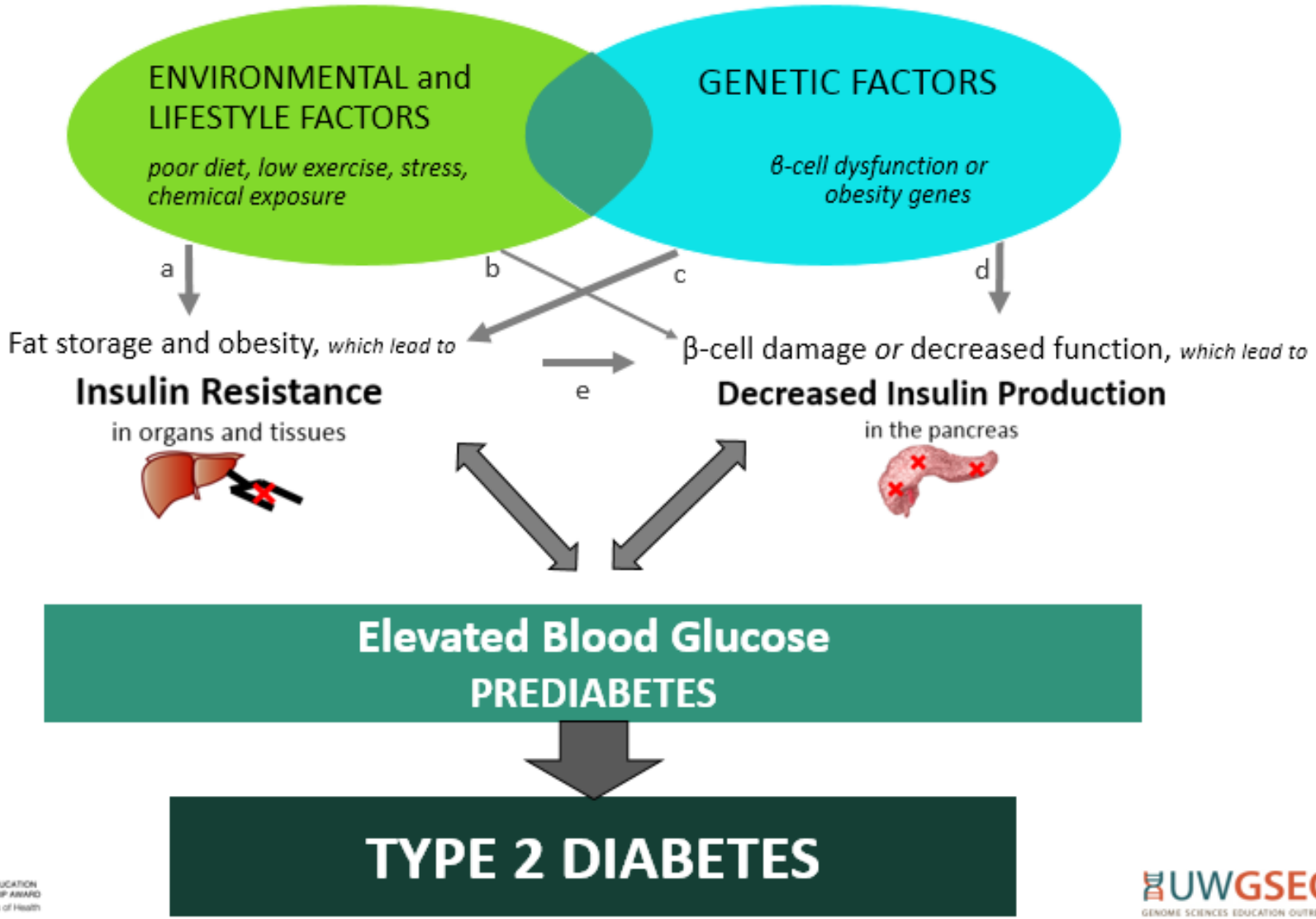
Front of cards

Environmental Factor 25 How are your stress levels, on an average day? Diabetes.co.uk (2013). Diabetes warning for stressed men. http://www.diabetes.co.uk/news/2013/Feb/type-2-diabetes-warning-for-stressed-men-96045737.html	
Gene 1 Melanocortin-4 (MC4) Receptor http://www.diabetes.org/news-research/research/research-database/molecular-genetics-of-human-obesity.html	**Gene 2** Leptin (LEPR) Receptor http://ghr.nlm.nih.gov/condition=leptin-receptor-deficiency
Gene 3 PPAR Gene Family http://www.diabetesselfmanagement.com/Articles/Diabetes-Definitions/ppar_agonists/ Marie-France Hivert et al., Updated Genetic Score Based on 34 Confirmed Type 2 Diabetes Loci is Associated with Diabetes Incidence and Regression to Normoglycemia in the Diabetes Prevention Program. 2011. Diabetes, 6, 1340-1348.	**Gene 4** *TC7L2* Marie-France Hivert et al., Updated Genetic Score Based on 34 Confirmed Type 2 Diabetes Loci is Associated with Diabetes Incidence and Regression to Normoglycemia in the Diabetes Prevention Program. 2011. Diabetes, 6, 1340-1348. http://www.ncbi.nlm.nih.gov/omim http://www.ncbi.nlm.nih.gov/SNP/
Gene 5 *FTO* Frayling, T. M., Timpson, N. J., Weedon, M. N., Zeggini, E., Freathy, R. M., Lindgren, C. M., Perry, J. R. B., Elliott, K. S., Lango, H., Rayner, N. W., Shields, B., Harries, L. W., and 30 others. A common variant in the FTO gene is associated with body mass index and predisposes to childhood and adult obesity. Science 316: 889-894, 2007. http://www.ncbi.nlm.nih.gov/omim http://www.ncbi.nlm.nih.gov/SNP/	**Gene 6** *CDKAL1* Marie-France Hivert et al., Updated Genetic Score Based on 34 Confirmed Type 2 Diabetes Loci is Associated with Diabetes Incidence and Regression to Normoglycemia in the Diabetes Prevention Program. 2011. Diabetes, 6, 1340-1348. http://www.ncbi.nlm.nih.gov/omim http://www.ncbi.nlm.nih.gov/SNP/

Back of cards

	From a 35 year longitudinal study of 7000 Swedish men, it was found that chronically stressed men had a 45% higher risk of developing type 2 diabetes. Stress results in the release of the hormone cortisol, which raises blood pressure, and raises blood glucose by causing insulin resistance.
Leptin is a hormone produced by fat cells that manages appetite and metabolism. Binding of leptin to leptin receptors reduces the amount of glucose released into to the blood by the liver and increases glucose uptake from the blood into the muscle. A mutation to the LEPR (leptin receptor) is a rare cause of obesity.	The MC4 receptor is expressed in the brain and helps match food intake to energy expenditure. Mutations in the MC4 receptor can predispose an individual to severe obesity. Mutations in the MC4 receptor gene account for 1 to 6% of cases of severe obesity cases
The protein coded for by the gene TC7L2 is involved in maintaining glucose homeostasis. Risk alleles in this gene have been shown to be associated with impaired β cell function and type 2 diabetes in European populations	This gene family regulates the body's breakdown of fatty acids, the generation of fat cells and affects blood glucose control. A variation in the PPAR-gamma gene is associated with a *reduction* in the risk for type 2 diabetes as it predisposes people to having less fat. A group of anti-diabetic drugs targets the PPAR-gamma gene
The gene CDKAL1 is expressed the most in skeletal muscle and the brain. The protein from this gene may be involved with insulin release, and certain allele combinations decrease insulin levels by 20%.It is thought to be associated with decreased β cell function.	The gene FTO is involved in hunger control, and people with the risk alleles are associated with increased body mass indexes and rates of obesity, both of which are linked to type 2 diabetes.

