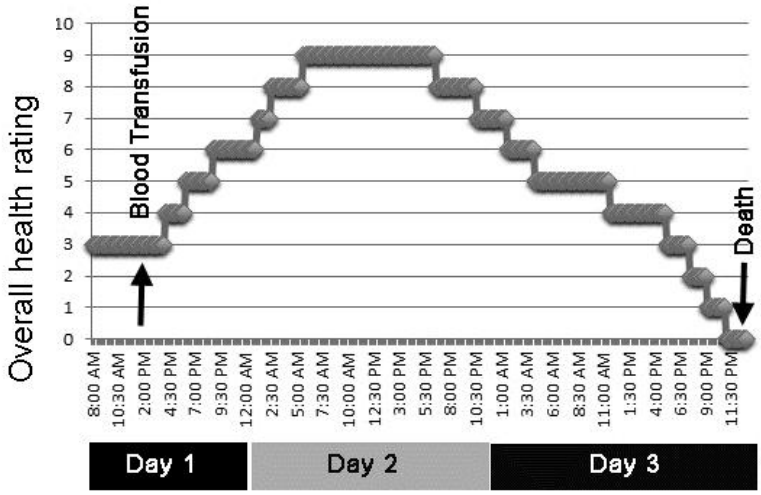
Introductory Materials

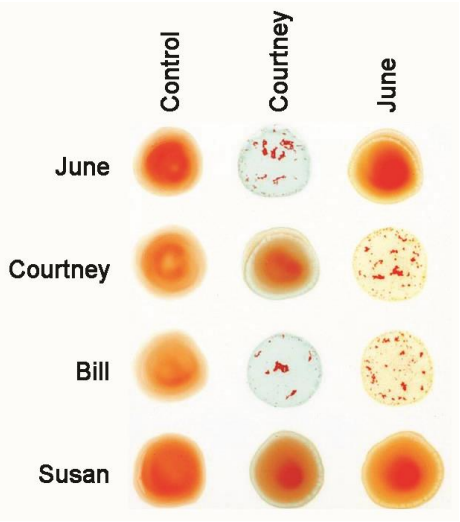
The Discovery of Blood Type Through Patterns

Different pieces of data helped scientists understand that the body produces different blood types. Karl Landsteiner won the 1930 Nobel Prize in Physiology or Medicine for his discovery of human blood groups.

First human-to-human blood transfusion on September 25, 1818. Patient's health improved prior to death.



Mixing drops of blood from different people can change the appearance of the blood

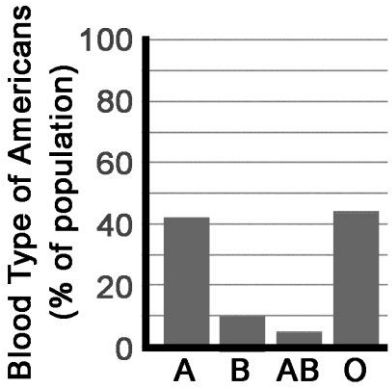


Key:

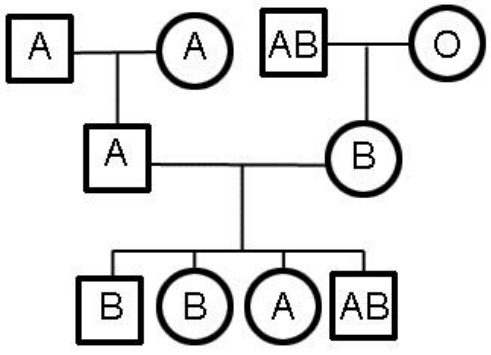
Blood remains a liquid

Blood clots and clumps

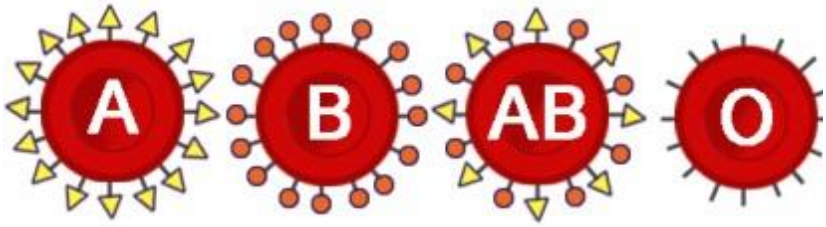
Some blood types more common than others



Blood type is inherited



Red blood cells have different sugars on their surface. Antibodies recognize the shape of these sugars and kill red blood cells if the sugars don't match the person's blood type.



About the Dutch Hunger Famine

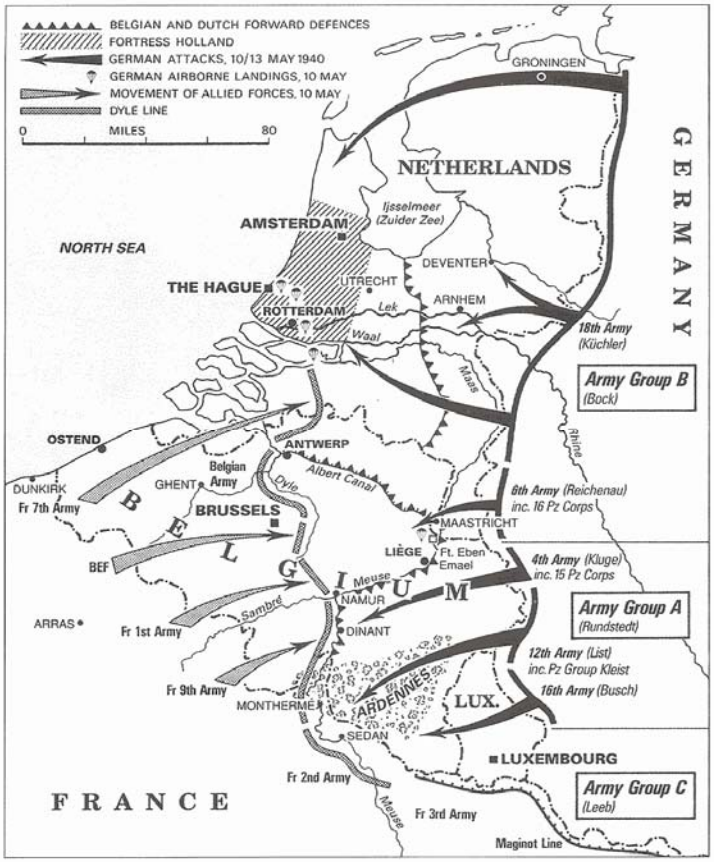
The Dutch Hunger Winter describes a period of time during World War Two when there was a severe food shortage because of wartime blockade of food supplies.

Location of the Netherlands (Holland)

Because it was winter, it was difficult to grow food.

They ate tulip bulbs (which form the flower) and dug roots from the ground.

World War Two cut off food supplies coming into the country for many months



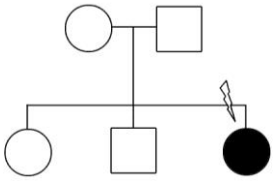
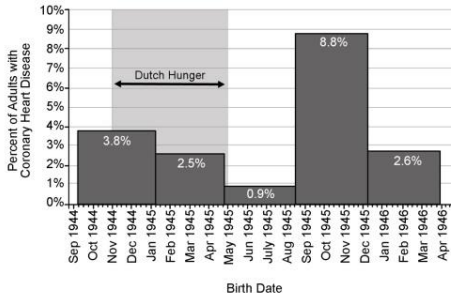
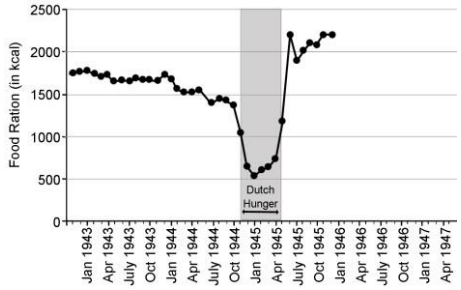
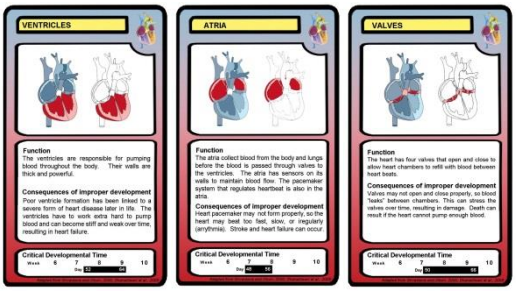
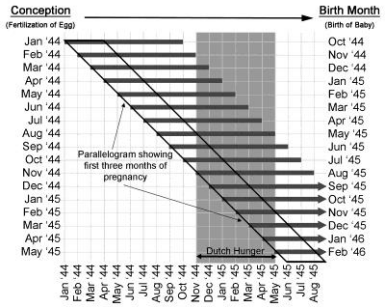
Effects of the famine on women and children living in the Netherlands

Pattern Notes Summary Sheet

Name: Group #

Pattern Notes Summary Sheet for Home Group

Instructions: Use this sheet to compile findings from your fellow experts. Write down the inferences you discovered from all five expert groups based on the "Final Analysis" answers at the bottom of each task card.

Pattern	Inference
	**Task Card A. Dutch Hunger Pedigree Chart** Q. Babies who developed heart disease as adults were born _____ the Dutch Hunger.
	**Task Card B. Adult Heart Disease Histogram** Q. Adults most affected by heart disease at age 50 were_____ the Dutch Hunger.
	**Task Card C. Caloric Intake Line Graph** Q. Babies exposed to poor nutrition from the Dutch Hunger were born between _____ and _____
	**Task Card D. Heart Development Timeline** Q. A baby's developing heart is most sensitive to stress resulting from lack of nutrition _____.
	**Task Card E. Dutch Hunger Pregnancy Diagram** Q. Which babies would you expect to be most sensitive to the Dutch Hunger food shortage?