Contributions to Type 2 Diabetes



SEPA Science Education Partnership Award. Supported by the National Institutes of Health

UWGSEO Genome Sciences Education Outreach

Lesson 8 Who decides?

Overview
In this lesson, students are introduced to a series of quotes from individuals who hold a variety of views concerning the rising rates of type 2 diabetes and obesity in the United States. Students are introduced to the ethical principles *Respect for Persons, Justice,* and *Maximizing Benefits/Minimizing Harms* in order to better understand the wide range of views on this subject. Next, students learn about the Healthy, Hunger-Free Kids Act of 2010 and participate in a ***Structured Academic Controversy*** about the policy, eventually coming to their own well-supported position on the issue.

Enduring understanding:
- Public health policies, personal choice, community resources, socio-economic status and other factors all contribute to a person's risk of developing type 2 diabetes and obesity. These factors also provide productive areas for preventative measures.
- The field of ethics can help us consider alternate viewpoints in the face of conflicting choices, and can provide an organizing framework to help in decision-making.

Essential question: As a society, how do we make the best decisions about policies that affect many people?

Learning objectives
Students will be able to:
- Understand other positions on an issue, even if they don't agree with it.
- Engage in shared decision-making.
- Support their own position using the principles Respect for Persons, Justice, and Maximizing Benefits/Minimizing Harms.

Time: One to two 50 minute periods

This lesson connects to the Next Generation Science Standards in the following ways:

Constructing Explanations and Designing Solutions
HS-LS2-7: Design, evaluate and refine a solution to a complex, real-world problem

Engaging in Argument from Evidence:
HS-LS2-6: Evaluate the claims, evidence and reasoning behind currently accepted explanation or solution to determine the merits of arguments.

HS-LS2-8: Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.

Ties to Nature of Science: Science is influenced by society and society is influenced by science.

Materials

Materials	Quantity
Computer and projector	1 per class
PowerPoint presentation found at http://gsoutreach.gs.washington.edu/ (see GEMs Instructional Materials)	1 per class
Teacher Resource: *A variety of views on type 2 diabetes and obesity*	1 per class
YouTube Video: Uproar Over School Lunches https://www.youtube.com/watch?v=olZVsiH3qrY	
Student Sheet 8: *Structured Academic Controversy Worksheet*	1 per student
Student Resource 8.1: *Background on Healthy, Hunger-Free Kids Act*	1 per student
Student Resource 8.2: *Position Statement: FOR*	1 per student for half the class
Student Resource 8.3: *Position Statement: AGAINST*	1 per student for half the class

Lesson Preparation

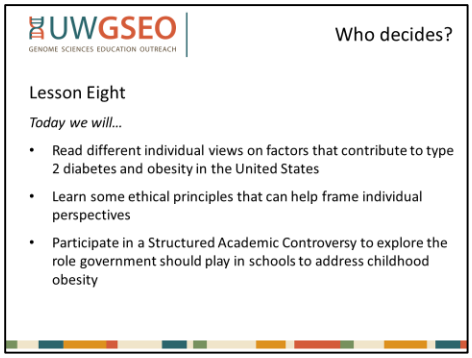
Make copies of materials, as indicated above. *Student Sheets* are needed one per student, and *Student Resources* may be put in page protectors and reused with subsequent classes.

Procedures

Part 1 (Engage): Views on diabetes and obesity (*10 minutes*)

1. Using the PowerPoint presentation found at www.gsoutreach.gs.washington.edu, introduce the lesson to students.

Slide 1

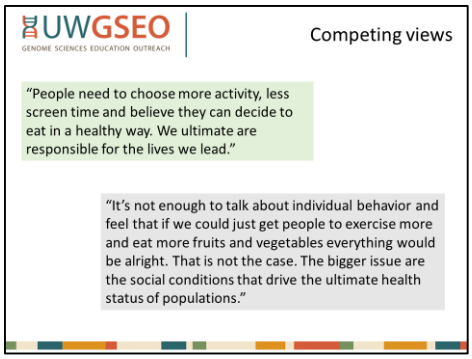


2. Since students may be sharing personal viewpoints during this lesson, it is especially important to remind them of your classroom discussion norms, or set some norms if you have not already done this. For example, students should speak one at a time, hear all sides equally, listen well enough to respond, and back up their opinions with clear reasons.

3. Pass out the quotes from various individuals with views on the conditions leading to type 2 diabetes or the obesity epidemic, found in Teacher Resource: *A variety of views on type 2 diabetes and obesity.*

4. Introduce the quotes using the PowerPoint slides. Have students read the quotes found on their cards as the correct slide appears.

Slides 2 - 6



5. Ask students, ***"How do we make decisions about issues that affect all of us, when there are so many competing viewpoints?"***

Part 2 (Explore/Explain) Introduction to ethical principles *(10 minutes)*

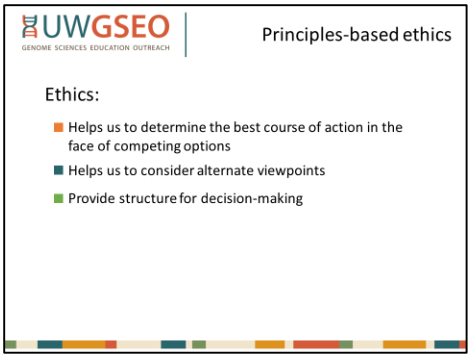
6. Explain to students that the field of ethics can help us determine the best course of action about issues for which there are many competing views. Because we live in a democratic society made up of various religious, ethnic, racial and political groups, the field of ethics can help us consider alternate viewpoints, and can provide an organizing framework to help in decision-making.

7. Introduce students to ***Principles-based ethics*** which include the following principles:

Respect for Persons (Autonomy)	Acknowledges a person's right to make choices, to hold views and to take actions based on personal values and beliefs. It emphasizes an individual's autonomy and the responsibility a person has for his or her own life.
Justice	Stresses fairness and giving people equal treatment. Justice dictates that resources, risks, and costs should be distributed equitably.
Maximizing benefits/ Minimizing harms	Stresses "doing good" and "doing no harm"—to provide benefit to people and contribute to their welfare, while avoiding intentionally inflicting harm on others.

Source: *Bioethics 101*, Northwest Association for Biomedical Research, NWABR.org

Slides 7 – 11 provide students with background on principles-based ethics.

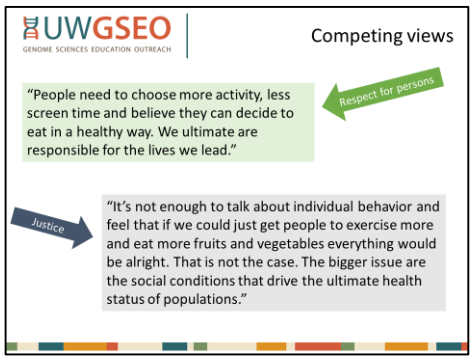


8. Ask students if the concepts behind the ethical principles are familiar to them, and where they think these principles came from. Let students know that the historical basis for the principles goes back thousands of years. They are rooted in, among others, Aristotle's teachings, the Hippocratic Oath doctors take before practicing medicine ("do no harm"), the Nuremburg Code created after World War II, and the Belmont Report from the 1970s.

9. The principles represent different ways of thinking about issues that affect groups of people living together in societies. As such, while ethical principles may conflict with each other, or different groups of people may prioritize different principles, no one principle is "right" while another is "wrong."

10. Ask students to revisit the quotes from their individual and see if they can identify the ethical perspective that person might be coming from. It may be helpful to know that in this particular issue, the greatest tension is between the principles *Respect for Persons* and *Justice,* though one could make an argument for *Maximizing benefits and Minimizing risks* for a few quotes (see note).

Slide 12



Note: The principle *Maximizing benefits/Minimizing harms* comes into play most directly when the speaker refers to policies or practices that may cause harm, such as conscientious efforts on the part of food manufacturers to get people "hooked" on processed food, or comparing the food companies to the tobacco companies.

11. If students have trouble identifying the ethical perspective of their speaker, share the following table with them.

With this Principle….	You may see these key words….
Respect for Persons	Rights, Individual, responsibility, self-determination
Justice	Social/society, wealth, access, fairness, equity
Benefits/Risks	Balance, weighing risks and benefits, doing good, doing harm

Part 3 (Elaborate) Structured Academic Controversy *(30 min)*

Structured Academic Controversy (SAC) is a small group deliberation model where students explore both sides of an issue before examining their own personal views. Active listening is an important part of the process. The topic for the SAC will be the *Healthy, Hunger-Free Kids Act of 2010*. Students will receive background information on the topic, watch an ABC news report and receive position statements about the issue during the Structured Academic Controversy.

12. Ask students to get into groups of four. Two students will initially represent the FOR position and two will represent the AGAINST position to the question.

13. Before getting into the topic, share with students the framework of a Structured Academic Controversy. The basic framework is outlined below:

Note: Students will have a chance to justify their personal position on the issue at the end of the SAC, so encourage them to not be too concerned about the side they are initially asked to represent.

- Two students represent the ***FOR*** position; two argue the ***AGAINST*** position.
- Each pair watches a video and/or reads background for their position and prepares their argument.
- Pair A presents while Pair B listens.
- Pair B paraphrases Pair A's arguments and asks clarifying questions only (this is not the time for discussion).
- Pair B presents while Pair A listens.
- Pair A paraphrases Pair B's arguments and asks clarifying questions only.
- Students drop their assigned roles and discuss their own personal positions.
- Students clarify areas of agreement and disagreement.

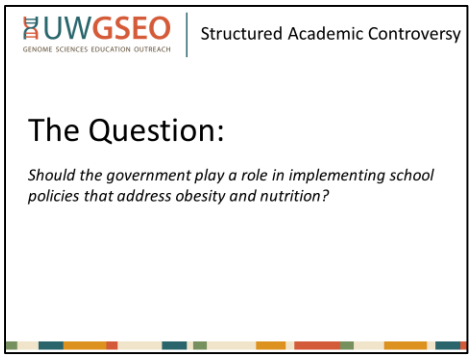
14. Introduce the topic of the *Healthy, Hunger-Free Kids Act* by passing out Student Resource 8.1—Background on the *Healthy, Hunger-Free Kids Act* and reading it either individually or as a class.

15. Show students the ABC video *Uproar over School Lunches* found at https://www.youtube.com/watch?v=olZVsiH3qrY. (4:10)

16. Introduce the question that students will be exploring during the Structured Academic Controversy:

Should the government play a role in implementing school policies that address obesity and nutrition?

Slide 13



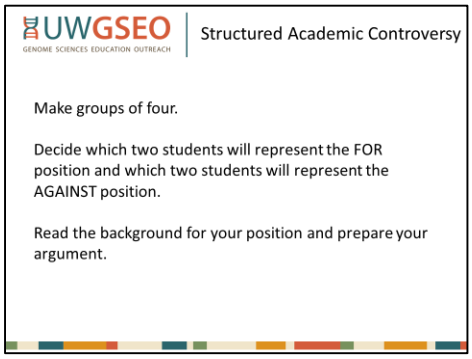
17. Distribute Student Handout 8.1—*Structured Academic Controversy Worksheet* to each student.

18. Have students meet in their FOR (*yes*, the government *should* play a role) or AGAINST (*no*, the government *should not* play a role) pair groups to discuss the video and brainstorm points that support their position.

19. In their pair groups, have students fill out as much as they can in the *Relevant Facts* and *Individuals and their primary concerns* sections of Student Handout 8.1-- *Structured Academic Controversy Worksheet.*

20. After adequate time for discussion, hand out additional information supporting each stance found on Student Resource 8.2—*FOR Position Statement*, and Student Resource 8.3—*AGAINST Position Statement.* Students should continue representing their assigned position at this point, not their personal position.

Slide 14

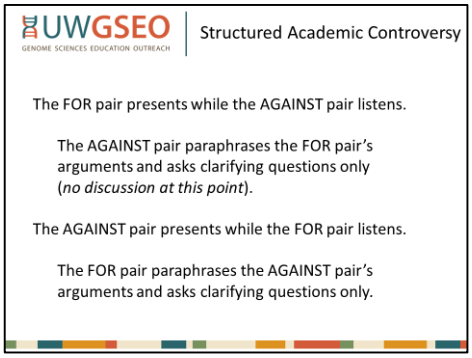


Note: Slides 14, 15 and 16 can be used to walk students through the steps of the SAC, if needed.

21. Ask each pair to read the additional background information supporting their position. Using all of the resources available, have each pair plan a presentation of their position and arguments. Students should focus on the ***three most important arguments***.

22. **Have one side present, while the other side listens and then repeats.** Have one side presents their three important arguments to the other side. The other side needs to listen carefully, take notes, and then paraphrase the arguments back in order to be sure that they understand them, while asking clarifying questions as necessary. Emphasize that there is no discussion at this point. The presenters should be satisfied that their position has been heard and understood.

Slide 15



23. **Have the pairs switch** and repeat the process.