Based on your inferences above, is there a pattern in the data between Dutch Hunger and heart disease? Explain your choice.

_____

_____

Student Task Cards for Expert Groups

TASK CARD A

Name: Group #

Dutch Hunger Pedigree Chart

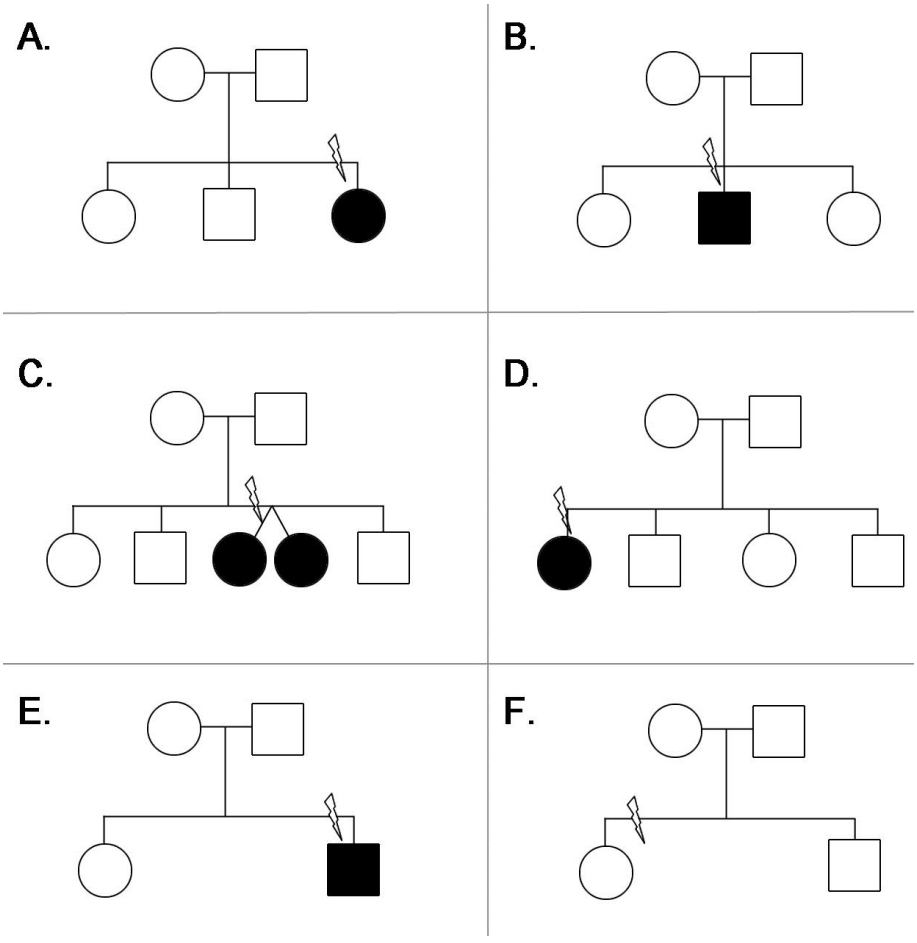
Job Title – Geneticist

Job Description – You study genetic traits in humans and how they are passed on to future generations.

Description of Data – A pedigree chart shows how a trait is passed down through the generations. The key shows you the meaning of the various symbols.

If a person is affected by the trait being studied, their circle or square will be filled . The trait that is being studied here is heart disease, so if the shape is dark, the person developed heart disease when they became an adult. If it is clear, they were healthy as an adult.

The signifies the six month period of time that we now call the "Dutch Hunger"(Nov 1944-May 1945). During that time, food supply trains to the Netherlands (where the Dutch lived) were cut off by a wartime blockade so many Dutch died or starved during that time.



Key for Pedigree Chart *The oldest child is always on the left*	
	Female
	Female with heart disease
	Male
	Male with heart disease
	Married couple
	Sister and brother
	Two brothers
	Twin sisters
	Mother and father with a daughter and son
	Shows when the Dutch Hunger occurred
	Shows a family where the girl was born before the famine and the boy was born after the famine.

Your Task – Follow the steps below to determine if the patterns on the pedigree charts below support a link between the Dutch Hunger period and developing heart disease in adulthood.

TASK CARD A

Name: Group #

Step 1) When reading a pedigree chart, what do the following symbols mean?

_____

_____

_____

_____

Step 2) What does the ⚡ signify? _____

Step 3) In the pedigree chart in panel A, is the oldest child a boy or a girl? Circle one: Boy Girl

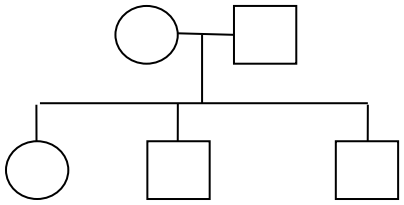
Step 4) In the pedigree chart in panel B, when did the mother almost starve?

____ Before the first child was born
____ Before the middle child was born
____ Before the youngest child was born

Step 5) In the pedigree chart in panel D, when did the mother almost starve?

____ Before the first child was born
____ Before the middle child was born
____ Before the youngest child was born

Step 6) The pedigree chart at right shows a family that experienced the Dutch Hunger while the mom was pregnant with the first son. Shade the child that has heart disease and place a ⚡ where the Dutch Hunger occurred.



Final Analysis -

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. Use the pedigree charts to look at the patterns shown in all six pedigree charts and complete the following sentence.

Babies who developed heart disease as adults were born _____ the Dutch Hunger (Circle one).

immediately before	immediately after	anytime before	anytime after	nowhere near

What information from the pedigree charts support your choice? _____

_____

_____

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

TASK CARD B

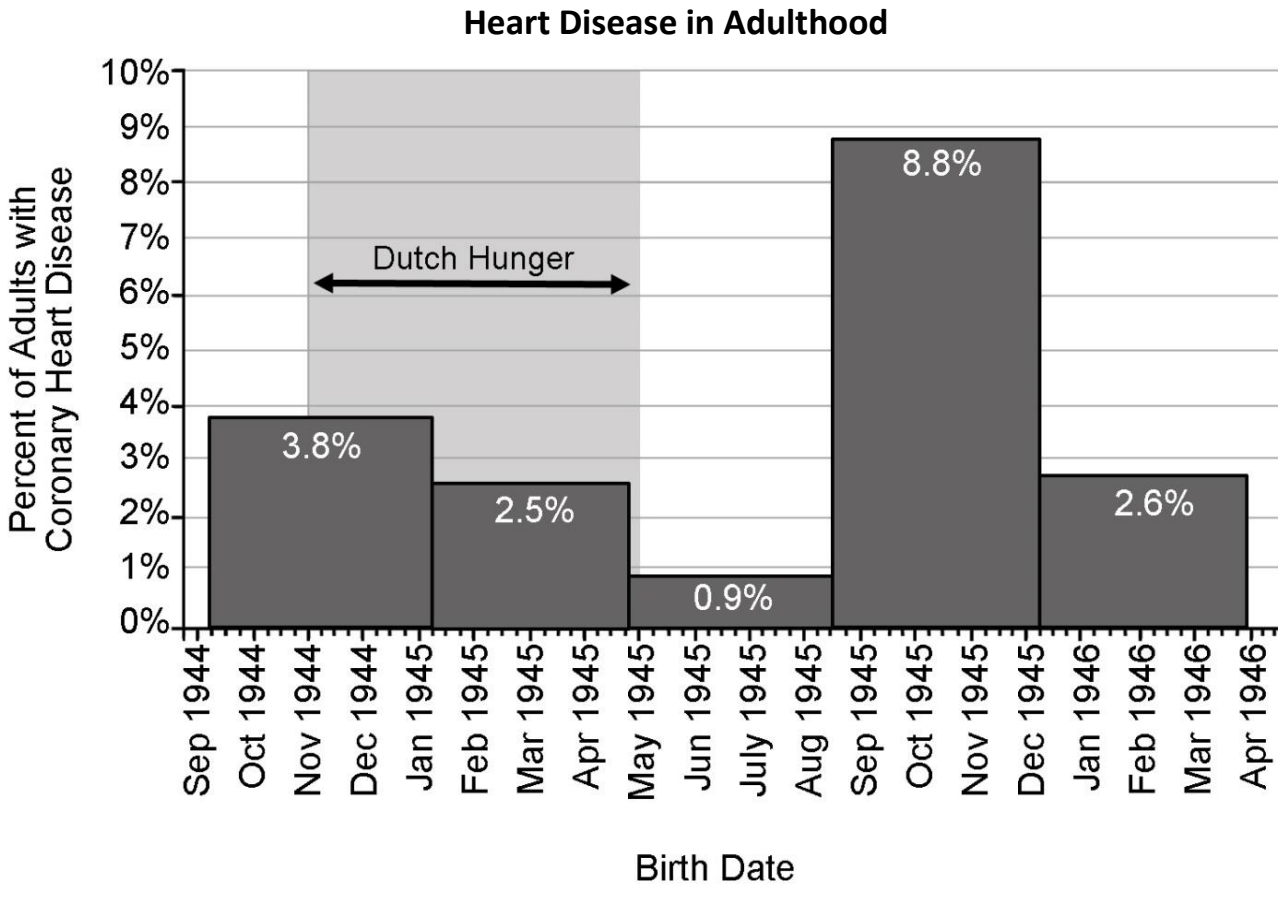
Name: Group #

Adult Heart Disease Bar Graph

Job Title - Cardiologist

Job Description: You are a doctor specializing in diseases of the heart. Starting in 1995, you noticed an unusual increase in the number of patients who developed heart disease by age 50. You decide to study this and have been recording data on these patients ever since. You know that when these people were born, there had been a severe food shortage during World War Two.