24. **Next, ask students to drop their roles.** Challenge students to proceed as their own individual selves with their own opinions and positions. They should use information from their own experiences as well as the background readings. Ask students, ***"See if you can clarify areas of agreement and disagreement. Feel free to change your mind."***

Slide 16

25. While working through the Structured Academic Controversy, students should continue to fill out Student Handout 8.1—*Structured Academic Controversy Worksheet.*

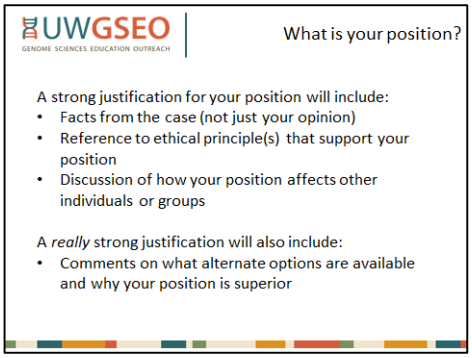
Closure (Evaluate)

26. Gather student attention back from the small groups, and ask students to share the ***common ground*** reached in the argument (referring to the next-to-last part of Student Handout 8—*Structured Academic Controversy Worksheet*).

27. Ask students to identify the extreme positions on the spectrum of stakeholder views. What would happen if there was *no* government involvement whatsoever? What if there was *total* government involvement? How do extreme positions advance a cause? Or does change come from a more central stance?

28. After students have fully discussed the issue, have them write up their own personal position on this issue, as described in the last box of the *Structured Academic Controversy Worksheet*. Tell students that a strong position will incorporate facts from the case, not just their opinions. Their position can be strengthened by reference to supporting ethical principle(s), and an explanation of how their position will impact other individuals or groups.

Slide 17



29. Ask students to reflect on today's lesson consider the question:

    "How does this relate to our Driving Question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?"***

30. How can knowledge gained today be incorporated into their Call to Action products?

Note: As students have now completed the curricular portion of the Diabetes Unit, It is important to allow sufficient time for groups to work together on their Call to Action products and revisit the *Chalk Talk* posters from Lesson One. At least two class periods are recommended. More information can be found in the *Assessment* portion of this unit.

Resources and Extensions

- Teachers who would like more information on ethical theories and their application in the classroom will find lessons, activities, student handouts and teachers resources in *An Ethics Primer: Lesson Ideas and Ethics Background.* The curriculum unit *Bioethics 101* provides a sequential set of lessons to introduce ethics into the science classroom. Both curricula are produced through the Northwest Association for Biomedical Research and available free for download from NWABR.org.

- A video of a teacher describing the practice of Structured Academic Controversy and possible modifications can be found here: http://vimeo.com/39005142

- A number of the quotes came the following article, or reader responses to the article:

  Moss, Michael. "The extraordinary science of junk food." The New York Times. February, 2013. [http://www.nytimes.com/2013/02/24/magazine/the-extraordinary-science-of-junk-food.html?pagewanted=all&_r=0]

  As an extension, students could read the article and further analyze the ethical perspective of chosen reader comments, of which there are many.

- Other quotes came from the episode "In Sickness and in Wealth" from the film *Unnatural Causes* available from California Newsreel.

Instructions: Print out and cut apart the following cards to give to groups of students.
Cut off the ethical principle written horizontally on each card, before giving the cards to students.

"If you're in an impoverished community and don't have access to health choices for food and safe places to exercise, you're tremendously disempowered when it comes to a disease like diabetes. That has nothing to do with how much medication is in the pharmacy and everything to do with a sense of control, a sense of self-empowerment… a sense of hope for the future." Source, Unnatural Causes	Justice
"It's not enough to talk about individual behavior and feel that if we could just get people to exercise more and eat more fruits and vegetables everything would be alright. That is not the case. The bigger issues are the social conditions that drive the ultimate health status of populations." Adewale Troutman, MD, Director of Louisville Metro Public Health and Wellness	Justice
"It's about human rights, it's about addressing the social determinants of health, it's about fairness, it's about health equity and social justice." Adewale Troutman, MD Director of Louisville Metro Public Health and Wellness	Justice
"So why are the diabetes and obesity and hypertension numbers still spiraling out of control? It's not just a matter of poor willpower on the part of the consumer and a give-the-people-what-they-want attitude on the part of the food manufacturers. What I found, over four years of research and reporting, was a conscious effort — taking place in labs and marketing meetings and grocery-store aisles — to get people hooked on foods that are convenient and inexpensive." Michael Moss, *The Extraordinary Science of Addictive Junk Food*, New York Times, Feb. 20, 2013	Harms and Benefits
"People need to choose more activity, less screen time and believe they can decide to eat in a healthy way. We ultimately are responsible for the lives we lead." Reader comment from *The Extraordinary Science of Addictive Junk Food* : Phil from Canada	Respect for Persons

"In America, it's the strongest relationship that you'll find pretty much anywhere that health equals wealth." Tony Iton, Director, Public Health Department, Alameda County, California	Justice
"The vast majority of improvements in health over the last century have had very little to do with medical innovation. What really counts is…nonmedical things, like thinking about the distribution of wealth in our society, or providing public health infrastructure, or better education for people, or better housing. All of those things that are not medical phenomena." Unnatural Causes	Justice
"As a culture, we've become upset by the tobacco companies advertising to children, but we sit idly by while the food companies do the very same thing. And we could make a claim that the toll taken on the public health by a poor diet rivals that taken by tobacco." Kelly Brownell, Professor of Psychology and Public Health, Yale University	Harms and Benefits
"Some people say healthy food is too expensive. A bag of potato chips costs over $3.00. A bag of candy costs about $3.00. I just bought a bag of baby spinach for $1.98. I bought a bag of fresh snap peas for $2.98. Frozen vegetables (at WalMart) run about $1.50. Different parts of the country have different price ranges, but where I live, fruits and vegetables are cheaper than candy and potato chips." Reader comment from *The Extraordinary Science of Addictive Junk Food* : Linda from Oklahoma	Respect for Persons
I like junk food as much as anybody. But when I finally got on the scale, I realized I had to lose 20 pounds. So I went on a high-protein, higher-fat, low-carbs, low-sugar regimen, and lost 20 pounds in 2 months - with minimal exercise. And I did not have as single Dorito or other chip. It's called being disciplined and motivated. If you are disciplined and motivated, you are, you can go "cold turkey" off junk food in one day. This is not heroin or crystal meth, for goodness sakes. Reader comment from *The Extraordinary Science of Addictive Junk Food* : Joseph from Albany	Respect for Persons
"People could point to these things [Lunchables] and say, 'They've got too much sugar, they've got too much salt. Well, that's what the consumer wants, and we're not putting a gun to their head to eat it. That's what they want. If we give them less, they'll buy less, and the competitor will get our market. So you're sort of trapped." Geoffrey Bible, former C.E.O. of Philip Morris	Respect for Persons

Name: _____ Date: _____ Period: _____

Structured Academic Controversy Worksheet

The Issue: *Should the government play a role in implementing school policies that address obesity and type 2 diabetes?*

Team Members ***FOR:*** (Y*es*, the government *should* play a role)

1. _____
2. _____

Team Members ***AGAINST****: (No,* the government *should not* play a role)

1. _____
2. _____

Relevant facts:
Individuals (or groups) and their primary concerns:

Structured Academic Controversy worksheet courtesy of Northwest Association for Biomedical Research, www.nwabr.org.