Description of Data: You've gathered data about when these people were born and whether or not they developed heart disease as an adult. You've graphed this information below. (Source: Roseboom et al., 2001)



Your Task: Use the following steps to analyze the graph above.

TASK CARD B

Name: Group #

Step 1) Look at the first week after "Sep 1944" to the first week after "Jan 1945". What percent of these people born during that time reported heart disease at age 50?

___% of people born between Sep 1944 and Jan 1945 developed heart disease as an adult.

Step 2) Now look at the time period between the second week of August 1945 and first week of December 1945. What percent of these people reported heart disease at age 50?

____% of people born between Aug 1945 and Dec 1945 developed heart disease as an adult.

Step 3) Compare the health of people born in the middle of the food shortage (between the first week of Jan 1945 and the third week of April 1945) with those born after the famine (between the second week of Aug 1945 and first week of Dec 1945). Circle which of these statements are true?

a) The amount of heart disease is about the same for both groups.
b) The amount of heart disease is larger in the people born in the Jan 1945-Apr 1945 group.
c) There is more than twice as much heart disease in the Aug 1945-Dec 1945 group.

Step 4) If it takes 9 months for a baby to be born, when would a baby born in December 1945 have been conceived (fertilization of the egg)?

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec

Month: _____ Year: _____

Step 5) When was a baby conceived if he/she was born in August, 1945?

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct

Month: _____ Year: _____

Step 6) Were babies born between Aug 1945 and Dec 1945 exposed to poor nutrition from the Dutch Hunger In the womb? Explain using data from the graph.

Circle: Yes, they were exposed to Dutch Hunger No, they were not exposed to Dutch Hunger

What information from the graph supports your choice? _____

_____

Final Analysis

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. Use the histogram to complete the following sentence.

Adults most affected by heart disease at age 50 were_____ the Dutch Hunger.

Born before	Born during	Conceived before	Conceived during	Conceived after

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

Interesting Dilemmas (but researchers are still studying the answers)

Considering that the graph is based on reports of the babies who have survived to age fifty, can you explain this:

The babies born from February to May 1945 (during the worst times of food shortage) report less heart disease than those born before or after. What are some possible explanations and what would you need to know to test them?

_____

_____

_____

TASK CARD C

Name: Group #

Calorie Intake of Dutch Hunger Line Graph

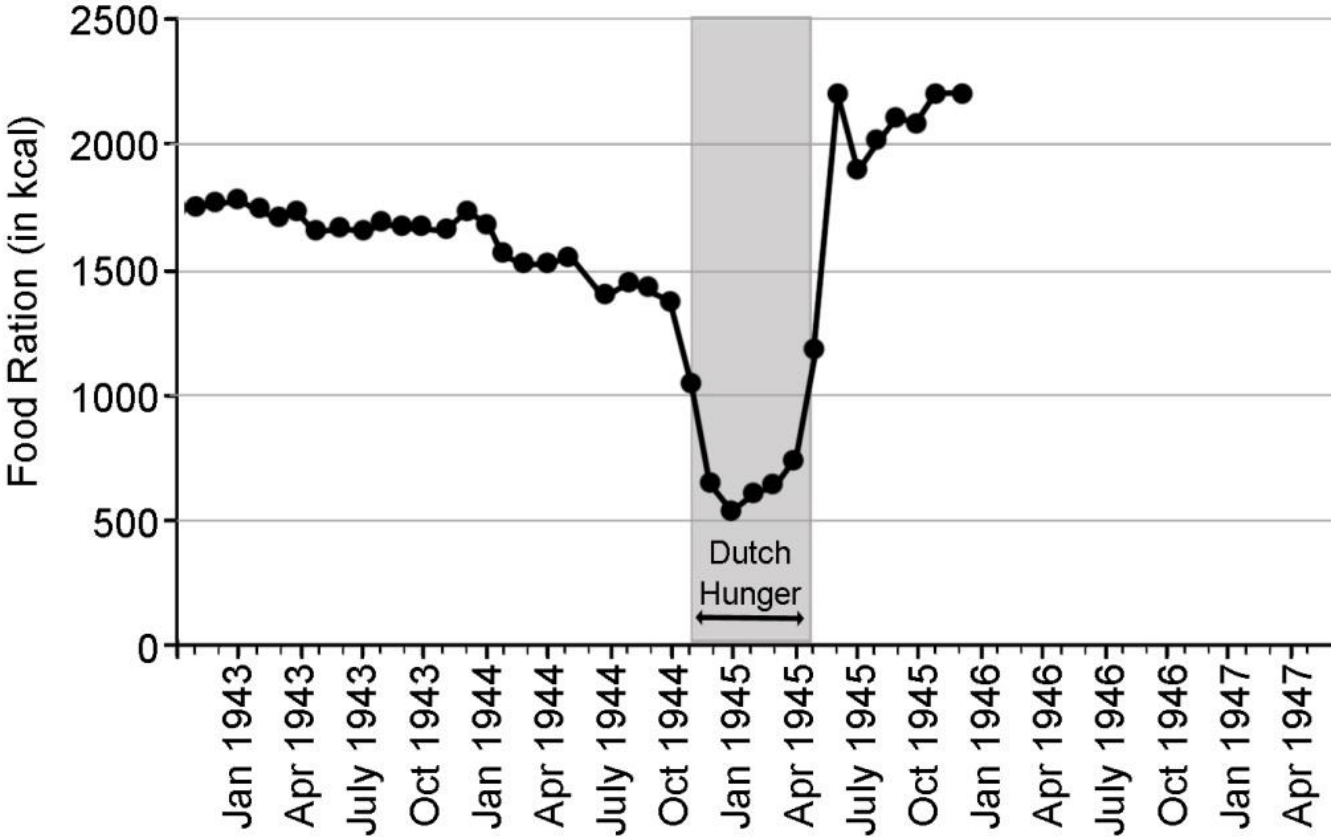
Job Title Epidemiologist (pronounced “Ep-eh-DEE-me-oh-lo-gist”, also known as a Public Health Researcher)

Job Description: You are investigating heart health patterns of seventy-year-old people in your community in The Netherlands. You are determining if their life history relates to their heart problems.

Description of Data: You know that there was a severe food shortage a long time ago because of wartime conditions. This period was called the "Dutch Hunger." Food was very difficult to obtain. Each person was limited to a certain share (ration) of food each day. You begin to look into this.

Your Task: Look at the graph below for the pattern of food available over the period of November 1942 to December 1945 (Source: Scholte et al., 2012). Use the steps on the other page to lead you to your final analysis.

Food Rations in the Netherlands during World War II



TASK CARD C

Name: Group #

Step 1) Look at "Jan 1943" on the top graph. The tick mark to the right of "Jan 1943" represents the unlabeled month of:

Month _____ Year_____

Step 2) Look at the gray box labeled "Dutch Hunger" which represents when food dropped below 1000 kcal per day. Circle the month and year when the "Dutch Hunger" food shortage (famine) began.

a)

Oct 1944	Nov 1944	Dec 1944	Jan 1945	Feb 1945	Mar 1945	Apr 1945	May 1945	Jun 1945

The Dutch Hunger ended when calories rose above 1000 kcal again. Circle the month and year when the Dutch Hunger ended.

b)

Oct 1944	Nov 1944	Dec 1944	Jan 1945	Feb 1945	Mar 1945	Apr 1945	May 1945	Jun 1945

Step 3) A baby spends 9 months in the womb between conception (when an egg is fertilized) and birth.

a) If a baby was conceived at the start of the Dutch Hunger (answer from 2a), shade below the nine months of pregnancy when that baby would be in the womb.

b) If a baby was conceived during the last month of the Dutch Hunger food shortage (answer from 2b), shade below the nine months of pregnancy when that the baby would be in the womb.

	Jan 1944	Feb 1944	Mar 1944	Apr 1944	May 1944	Jun 1944	Jul 1944	Aug 1944	Sep 1944	Oct 1944	Nov 1944	Dec 1944	Jan 1945	Feb 1945	Mar 1945	Apr 1945	May 1945	Jun 1945	Jul 1945	Aug 1945	Sep 1945	Oct 1945	Nov 1945	Dec 1945	Jan 1946	Feb 1946
3a																										
3b																										

Step 5) Would a baby born at the beginning of October 1945 (after the severe food shortage occurred) have been exposed to the Dutch Hunger in the womb? Explain using data from the graph.

Circle one: Was exposed to Dutch Hunger Was not exposed to Dutch Hunger

What information from the graph supports your choice? _____

_____

_____

Final Analysis

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. Use the information above to complete the following sentence.