Structured Academic Controversy Worksheet (continued)

Main argument(s) ***FOR:***	Main argument(s) ***AGAINST:***
1. 2. 3.	1. 2. 3.
List of possible solutions: (What are the options furthest out on each side? What options are in the middle ground?)	
Common ground reached:	
My position is… On a separate piece of paper, explain your position on this issue. To support your position, incorporate FACTS from the case, ties to ETHICAL PRINCIPLE(S), and describe how your position will AFFECT OTHER INDIVIDUALS or groups.	

Background on *Healthy, Hunger-Free Kids Act*

In 2010, Democrats and Republicans worked together to pass the Healthy, Hunger-Free Kids Act. One goal of the law was to help reduce childhood obesity and increase the health of children across the country by providing balanced meals. This law helps ensure that every American child has access to healthy foods and good nutrition through programs such as the National School Lunch Program.

Schools that participate in the National School Lunch Program receive money from the U.S. Department of Agriculture (USDA) for each meal they serve. In return, they must serve lunches that meet Federal requirements. All students can participate in the school lunch program, and students from low-income families qualify for free or reduced-priced lunches. The National School Lunch Program serves over 31 million students on a typical day, and about 60% of the participants nationwide qualify for free or reduced cost lunches.

The new standards began to go into effect in 2012. The law works to enhance school nutrition in a number of ways, including:

- Setting nutrition standards for all foods sold on the school campus throughout the school day, including foods from vending machines and school stores.
- Offering only lower-fat milk options.
- Requiring that water is available for free during meal service.
- Providing schools money for farm-to-school programs.

The law sets limits for the total number of calories available to students based on their ages (up to 850 calories for a high school student), and requires that more of these calories come from whole grains, fruits, and vegetables, and fewer calories come from fats and sugars. The use of salt is also limited.

Sources:

United States Department of Agriculture, *Fact Sheet: Healthy, Hunger-Free Kids Act School Meals Implementation*, Washington, D.C., viewed June 9, 2014 <http://www.fns.usda.gov/pressrelease/2014/009814>

United States Department of Agriculture, *Fact Sheet: National School Lunch Program*, Washington, D.C., viewed June 9, 2014 <http://www.fns.usda.gov/sites/default/files/NSLPFactSheet.pdf>

Food Research and Action Center, *Summary of School Nutrition Program Provisions in the Healthy, Hunger-Free Kids Act of 2010,* Washington, D.C., viewed June 9, 2014.
< http://frac.org/wp-content/uploads/2010/04/cnr_school_nutrition_program_provisions_summary.pdf>

Position Statement: FOR

Should the government play a role in implementing school policies that address obesity and nutrition?

YES, the government should play a role. It is the role of the government to promote safe policies and contribute to the health and well-being of the public. Successful, life-saving, public health campaigns of the past include the creation of laws for the use of seat belts and child car-seats, and the sale and marketing of tobacco products.

While the USDA has always established nutritional standards for School Lunch Nutrition Program, the guidelines in the past have not applied to foods sold outside of the cafeteria in snack bars, vending machines and school stores. This has allowed schools to sell candy, soda and other items that compete with the healthier choices offered by the cafeteria. It has also allowed cola companies such as Coca Cola and Pepsi to offer funding to cash-strapped schools in return for offering their products, so that almost 80% of public schools in the US now sell Coke and Pepsi products. The Healthy, Hunger-Free Kids Act applies the tighter nutrition standards to *all* foods sold on the school campuses, which leads to healthier snack and drink options.

The state of California limits the sale of junk food in the schools, and a study published in the *Archives of Pediatric Adolescent Medicine* in 2012 found that students in California take in significantly fewer total calories than kids in states with fewer restrictions on junk food sold in schools.

Childhood obesity rates have nearly tripled in the last 30 years, rising even faster than adult obesity rates. This puts considerable strain on individuals, families, communities and health care systems as people become more likely to develop type 2 diabetes, heart disease, and other obesity-related health conditions. The cost of treating these conditions is burdensome. The direct medical costs to treat and care for people with type 2 diabetes in 2007 was estimated to be $116 billon, with the medical expenses for a person diagnosed with diabetes to be more than twice those than for a person without diabetes. It is the role of the government to provide leadership for such large-scale challenges. Working to *prevent* children from becoming obese by offering and encouraging healthy foods through the school lunch program is an appropriate and necessary role for the government.

Center for Disease Control. *Chronic Disease Prevention and Health Promotion: Diabetes*. Viewed June 10, 2014. < http://www.cdc.gov/chronicdisease/resources/publications/aag/ddt.htm>

Trust for America's Health. *TFAH Issues: Obesity.* Washington, D.C. Viewed June 10, 2014. < http://healthyamericans.org/obesity/>

Finkelstein, DM, Hill, EL, Whitaker, RC. *School Food Environments and Policies in US Public Schools*. Pediatrics Vol. 122 No. 1 July 1, 2008 pp. e251 -e259.

Position Statement: AGAINST

Should the government play a role in implementing school policies that address obesity and nutrition?

NO, the government should NOT play a role. The government should respect the voluntary choices made by individuals when it comes to what they eat. Students generally understand the difference between healthy and unhealthy foods and make choices about food based on complex personal preferences. Government intervention in this process is unnecessary and oversteps the role of government.

The Healthy, Hunger-Free Kids Act limits a high school student's lunch to 850 calories, which is too low for growing students, especially those participating in sports. A high school boy, on average, needs between 2,200 and 3,200 calories a day, and a high school girl requires between 1,800 to 2,400 calories. A student involved in a strenuous sport may need 3,500 calories a day. When sports teams meet directly after school, students may have to rely on food provided in the schools. If high calorie food choices are removed from vending machines under the law, students will have even fewer options to keep them sustained until their next meal.

By increasing whole grains, fruits, and vegetables, and limiting fat, sugar, and salt, the new law does not provide students with food that they want to eat. This leads to increased waste, as students throw away food they must take but will not eat. Because students do not want to eat the new school lunches, about one million students dropped from the full-priced Nation School Lunch program in the 2012-2013 school year.

About 10% of the affected schools have found the program too expensive to implement. Even though the Federal government reimburses schools more money per lunch than in years past, schools are paying more for the type of food they are mandated to serve. Schools having trouble adopting the new standards should be able to opt out of the Healthy, Hunger-Free Kids Act and provide their students choices based on the needs and wants of their student population. The government should not intervene in this most basic aspect of our lives.

Wasson, Erik. *Michelle bites back on school lunches*. The Hill, Accessed June 10, 2014. < http://thehill.com/policy/finance/207278-first-lady-comes-out-swinging-against-gop-lunch-plans>

Duyff, Roberta. (2006). American Dietetic Association Complete Food and Nutrition Guide, 3rd ed. Access June 10, 2014. < http://www.eatright.org/kids/article.aspx?id=6442459420>

Bakst, Daren. *Government control of your diet: threats to "Freedom to Eat"* The Heritage Foundation, Washington, D.C. Accessed June 10, 2014. <http://www.heritage.org/research/reports/2013/09/obamacare-menu-labeling-requirement-government-control-of-your-diet>

Overview

Chalk Talk: As a *formative assessment*, students should participate in the final installment of silent *Chalk Talk* after completing the unit. At the beginning of the unit, students took part in this silent conversation technique by adding their comments, questions and reactions to a series of posters addressing themes found throughout the type 2 diabetes curriculum. Ideally, the posters should have been revisited once or twice during the unit, and then for the last time during the final assessment time.