Babies exposed to poor nutrition resulting from the Dutch Hunger were born between

_____ and _____.

[Month, Year] [Month, Year]

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

TASK CARD D

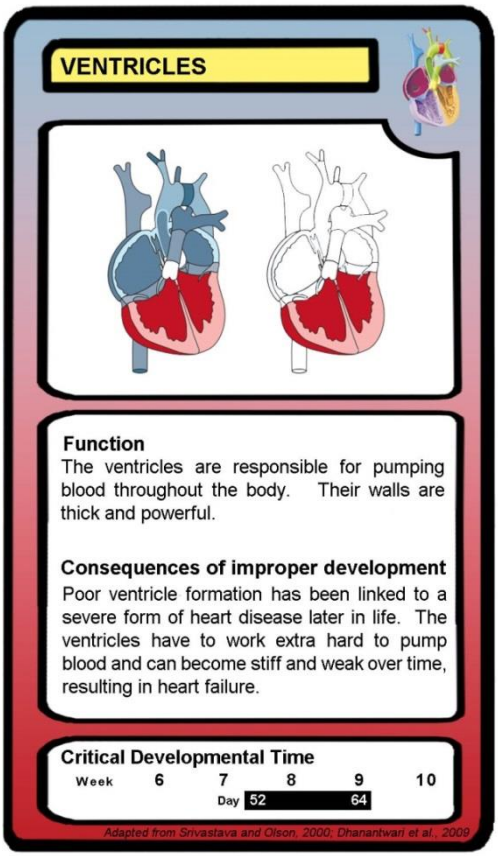
Name: Group #

Heart Development Timeline

Job Title – Cardiac embryologist (pronounced "em-bree-ah-low-gist")

Job Description: You study how the heart develops and grows from a simple group of cells to a fully functional heart with chambers and working valves.

Description of Data:
These research cards show three different regions of the heart: the atria, ventricles and valves. One of these cards is shown on the right.



The black box at the bottom of each card ( ) shows each heart region's "Critical Development Time" -- the period of time when that heart region is most sensitive to the mother's nutrition during pregnancy.

Each heart region has a different function and is formed at different times during pregnancy. Lack of nutrition in the first six weeks of a baby's development leads to heart defects at birth. After 6 weeks, the mother's nutrition affects each heart region differently, with the consequences of these developmental problems not seen until adulthood.

Key Terms and Time Periods:

Conception:	When the egg is fertilized. The start of pregnancy.
Pregnancy:	When a baby is in the mother's womb. Lasts 9 months. Baby's organ development happens during this time.
Birth:	When the baby is born after 9 months

Your Task:
Use the research cards and steps on the other page to determine how a mother's nutrition affects the heart development of her baby.

TASK CARD D

Name: Group #

Step 1) Look at the research cards. They describe three regions of the heart. The black bar at the bottom of each card describes the developmental time that is critical for that heart region's formation.

Circle which region of the heart…

Has its critical developmental time first?	Ventricles	Atria	Valves	Day number? _____
Has the longest period of time when critical development is taking place?	Ventricles	Atria	Valves	How many days? _____

Step 2) Looking at all three heart regions, the heart's critical developmental period is finished by which week?

Week number: _____

Step 3) If a baby was in its 65th day of development and there was a large snowstorm that trapped a pregnant mother in her car for a day without food, which region of the heart would be affected?

Circle one: Ventricles Atria Valves

What symptom might you expect someone to develop in adulthood if this region was affected?

___ Blood may leak between chambers
___ They may develop a severe form of heart disease later in life
___ Their heart may beat too fast, slow or irregularly

Step 4) What if the lack of food occurred over several days, such as Days 57-60? Which region(s) of the heart would be affected?

Circle all that apply: Ventricles Atria Valves

What symptom(s) might you expect someone to develop in adulthood if this region was affected? (check all that apply)

___ Blood may leak between chambers
___ They may develop a severe form of heart disease later in life
___ Their heart may beat too fast, slow or irregularly

Final Analysis

You have important information to add to the investigation about possible health problems that the Dutch Hunger babies have in later life. Use the cards to complete the following sentence.

A baby's developing heart is most sensitive to stress resulting from lack of nutrition _____.

before the baby is conceived.	during the first 10 weeks of pregnancy.	during weeks 28-34 of pregnancy.	after the baby is born.

Would you expect the nutrition a baby experienced in the womb to contribute to heart disease in adulthood – for example, when the baby grows up to be 65 year old man? What information from the cards supports your choice?

_____

_____

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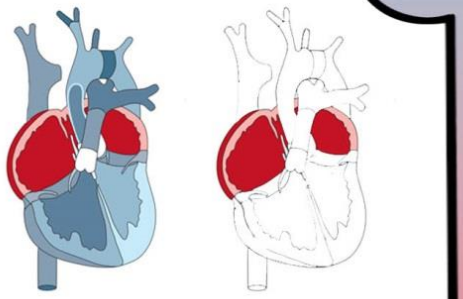
ATRIA



Function
The atria collect blood from the body and lungs before the blood is passed through valves to the ventricles. The atria has sensors on its walls to maintain blood flow. The pacemaker system that regulates heartbeat is also in the atria.

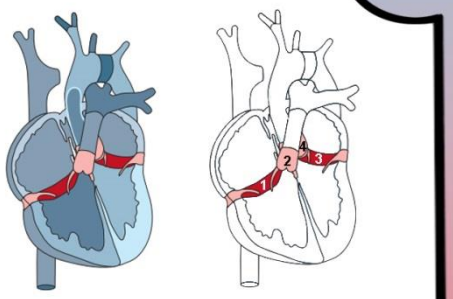
Consequences of improper development
Heart pacemaker may not form properly, so the heart may beat too fast, slow, or iregularly (arrythmia). Stroke and heart failure can occur.

Critical Developmental Time

Week	6	7	8	9	10
Day	48		56		

Adapted from Srivastava and Olson, 2000; Dhanantwari et al., 2009

VALVES



Function
The heart has four valves that open and close to allow heart chambers to refill with blood between heart beats.

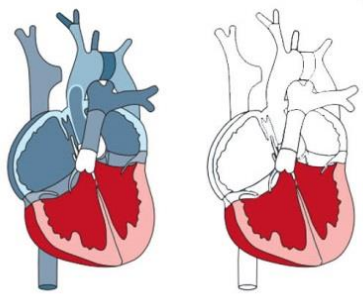
Consequences of improper development
Valves may not open and close properly, so blood "leaks" between chambers. This can stress the valves over time, resulting in damage. Death can result if the heart cannot pump enough blood.

Critical Developmental Time

Week	6	7	8	9	10
Day	50			66	

Adapted from Srivastava and Olson, 2000; Dhanantwari et al., 2009

VENTRICLES



Function
The ventricles are responsible for pumping blood throughout the body. Their walls are thick and powerful.

Consequences of improper development
Poor ventricle formation has been linked to a severe form of heart disease later in life. The ventricles have to work extra hard to pump blood and can become stiff and weak over time, resulting in heart failure.

Critical Developmental Time

Week	6	7	8	9	10
Day	52			64	

Adapted from Srivastava and Olson, 2000; Dhanantwari et al., 2009

TASK CARD E

Name: Group #

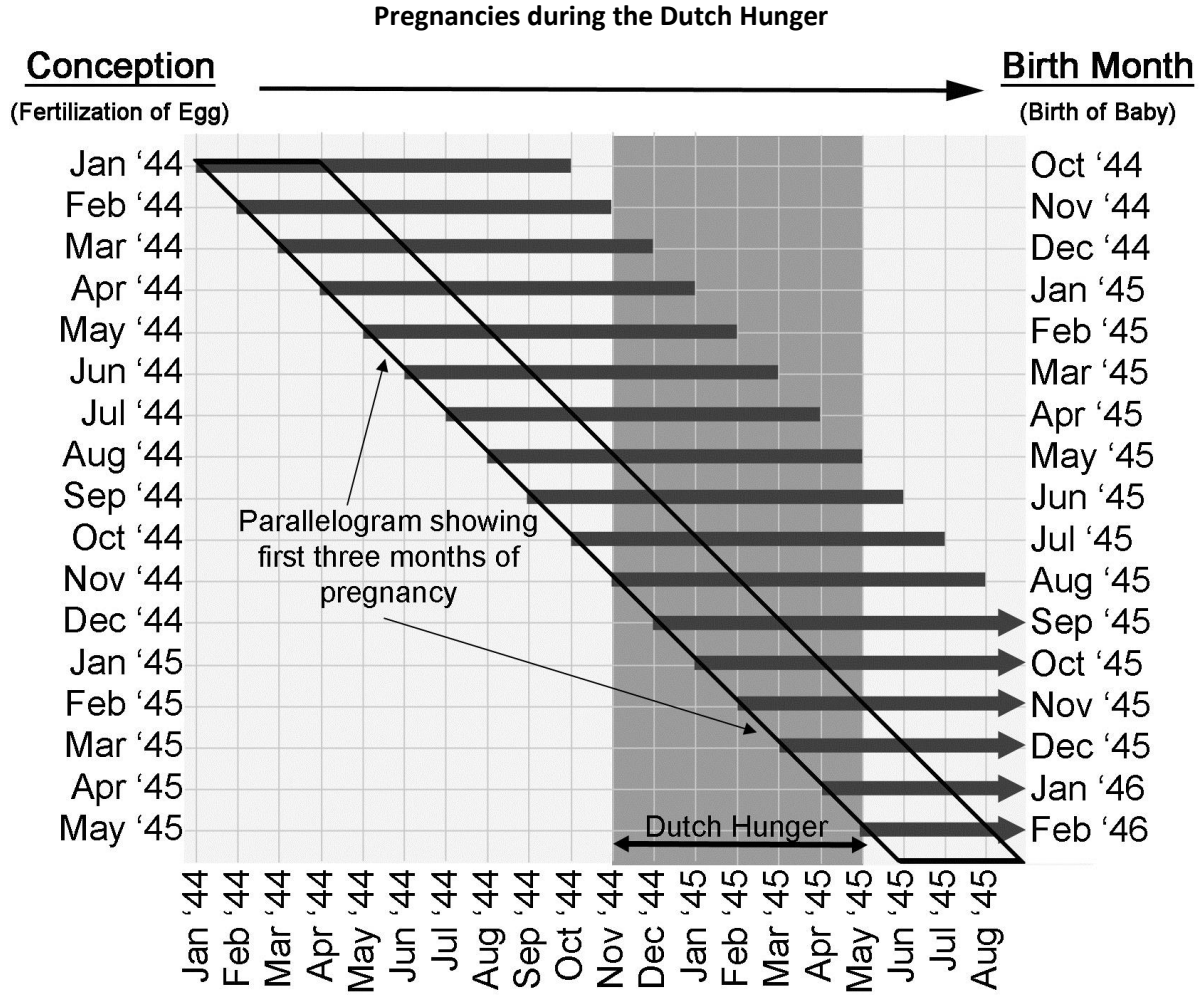
Dutch Hunger Pregnancy Diagram

Job Title - Pediatrician

Job Description: You study the development of babies and how their mother's health affects their baby's growth during pregnancy.

Description of Data:
During World War Two there was a severe food shortage known as the "Dutch Hunger". This diagram plots the pregnancies during that time and shows where in the pregnancy the "Dutch Hunger" occurred.

This symbol \ shows the time in the pregnancy that the babies are most affected by their mother's diet. This happens during the first three months of pregnancy (also known as first trimester). During this time all of their major organs are forming and organs fail to grow properly if they don't get the nutrients they need.



Your Task: Use the steps on the other page to analyze which pregnancies may be most affected by the food shortage.

TASK CARD E

Name: Group #

Step 1) First, you need to know how to read the graph. The dark horizontal bars represent the time in the womb for babies. Look under "Conception" for "Jan 1944". Follow the diagram across to the right to "Birth Month". If a baby is conceived in Jan 1944, when would it be born?

Month _____ Year _____

Step 2) Look under "Birth Month" for "Apr 1945". Follow the diagram back over to the left to find out the month of "Conception". For a baby born in April of 1945, when was it conceived?

Month _____ Year _____

Step 3) The parallelogram \ represents the first 3 months of a pregnancy when organs are forming. For a baby born in Feb 1946, when did these first 3 months of organ development occur?

From [Month____ Year____ to [Month_____ Year _____]

Step 4) Move your finger up the parallelogram \ to answer the following: Which babies were most affected by the Dutch Hunger in their first three months of development?

A. Earliest possible birth month for a baby who had its first three months of development entirely during the Dutch Hunger. Month_____ Year _____

B. Latest possible birth month for a baby who had its first three months of development entirely during the Dutch Hunger. Month_____ Year _____

Step 5) Below are listed five birth months. Assuming that the first trimester is most sensitive to lack of food, use the diagram to decide which baby you think might be most sensitive to the Dutch Hunger.

Jan 1945 Jul 1945 Oct 1945 Dec 1945 Feb 1946

What information from the diagram supports your choice? _____

_____

Final Analysis

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. As a group, determine:

Which babies would you expect to be most sensitive to the Dutch Hunger food shortage (Circle one)?

A) Babies born before the famine but were undernourished as newborn infants.
B) Babies whose first trimester overlapped the famine even if they were born after the famine.
C) Babies whose mothers were pregnant any time during the famine.
D) Babies born soon after the famine started.

Babies expected to be most sensitive to the Dutch Hunger food shortage were born between

Month_____ Year _____ to Month_____ Year _____

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

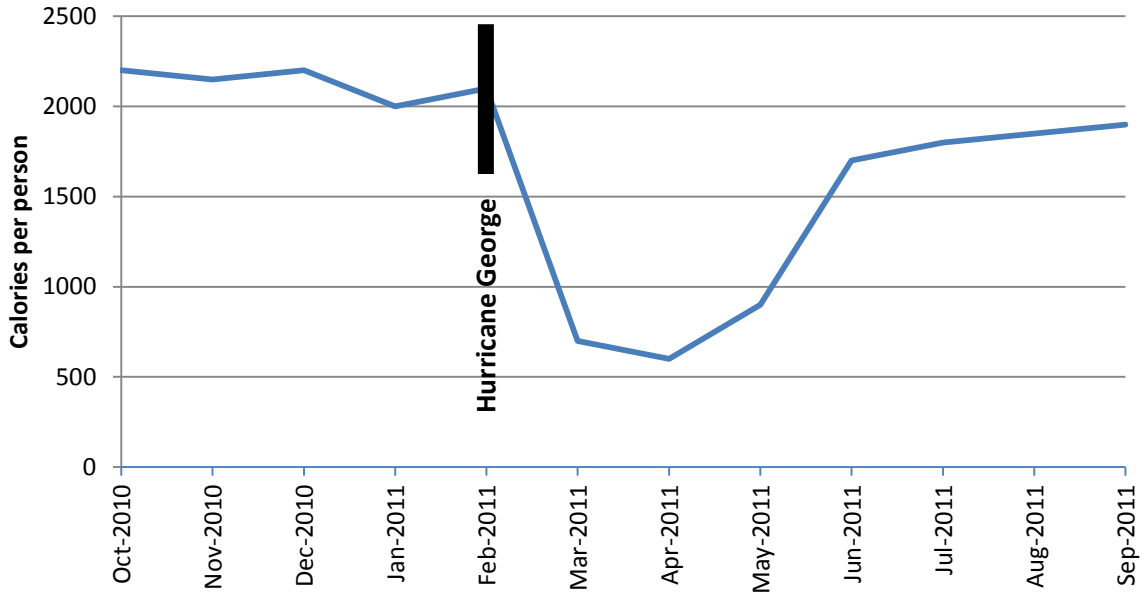
Summative Assessments

Name: Group #

Hurricane George and Costa Blanca

Hurricane George strikes the (fictional) island of Costa Blanca in early February of 2011. The typical food supply was mostly wiped out and, due to its remoteness and debris in surrounding waters, it takes a few months for relief supplies to restore the food supply for the residents. Here is a graph of the number of calories per person per day consumed over that period of time.

Calorie Intake 2010-2011



1. Use what you have learned to explain what we might expect 50 years after Hurricane George and the resulting food supply shortage (famine) in Costa Blanca. Who might you expect to show heart disease in later life?

_____

_____

_____

2. Explain how environmental stressors (such as famine) experienced by a person in the womb could cause a health effect in an adult?

_____

_____

_____

3. What other natural or human-made events might impact the health of a population?

_____

_____

_____

Scoring Rubric for Hurricane George Summative Assessment

Question	Exemplary (4)	Accomplished (3)	Developing (2)	Beginning (1)	Score
1) Prediction of who may show heart disease	The student identifies that a baby in the womb would be predicted to show health effects 50 years later, particularly one in the first trimester of pregnancy when the food shortage occurred	The student identifies that a baby in the womb would be predicted to show health effects 50 years later,	The student identifies that a baby would be affected.	No clear understanding connection to the lesson.	
2) Mechanism for environmental stressors affecting health of the adult	The student identifies that organ development is being formed during pregnancy. An organ that doesn't form properly during development will not be able to function as well later in life.	The student identifies that organ development is occurring during pregnancy. No outcome is provided to influence adult health.	The student identifies that babies are sensitive to stress.	No clear understanding connection to the lesson.	
3) Other examples of events that cause stress	The student identifies 3 examples that span different types of human and man-made disasters or events	The student identifies 1-2 examples that span different types of human and man-made disasters or events	The student identifies 1-2 examples that are all similar to the hurricane or famine example, but without further elaboration	The student identifies the same examples provided, i.e. the hurricane or famine, without further elaboration	

Example Scoring: 10-12 = A; 8-9 = B; 6-7=C; 4-5=D; 0-3=F

Name: Group #

Bees and Berries

A group of students noticed bees around new berry plants growing in their school garden. They decide to study whether bees may be pollinating the flowers on berry plant. They count ten plants in the school's garden. Each week, starting in March, they recorded the number of flowers in bloom on the plants, the number of bees visiting the plants, and the number of ripe fruit on the plants. Of course, at first there was no ripe fruit and later there were no flowers in bloom. Two students continued their work over the summer. Here is a table of their results:

	Week Number	**Number of plant flowers**	**Number of bees present**	**Number of berries ripe**
3/1	1	0	0	0
3/8	2	0	0	0
3/15	3	0	0	0
3/22	4	0	0	0
3/29	5	0	0	0
4/5	6	0	0	0
4/12	7	7	2	0
4/19	8	14	4	0
4/26	9	21	6	0
5/3	10	35	11	0
5/10	11	49	15	0
5/17	12	70	21	0
5/24	13	75	23	0
5/31	14	65	20	0
6/7	15	53	16	2
6/14	16	31	9	7
6/21	17	7	2	15
6/28	18	0	0	29
7/5	19	0	0	45
7/12	20	0	0	36
7/19	21	0	0	19
7/26	22	0	0	12
8/2	23	0	0	7
8/9	24	0	0	4
8/16	25	0	0	0
8/23	26	0	0	0
8/30	27	0	0	0

Use their data to answer the following questions:

1) How many weeks does it take for the fruit of this plant to go from flower to ripe fruit? Explain how you used the data to estimate this.

_____

_____

_____

2) If warm weather triggers bees to come earlier but does not affect the flowering of the plant as much, how might climate change affect the berry production of these plants?