After adding to the "conversation" a final time (ideally in a new pen color for each poster), the class can engage in a whole class discussion about what students observed and how their understanding and beliefs about the causes, preventions and impacts of type 2 diabetes have changed, or not, over time. This provides the teacher with a formative assessment of students understanding.

Call to Action: As a *summative assessment*, students continue to work on their *Call to Action* products, in which they have been synthesizing and applying their learning throughout the unit by creating a product that demonstrates their understanding of type 2 diabetes, addresses a specific diabetes-related problem, and contributes to a solution. Successful *Call to Action* products implement direct, meaningful, and relevant actions in order to make a contribution towards combatting diabetes within the students' communities.

Learning Objectives

Students will be able to:

- Understand a problem associated with type 2 diabetes and implement a Call to Action product that contributes to a solution for the particular problem
- Develop a presentation for a specific target audience that communicates the goals, methods, results, and conclusions of the product.

Time: Students should be working in groups throughout the unit to identify areas of interest, and then assimilate, integrate and apply new information as they learn it. In creating a product, students identify an audience, and showcase their understanding of type 2 diabetes through an activity that is meaningful for that audience. At the end of the unit, students should be given at least two class periods to finalize their products.

Materials

Materials	Quantity
Computers for students	1 per student, if possible
Call to Action Resources*	Available for students
Call to Action Group Planning Worksheet*	1 per group
Grading Rubric	1 per student

**These documents are available in Word form at:*
https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/

Project Based Learning

Type 2 diabetes is a complex condition that brings together issues of health care, scientific research, environmental influences, personal choice, access to resources, diet and exercise, social justice, public policy and more. The nature of this complex topic lends itself well to a *Project Based Learning* approach in the classroom. Using this teaching method, students work for an extended period of time to investigate and respond to this multi-faceted topic by addressing a specific diabetes-related problem and finding ways to contribute to a solution.

As with other project-based units, this curriculum is focused by a *driving question* that is open-ended and allows for students to make choices about which aspects of type 2 diabetes they would most like to explore as they create a project product. The driving question creates a *need to know* for the students, and each lesson contributes to the overall content knowledge and skill base that students will need to rely on as they implement direct, meaningful and relevant actions in order to make a contribution towards combatting diabetes within the students' communities. The driving question for this unit is:

How can the growth of type 2 diabetes [in the Yakima Valley] be slowed?

In order to deeply consider the driving question, students have been provided with information to answer a number of other complex questions, including:

- What causes type 2 diabetes?
- How can it be prevented or slowed?
- Why is it growing?
- Are there aspects of my environment (i.e. Yakima Valley) that contribute to this condition?
- Are there social factors in my area that contribute to type 2 diabetes?
- How do we as a society make decisions about policies that affect many of us?

A helpful resource with background materials and resources for Project Based Learning and can be found at the Buck Institute for Education (www.bie.org).

Project Ideas

Ideas for projects may include:

- Survey and analyze foods typically given at food banks
- Develop a cookbook
- Enroll a team/create an educational table for a *Tour de Cure* or other event
- "Do This, Not That" (in parallel to book "Eat This, Not That")
- Develop a script for a "living room focus group"
- Propose public policy at local or state level to improve health
- Develop a monthly healthy menu plan for a family of four given a budget
- Assess the nutritional quality of school lunch programs
- Educate peers and others on sugar content of common drinks

Call to Action Resources

Name of resource
"A Call to Action on Diabetes." International Diabetes Federation. Nov. 2010. Web. <http://www.idf.org/webdata/Call-to-Action-on-Diabetes.pdf>. "A Health Literacy Curriculum for ESOL Learners (Intermediate Level) | Queens Library." A Health Literacy Curriculum for ESOL Learners (Intermediate Level) | Queens Library. Queens Library, 2012. Web. 22 May 2012. <http://www.queenslibrary.org/services/health-info/english-for-your-health/teacher-intermediate-level>. "American Diabetes Association: Diabetes." 1995-2012. Web. 22 May 2012. <http://www.diabetes.org/>. "America's Move to Raise a Healthier Generation of Kids." Let's Move! USDA. Web. 29 May 2012. <http://www.letsmove.gov/>. "Characteristics of an Effective Health Education Curriculum." Centers for Disease Control and Prevention. 29 Nov. 2011. Web. 29 May 2012. <http://www.cdc.gov/healthyyouth/sher/characteristics/index.htm>. "Diabetes." WHO. 2012. Web. 22 May 2012. <http://www.who.int/mediacentre/factsheets/fs312/en/>. "Diabetes Public Health Resource." Centers for Disease Control and Prevention. 2012. Web. 22 May 2012. <http://www.cdc.gov/diabetes/>. "Final Rule: Nutrition Standards in the National School Lunch and School Breakfast Programs." United States Department of Agriculture. 25 May 2012. Web. 29 May 2012. <http://www.fns.usda.gov/cnd/Governance/Legislation/nutritionstandards.htm>.

Gill-Carey, O., and AT Hattersley. "Genetics and Type 2 Diabetes in Youth." National Center for Biotechnology Information. U.S. National Library of Medicine, 2007. Web. 29 May 2012. <http://www.ncbi.nlm.nih.gov/pubmed/17991132>.

"NHLBI-Portion Distortion Quiz." Stay Young At Heart. National Heart, Lung and Blood Institute. Web. 29 May 2012. <http://hp2010.nhlbihin.net/portion/index.htm>.

"NIH and the Weight of the Nation - Health Information - National Institutes of Health (NIH)." U.S National Library of Medicine. 15 May 2012. Web. 29 May 2012. <http://www.nih.gov/health/NIHandweightofthenation/>.

"NIH Research Featured in HBO Documentary Series on Obesity." National Heart, Lung and Blood Institute. National Institute of Health. Web. 29 May 2012. <http://www.nhlbi.nih.gov/news/press-releases/2012/nih-research-featured-in-hbo-documentary-series-on-obesity.html>.

"Succeed at Weight Loss with Lose It!" Lose It! -. Fit Now, Inc. Web. 29 May 2012. <http://www.loseit.com/>.

"SuperTracker." SuperTracker. United States Department of Agriculture. Web. 29 May 2012. <http://www.choosemyplate.gov/supertracker-tools/supertracker.html>.

"Type 2 Diabetes." MedlinePlus Medical Encyclopedia. U.S. National Library of Medicine, 19 Apr. 2012. Web. 29 May 2012. <http://www.nlm.nih.gov/medlineplus/ency/article/000313.htm>.

The Weight of the Nation resources:

"The Weight of the Nation." HBO. Home Box Office, Inc., 2012. Web. 29 May 2012. <http://theweightofthenation.hbo.com/>.

"The Weight of the Nation: A Model of Community Action." HBO. Home Box Office, Inc. Web. 29 May 2012. <http://theweightofthenation.hbo.com/films/bonus-shorts/healthy-mom-healthy-baby-the-risks-of-excess-weight>.