_____

_____

_____

3) Bees are responsible for pollinating 15-30% of all food that United States consumers eat (Roach, 2004). Their numbers have dropped by half in the last 60 years. If their numbers continue to decline, what would you expect to happen to the United States food supply?

_____

_____

_____

4) For a family who got *all* of their food from bee-pollinated crops, how might a large decline in bees affect their family's health now and in 50 years?

_____

_____

_____

Scoring Rubric for Berries and Bees Summative Assessment

Question	Exemplary (4)	Accomplished (3)	Developing (2)	Beginning (1)	Score
1) Weeks for fruit to flower	The student identifies the range in weeks and describes how the range was calculated.	The student identifies an exact week number and describes how the data were used to estimate the weeks.	The student identifies the incorrect numbers of weeks or does not describe how the data were used to estimate.	Incorrect number of weeks and no reasoning	
2) Bees arrive early; flowers stay the same	The student identifies a possible decline in berry production and describes flower pollination timing as why this would be the case. Identifies alternate scenario as well.	The student identifies a decline in berry production and describes flower pollination timing.	The student incorrectly identifies the direction of the berry production, but describes rationale for bees pollinating flowers for berry production.	The student does not tie together bees and pollination with berry production.	
3) Bees affecting US food supply	The student identifies that less bees would result in fewer crop flowers being pollinated, so less food would be produced.	The student identifies that less bees would result in fewer crop flowers being pollinated. Incorrect description of effect on food supply.	The student identifies that less bees would result in fewer crop flowers being pollinated. No description of effect onfood supply.	The student does not address bee numbers, pollination or food supply.	
4) Bees affecting human health now and in future	The student describes short and long-range health issue scenarios. Describes food restriction effects now (like weight loss or lack of food) and how food restriction during pregnancy might affect future health through organ formation, especially during first trimester.	The student describes possible short and long-range health issue scenarios. Describes that pregnancy might affect future health through no discussion of effects of nutrition on organ formation.	The student describes only short or long-range health issue scenarios. Minimal detail provided	The student does not adequately describe health issues and provides no justification for the answer.	

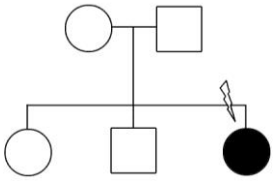
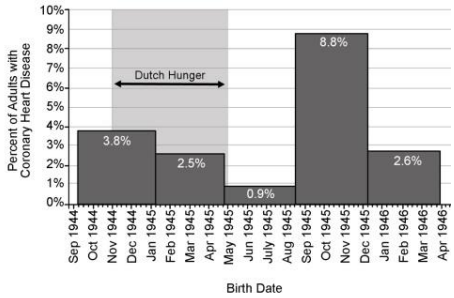
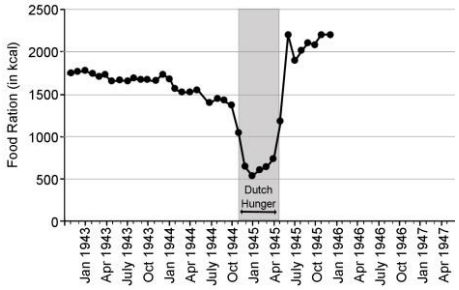
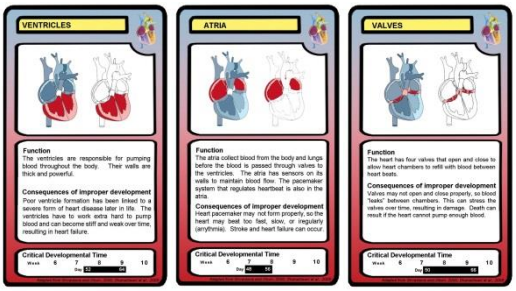
Example Scoring: 13-16 = A; 9-12 = B; 5-8=C; 5-7=D; 0-4=F

Answer Keys

Name: Group #

Pattern Notes Summary Sheet for Home Group

Instructions: Use this sheet to compile findings from your fellow experts. Write down the inferences you discovered from all five expert groups based on the "Final Analysis" answers at the bottom of each task card.

Pattern	Inference
	**Task Card A. Dutch Hunger Pedigree Chart** Q. Babies who developed heart disease as adults were born **_immediately after__** the Dutch Hunger.
	**Task Card B. Adult Heart Disease Histogram** Q. Adults most affected by heart disease at age 50 were__ **conceived during** ____ the Dutch Hunger.
	**Task Card C. Caloric Intake Line Graph** Q. Babies exposed to poor nutrition from the Dutch Hunger were born between **Aug 1945** and **Feb 1946**
	**Task Card D. Heart Development Timeline** Q. A baby's developing heart is most sensitive to stress resulting from lack of nutrition **_during the first 10 weeks of pregnancy_**.
	**Task Card E. Dutch Hunger Pregnancy Diagram** Q. Which babies would you expect to be most sensitive to the Dutch Hunger food shortage? **B.** Babies whose first trimester overlapped the famine even if they were born after the famine. Babies expected to be most sensitive to the Dutch Hunger food shortage were born between **_Aug__ _1945_** to **_Nov__1945_**

Based on your inferences above, is there a pattern in the data between Dutch Hunger and heart disease? Explain your choice. Babies who were conceived during the Dutch Hunger, particularly babies whose first three months of pregnancy occurred during the famine, were most likely to develop heart disease as adults because this is the same 10 week period that is critical for the development of heart cells which determine how the organ will function. Poor development of heart cells resulting from lack of nutrition can lead to increased risk of heart disease in adulthood.

TASK CARD A

Name: Group #

Dutch Hunger Pedigree Chart

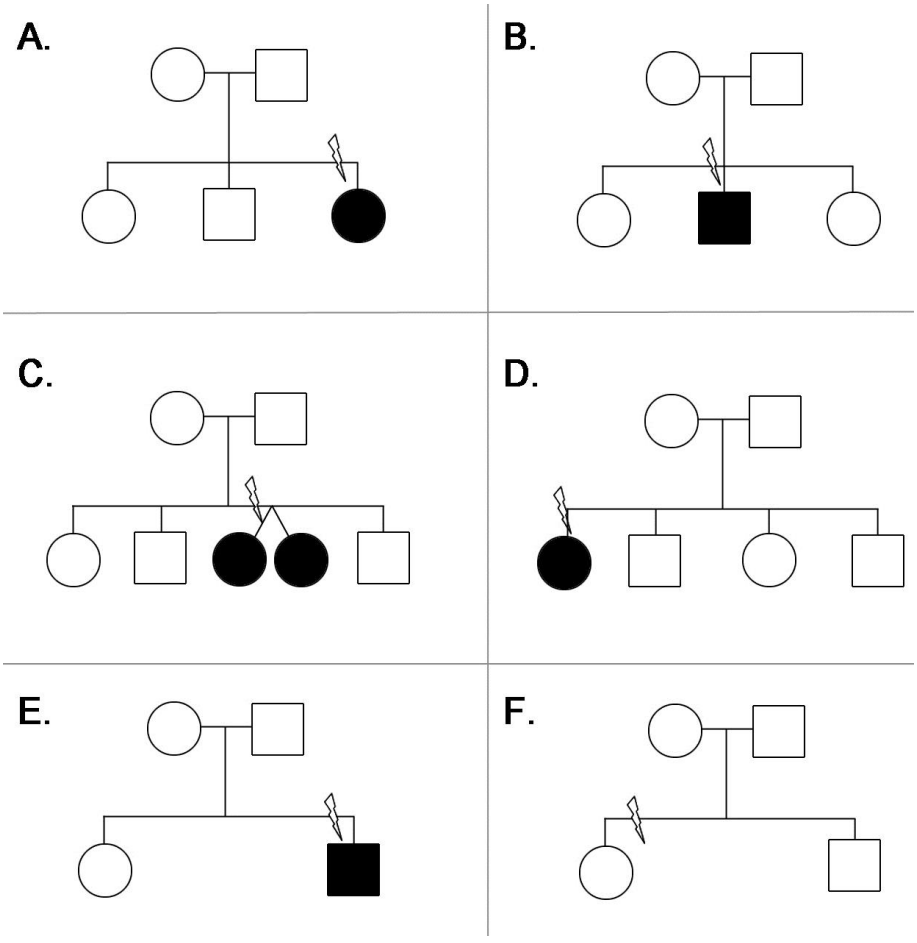
Job Title – Geneticist

Job Description – You study genetic traits in humans and how they are passed on to future generations.

Description of Data – A pedigree chart shows how a trait is passed down through the generations. The key shows you the meaning of the various symbols.

If a person is affected by the trait being studied, their circle or square will be filled . The trait that is being studied here is heart disease, so if the shape is dark, the person developed heart disease when they became an adult. If it is clear, they were healthy as an adult.

The signifies the six month period of time that we now call the "Dutch Hunger"(Nov 1944-May 1945). During that time, food supply trains to the Netherlands (where the Dutch lived) were cut off by a wartime blockade so many Dutch died or starved during that time.



Key for Pedigree Chart *The oldest child is always on the left*	
	Female
	Female with heart disease
	Male
	Male with heart disease
	Married couple
	Sister and brother
	Two brothers
	Twin sisters
	Mother and father with a daughter and son
	Shows when the Dutch Hunger occurred
	Shows a family where the girl was born before the famine and the boy was born after the famine.

Your Task – Follow the steps below to determine if the patterns on the pedigree charts below support a link between the Dutch Hunger period and developing heart disease in adulthood.

TASK CARD A

Name: Group #

Step 1) When reading a pedigree chart, what do the following symbols mean?

○	**Female**
●	**Female with heart disease**
■	**Male with heart disease**
○—□	**Parents (female on left, male on right – both with no heart disease)**

Step 2) What does the ↯ signify? **Dutch Hunger**

Step 3) In the pedigree chart in panel A, is the oldest child a boy or a girl? Circle one: Boy (Girl)

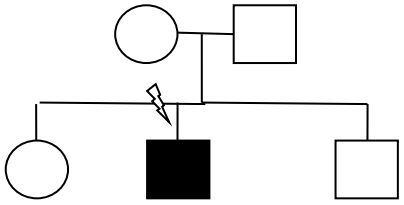
Step 4) In the pedigree chart in panel B, when did the mother almost starve?

____ Before the first child was born
__X_ Before the middle child was born
____ Before the youngest child was born

Step 5) In the pedigree chart in panel D, when did the mother almost starve?

__X_ Before the first child was born
____ Before the middle child was born
____ Before the youngest child was born

Step 6) The pedigree chart at right shows a family that experienced the Dutch Hunger while the mom was pregnant with the first son. Shade the child that has heart disease and place a ↯ where the Dutch Hunger occurred.



Final Analysis -

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. Use the pedigree charts to look at the patterns shown in all six pedigree charts and complete the following sentence.

Babies who developed heart disease as adults were born _____ the Dutch Hunger (Circle one).

immediately before	**immediately after**	anytime before	anytime after	nowhere near

What information from the pedigree charts support your choice? _____

Babies who develop heart disease are the ones who were exposed to the Dutch Hunger just before they were born. Not all siblings were affected, so it was "immediately after". _____

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

TASK CARD B

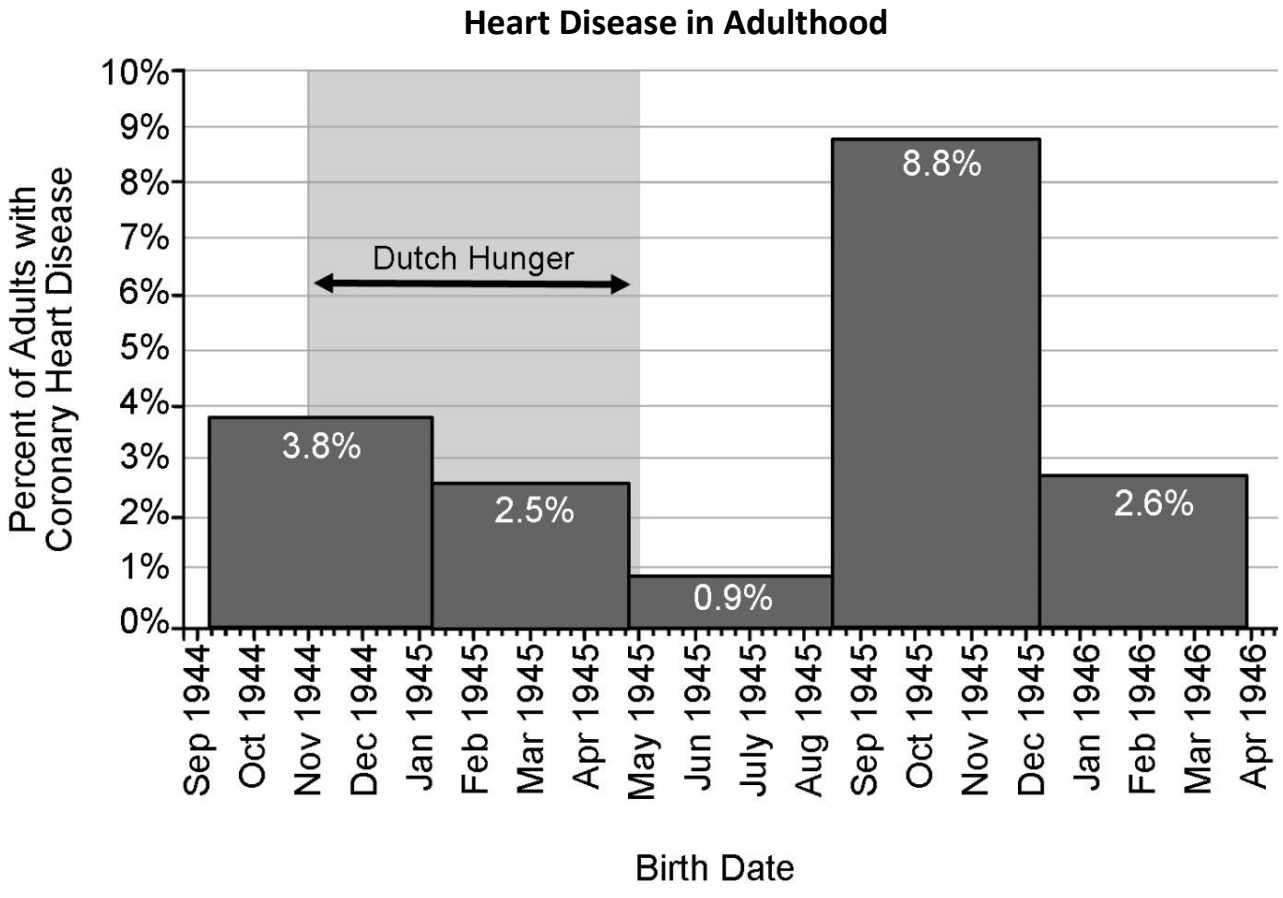
Name: Group #

Adult Heart Disease Bar Graph

Job Title - Cardiologist

Job Description: You are a doctor specializing in diseases of the heart. Starting in 1995, you noticed an unusual increase in the number of patients who developed heart disease by age 50. You decide to study this and have been recording data on these patients ever since. You know that when these people were born, there had been a severe food shortage during World War Two.

Description of Data: You've gathered data about when these people were born and whether or not they developed heart disease as an adult. You've graphed this information below. (Source: Roseboom et al., 2001)



Your Task: Use the following steps to analyze the graph above.

TASK CARD B

Name: Group #

Step 1) Look at the first week after "Sep 1944" to the first week after "Jan 1945". What percent of these people born during that time reported heart disease at age 50?

_**3.8**_% of people born between Sep 1944 and Jan 1945 developed heart disease as an adult.

Step 2) Now look at the time period between the second week of August 1945 and first week of December 1945. What percent of these people reported heart disease at age 50?

_**8.8**_% of people born between Aug 1945 and Dec 1945 developed heart disease as an adult.

Step 3) Compare the health of people born in the middle of the food shortage (between the first week of Jan 1945 and the third week of April 1945) with those born after the famine (between the second week of Aug 1945 and first week of Dec 1945). Circle which of these statements are true?

a) The amount of heart disease is about the same for both groups.
b) The amount of heart disease is larger in the people born in the Jan 1945-Apr 1945 group.
c) There is more than twice as much heart disease in the Aug 1945-Dec 1945 group.

Step 4) If it takes 9 months for a baby to be born, when would a baby born in December 1945 have been conceived (fertilization of the egg)?

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec

Month: __**Mar**_____ Year: __**1945**_____

Step 5) When was a baby conceived if he/she was born in August, 1945?

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct

Month: ___**Nov**____ Year: __**1944**_____

Step 6) Were babies born between Aug 1945 and Dec 1945 exposed to poor nutrition from the Dutch Hunger In the womb? Explain using data from the graph.

Circle: Yes, they were exposed to Dutch Hunger No, they were not exposed to Dutch Hunger

What information from the graph supports your choice? _**A baby born during this period was conceived during the Dutch Hunger and exposed to the famine during the early part of pregnancy.**_____

Final Analysis

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. Use the histogram to complete the following sentence.

Adults most affected by heart disease at age 50 were_____ the Dutch Hunger.

Born before	Born during	Conceived before	Conceived during	Conceived after

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

Interesting Dilemmas (but researchers are still studying the answers)

Considering that the graph is based on reports of the babies who have survived to age fifty, can you explain this:

The babies born from February to May 1945 (during the worst times of food shortage) report less heart disease than those born before or after. What are some possible explanations and what would you need to know to test them?

Possible explanations include but are not limited to:

- **Maybe those individuals who would have developed heart disease died in infancy or of other causes before they could be measured. What are the number of possible people, and the ones who died early versus later in life.**
- **Mothers may have had enough nutrition early in pregnancy when the baby's organs were forming. You would could compare groups of individuals during different times during the pregnancy**
- **Perhaps families kept stockpiles of food during the early periods, so that even if rations were dropping, they had enough food from their supplies or from their gardens, especially in the summer months. You could use mothers' body weights and look at if drops in body weights during the famine were linked to increased heart disease.**