"The Weight of the Nation: Download Materials." HBO. Home Box Office, Inc. Web. 29 May 2012. <http://theweightofthenation.hbo.com/screenings/download-materials>.

"The Weight of the Nation: Obesity and Type 2 Diabetes." HBO. Home Box Office, Inc. Web. 29 May 2012. <http://theweightofthenation.hbo.com/films/bonus-shorts/healthy-mom-healthy-baby-the-risks-of-excess-weight>.

"The Weight of the Nation: Schools & Early Care." HBO. Home Box Office, Inc. Web. 29 May 2012. <http://theweightofthenation.hbo.com/themes/schools-and-early-care>.

Call to Action Planning Worksheet

Student Sheet

Name: _____ Date: _____ Period: _____

Use this worksheet to plan your Diabetes Call to Action product.

Names:
Group Name:
Problem Statement: What specific problem will your project address?
Research: Before you decide on a product, you must do research about the problems or barriers associated with diabetes in your community and possible actions you can take. Summarize the research your group did before decided on a project. • Did you read news article or books on the issue? • Did you interview an expert of members of your community? • Did you observe the problem yourselves? • What facts or data did you gather?
Root cause of the problem: What have you learned about the causes of the problem?

Call to Action Planning Worksheet

Student Sheet

Your Diabetes Product

What exactly is your group going to do?
How did your group decide on your product?
What are the goals for your product? What do you hope to learn, teach, or accomplish?

Call to Action Planning Worksheet

Student Sheet

What is your plan for making this happen?
Tell us step-by-step what you plan to do. **1.** **2.** **3.** **4.** **5.** **6.** **7.** **8.** **9.** **10.**
What is the time frame for your product?
How do you think this product will make a difference?

Grading Rubric

Student Resource

Category	Highly Effective 4	Effective 3	Improvement Needed 2	Ineffective 1
Problem Statement	Problem is clearly stated in an engaging manner. The problem is important and relevant to the community	Problem is clearly stated, but not in an engaging manner. The problem is important and relevant to the community	Problem is stated, but not in an engaging manner. The problem is not relevant to the community	Problem is not stated.
Contains accurate scientific information	Contains accurate information about glucose homeostasis, prevention/treatment, and all other information is accurate	Scientific information is accurate, but does not go into detail about glucose homeostasis and prevention/treatment	Accurate scientific information is sparse	Inaccurate scientific information is present
Shows an understanding of social impacts	Impact(s) of diabetes given with multiple pieces of evidence.	Impact of diabetes given with at least one piece of evidence.	Impact of diabetes given without any evidence to support.	Impact of diabetes NOT given
Contributes to a solution	Solution clearly defines a method to solving the problem, and is relevant for community	Solution adequately defines a method to solving the problem, but is not relevant for community	Solution is not clearly stated OR is not relevant for community	No solutions given
Visual Quality	Meets these criteria: -Neat, legible, readable -Appropriate color and images -Space used effectively	Meets two of these criteria: -Neat, legible, readable -Appropriate color and images -Space used effectively	Meets one of these criteria: -Neat, legible, readable -Appropriate color and images -Space used effectively	Meets none of these criteria: -Neat, legible, readable -Appropriate color and images -Space used effectively
Effectiveness of Message	Project clearly motivates audience to engage in the call to action	Project adequately motivates audience to engage in the call to action	Project somewhat motivates audience to engage in the call to action	Project clearly does not motivate audience to engage in the call to action
Use of Resources	Appropriate resources used and properly cited	Resource used but either not appropriate or properly cited	Resource used but not appropriate or properly cited	No resources are used or cited

Appendix

Overview
The appendix to *Type 2 Diabetes: A complex disease of gene and environment interactions* contains a mix-and-match set of resources to augment student understanding of this topic and create thoughtful Call to Action products. The resources include additional ***Science Content, Student Support Materials***.

Science Content found in the Appendix include:

- PowerPoint slide set with scientific content, mostly in the form of graphs and tables, showing data from research on type 2 diabetes.

- Newspaper and research articles, including current articles about research studies and/or from news organizations that highlight different aspects of type 2 diabetes.

Student Support Materials found in the Appendix include:

- Student handouts and worksheets that scaffold student reading, viewing and analyzing scientific content.

- Structured classroom discussion strategies that encourage student participation, group discussion, thoughtful analysis, and foster a safe classroom atmosphere.

The student support materials can be used to help students analyze and process the science content. For example, a teachers may wish to pair a PowerPoint slide with higher-level data with a Socratic seminar discussion technique during which the whole class works together to come to a deeper understanding of the data. A teacher may also wish to assign an article found in the Science Content section together with the *My Evolution of Thought* worksheet to guide students in their reading. These supplementary materials can also support students with their Call to Action products.

Suggested materials may be accessed through their accompanying URLs due to possible copyright restrictions. For ease of following links, this document is also available in Word form at:

https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/

Science Content—PowerPoint Slides

POWERPOINT SLIDES
Name of resource *Contributions to Type 2 Diabetes, Glucose in Balance, and Oral Glucose Tolerance Test*
Description These three slides are found in the curriculum PPT, but can be used as the focus of a short Socratic seminar to gain deeper understanding of the complex topics
Author(s) UW Genome Sciences Education Outreach, New England Journal of Medicine, Diabetes
Location Slides 1 – 3 GEM_Diabetes_Appendix https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/
Name of resource *Glucose homeostasis graphic*
Description Red and green arrows show graphic representation of glucose homoeostasis
Author(s) Addison Wesley Longman
Location Slides 4 GEM_Diabetes_Appendix https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/
Name of resource *Graphs of insulin, glucagon and glucose levels over time*
Description These three graphs show different representations of the fluctuations in blood glucose, insulin and glucagon over time
Author(s) RH Unger, New England Journal of Medicine JD Brunzell, Journal of Clinical Endocrinology Metabolism
Location Slides 5, 6 and 7 GEM_Diabetes_Appendix https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/ http://www.medscape.org/viewarticle/551055 http://www.austincc.edu/apreview/EmphasisItems/Glucose_regulation.html
Name of resource *Diabetes incidence in non-Pima Mexicans, Mexican Pima and US Pima*
Description This slide shows the incidence of type 2 diabetes data in three different populations and is useful in discussing genetic and environmental aspect of type 2 diabetes in Pima Indians.
Author(s) LO Schultz, Diabetes Care
Location Slide 8 GEM_Diabetes_Appendix https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/

Name of resource *Data from the Diabetes Prevention Program (DPP)*
Description These two slides present data from a long-term research study comparing the effects of a placebo, Metformin, and intense lifestyle changes on different groups of people
Author(s) KA Jablonski, Diabetes, Copyright American Diabetes Association, Inc.
Location Slides 9 and 10 GEM_Diabetes_Appendix https://gsoutreach.gs.washington.edu/instructional-materials/gem-type-2-diabetes/

Science Content--Articles

ARTICLES
Name of resource *Diabetes: dirty air 'may raise' insulin resistance risk*
Description News article about how children's exposure to air traffic pollution could increase their risk of insulin resistance, which can lead to diabetes in adults.
Author(s) BBC News, ©2013, from a study in *Diabetologia*.
Location http://www.bbc.com/news/health-22465389
Name of resource *How fat grizzly bears stay diabetes-free (Science Mag) / A grizzly answer for obesity (NYT article)*
Description News articles reporting a study that measured blood glucose, insulin levels, body weight and other markers in grizzly bears before, during and after hibernation.
Author(s) Sarah C. P. Williams, Science Magazine, August, 2014 Kevin Corbit, The New York Times Opinion Pages, Feb, 2014
Location http://news.sciencemag.org/biology/2014/08/how-fat-grizzly-bears-stay-diabetes-free http://www.nytimes.com/2014/02/12/opinion/a-grizzly-answer-for-obesity.html?_r=0
Name of resource *Averting Diabetes Before It Takes Hold* *Beating Back the Risk of Diabetes*
Description These two New York Times articles give helpful background on type 2 diabetes, treatments, and preventions. Selected reader comments from both articles can also be used to provide additional views and perspectives about the issue.
Author(s) Jane E. Brody, New York Times Personal Health Section, Sept. 2014
Location http://well.blogs.nytimes.com/2014/09/08/prediabetes-blood-sugar/

http://well.blogs.nytimes.com/2014/09/15/beating-back-the-risk-of-diabetes/
Name of resources *Chinese Kids Gorge on Junk Food, With Familiar Consequences* *Nearly one-third of the world's population is obese or overweight, new data show* *Native Americans rediscover ancestral foods Miscellaneous Articles*
Description These three articles make the link between cultural environment and food intake.
Author(s) Chinese Kids: Dexter Roberts, Bloomberg Business Week, Sept. 2014 Nearly one-third: C. Murray and M. Ng, Institute for Health Metrics and Evaluation, UW, 2014 Native Americans: Minneapolis Star Tribune, adapted by Newsela staff, Sept. 2014
Locations http://www.businessweek.com/printer/articles/222714-chinese-kids-gorge-on-junk-food-with-familiar-consequences http://www.healthdata.org/news-release/nearly-one-third-world's-population-obese-or-overweight-new-data-show https://newsela.com/articles/nativeamerican-diets/id/5142/
Name of resource *Sugar substitutes, gut bacteria, and glucose intolerance (The Scientist)* *Artificial Sweeteners may disrupt body's blood sugar controls (NYT)*
Description These two articles report on a study published in *Nature* about how non-caloric sweeteners can spur glucose intolerance and effect gut bacteria.
Author(s) Anna Azvolinsky, The Scientist, Sept. 2014 Kenneth Chang, The New York Times, Sept. 2014
Location http://www.the-scientist.com/?articles.view/articleNo/41033/title/Sugar-Substitutes--Gut-Bacteria--and-Glucose-Intolerance/ http://well.blogs.nytimes.com/2014/09/17/artificial-sweeteners-may-disrupt-bodys-blood-sugar-controls/?_php=true&_type=blogs&_r=0

Student Support Materials

STUDENT SUPPORT MATERIALS
Name of resource *My Evolution of Thought*
Description This one-page worksheet used for article review helps students identify and reflect on a subject before and after reading and analysis.
Author(s) Northwest Association for Biomedical Research (NWABR)
Location https://www.nwabr.org/sites/default/files/Evolution_Thought_Article_Review_SNoSR.pdf

Name of resource *Media Review and Analysis*
Description This worksheet supports students in analyzing media for purpose, perspective, assumptions, claims and impact. It can be used for most types of media, and contains a section specifically used to analyze scientific research articles.
Author(s) NWABR
Location https://www.nwabr.org/sites/default/files/Media_Review_Worksheet_SNoSR.pdf
Name of resource *Worksheet to use with TED Talks*
Description This worksheet can be used with any TED talk to help guide student viewing.
Author(s) Laura Randazzo
Location http://www.teacherspayteachers.com/Product/TED-Talks-FREE-Worksheet-to-Use-With-ANY-TED-Talk-Public-Speaking-Grades-6-12-1348222

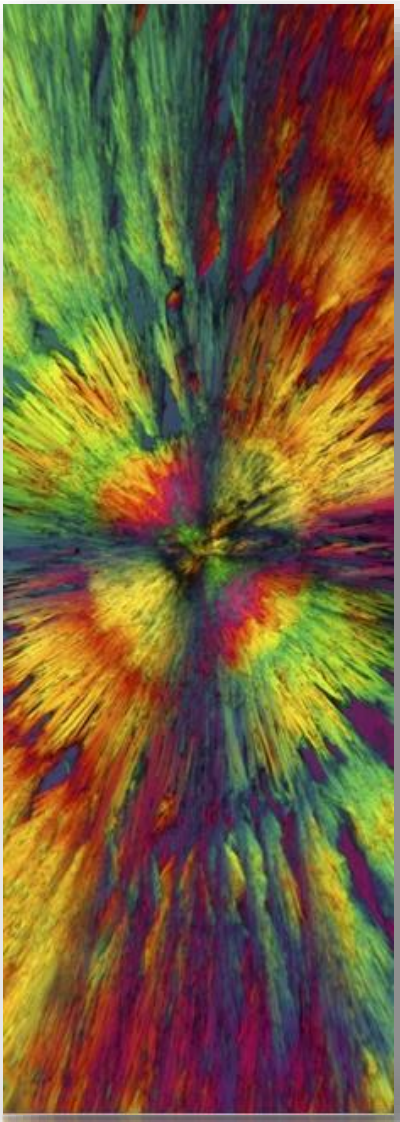
Structured Discussion Strategies

STRUCTURED DISCUSSION STRATEGIES
Name of resource *Socratic Seminar*
Description In this group discussion strategy, students work together to achieve deeper understanding of a text, graph, reading or other media.
Author(s) National Paideia Center, NWABR
Location Written description: https://www.nwabr.org/sites/default/files/SocSem.pdf Video: https://www.youtube.com/watch?v=9TckVl4e3Y0
Name of resource *Discussion Norm-Setting*
Description A guide for setting classroom discussion ground rules in order to foster a safe and communicative classroom environment.
Author(s) NWABR
Location https://www.nwabr.org/sites/default/files/pagefiles/Norm_Setting.pdf

Name of resource *Using Reader Comments as Stakeholder Cards*
Description Most electronic news articles have a reader comment section. Teachers can choose a range of appropriate comments to print out for students to read and report back on. This can be a helpful strategy for identifying differences in perspective, possible bias, argumentation skill (by providing examples of both strong and weak arguments), providing scientific and cultural context, and increasing student understanding.
Author(s) Readers/commenters on article
Location See comment section from article of interest

Other Resources

Name of resource *TED Talks*
Description TED (Technology, Entertainment and Design) talks are 10-20 minute talks by people with ideas to share. A good place to start would be with the talk by Dr. Peter Attia filmed in April 2013 at TEDMED 2013, titled: Is the obesity crisis hiding a bigger problem?
Author(s) Various
Location TED.com



SEPA SCIENCE EDUCATION PARTNERSHIP AWARD

Supported by the National Institutes of Health

UWGSEO

GENOME SCIENCES EDUCATION OUTREACH