TASK CARD C

Name: Group #

Calorie Intake of Dutch Hunger Line Graph

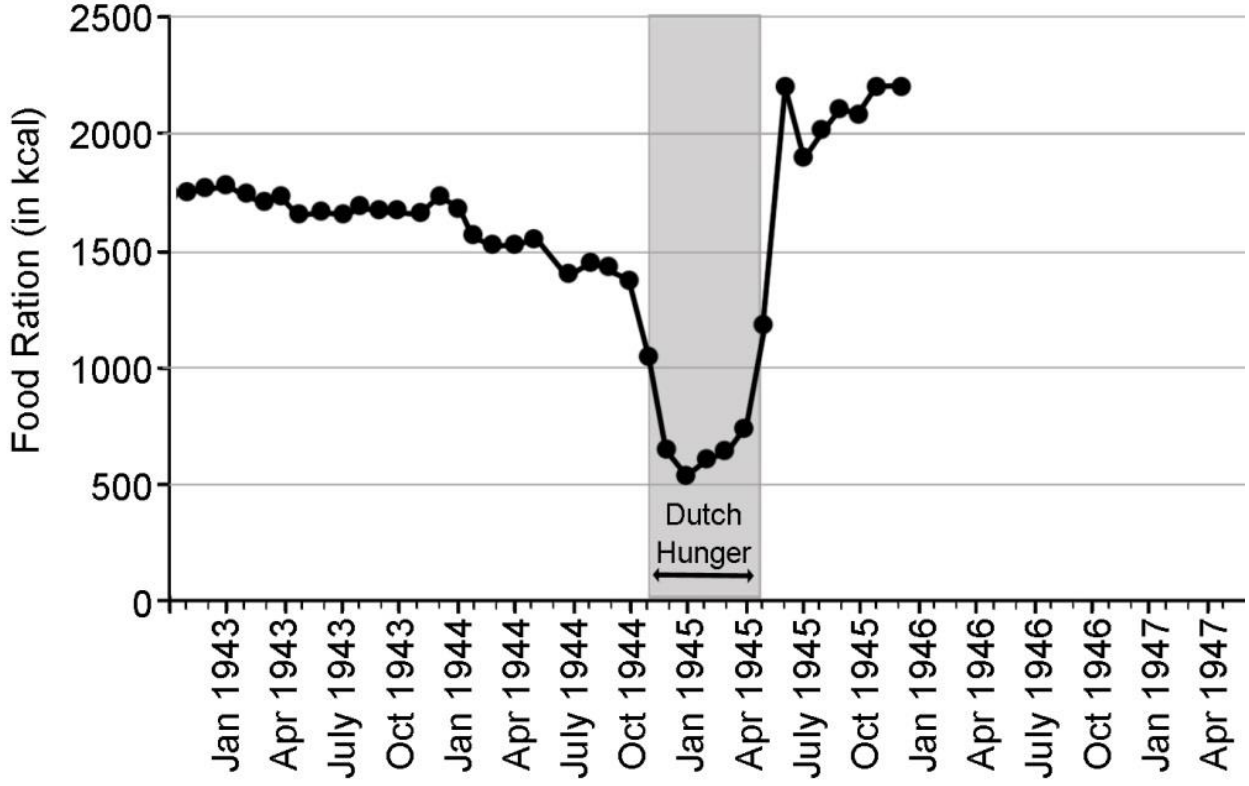
Job Title Epidemiologist (pronounced “Ep-eh-DEE-me-oh-lo-gist”, also known as a Public Health Researcher)

Job Description: You are investigating heart health patterns of seventy-year-old people in your community in The Netherlands. You are determining if their life history relates to their heart problems.

Description of Data: You know that there was a severe food shortage a long time ago because of wartime conditions. This period was called the "Dutch Hunger." Food was very difficult to obtain. Each person was limited to a certain share (ration) of food each day. You begin to look into this.

Your Task: Look at the graph below for the pattern of food available over the period of November 1942 to December 1945 (Source: Scholte et al., 2012). Use the steps on the other page to lead you to your final analysis.

Food Rations in the Netherlands during World War II



TASK CARD C

Name: Group #

Step 1) Look at "Jan 1943" on the top graph. The tick mark to the right of "Jan 1943" represents the unlabeled month of:

Month __**Feb**_____ Year__**1943**_____

Step 2) Look at the gray box labeled "Dutch Hunger" which represents when food dropped below 1000 kcal per day. Circle the month and year when the "Dutch Hunger" food shortage (famine) began.

a)

Oct 1944	Nov 1944	Dec 1944	Jan 1945	Feb 1945	Mar 1945	Apr 1945	May 1945	Jun 1945

The Dutch Hunger ended when calories rose above 1000 kcal again. Circle the month and year when the Dutch Hunger ended.

b)

Oct 1944	Nov 1944	Dec 1944	Jan 1945	Feb 1945	Mar 1945	Apr 1945	May 1945	Jun 1945

Step 3) A baby spends 9 months in the womb between conception (when an egg is fertilized) and birth.

a) If a baby was conceived at the start of the Dutch Hunger (answer from 2a), shade below the nine months of pregnancy when that baby would be in the womb.

b) If a baby was conceived during the last month of the Dutch Hunger food shortage (answer from 2b), shade below the nine months of pregnancy when that the baby would be in the womb.

	Jan 1944	Feb 1944	Mar 1944	Apr 1944	May 1944	Jun 1944	Jul 1944	Aug 1944	Sep 1944	Oct 1944	Nov 1944	Dec 1944	Jan 1945	Feb 1945	Mar 1945	Apr 1945	May 1945	Jun 1945	Jul 1945	Aug 1945	Sep 1945	Oct 1945	Nov 1945	Dec 1945	Jan 1946	Feb 1946
3a											1	2	3	4	5	6	7	8	9							
3b																	1	2	3	4	5	6	7	8	9	

Step 5) Would a baby born at the beginning of October 1945 (after the severe food shortage occurred) have been exposed to the ~~Dutch Hunger~~ in the womb? Explain using data from the graph.

Circle one: Was exposed to Dutch Hunger Was not exposed to Dutch Hunger

What information from the graph supports your choice? **A baby born in October 1945 would have been conceived in January 1945 (during the Dutch Hunger) and would have been exposed to the famine for 4 months.**

Final Analysis

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. Use the information above to complete the following sentence.

Babies exposed to poor nutrition resulting from the Dutch Hunger were born between
__**Aug 1945**_____ and ___**Feb 1946**_____.
[Month, Year] [Month, Year]

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

TASK CARD D

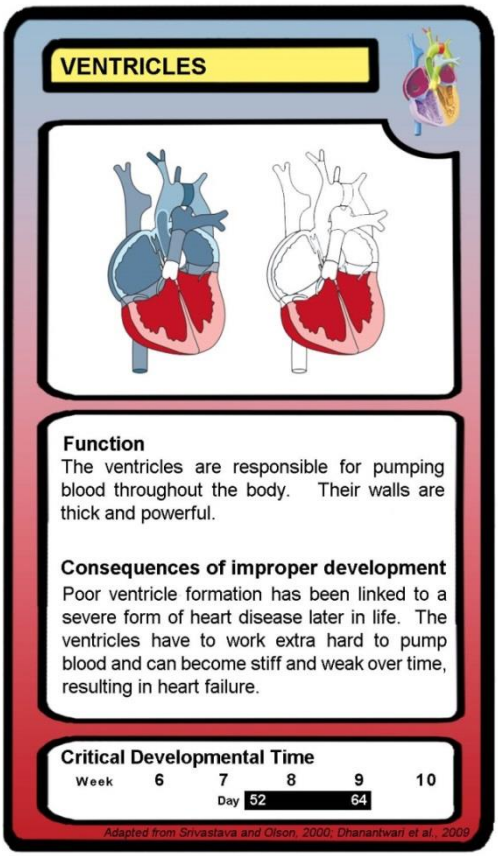
Name: Group #

Heart Development Timeline

Job Title – Cardiac embryologist (pronounced "em-bree-ah-low-gist")

Job Description: You study how the heart develops and grows from a simple group of cells to a fully functional heart with chambers and working valves.

Description of Data:
These research cards show three different regions of the heart: the atria, ventricles and valves. One of these cards is shown on the right.



The black box at the bottom of each card ( ) shows each heart region's "Critical Development Time" -- the period of time when that heart region is most sensitive to the mother's nutrition during pregnancy.

Each heart region has a different function and is formed at different times during pregnancy. Lack of nutrition in the first six weeks of a baby's development leads to heart defects at birth. After 6 weeks, the mother's nutrition affects each heart region differently, with the consequences of these developmental problems not seen until adulthood.

Key Terms and Time Periods:

Conception:	When the egg is fertilized. The start of pregnancy.
Pregnancy:	When a baby is in the mother's womb. Lasts 9 months. Baby's organ development happens during this time.
Birth:	When the baby is born after 9 months

Your Task:
Use the research cards and steps on the other page to determine how a mother's nutrition affects the heart development of her baby.

TASK CARD D

Name: Group #

Step 1) Look at the research cards. They describe three regions of the heart. The black bar at the bottom of each card describes the developmental time that is critical for that heart region's formation.

Circle which region of the heart…

Has its critical developmental time first? Ventricles (Atria) Valves Day number? **48**

Has the longest period of time when critical development is taking place? Ventricles Atria (Valves) How many days? **16**

Step 2) Looking at all three heart regions, the heart's critical developmental period is finished by which week?

Week number: **10**

Step 3) If a baby was in its 65th day of development and there was a large snowstorm that trapped a pregnant mother in her car for a day without food, which region of the heart would be affected?

Circle one: Ventricles Atria (Valves)

What symptom might you expect someone to develop in adulthood if this region was affected?

- _X_ Blood may leak between chambers
- ___ They may develop a severe form of heart disease later in life
- ___ Their heart may beat too fast, slow or irregularly

Step 4) What if the lack of food occurred over several days, such as Days 57-60? Which region(s) of the heart would be affected?

Circle all that apply: (Ventricles) Atria (Valves)

What symptom(s) might you expect someone to develop in adulthood if this region was affected? (check all that apply)

- _X_ Blood may leak between chambers
- _X_ They may develop a severe form of heart disease later in life
- ___ Their heart may beat too fast, slow or irregularly

Final Analysis

You have important information to add to the investigation about possible health problems that the Dutch Hunger babies have in later life. Use the cards to complete the following sentence.

A baby's developing heart is most sensitive to stress resulting from lack of nutrition _____.

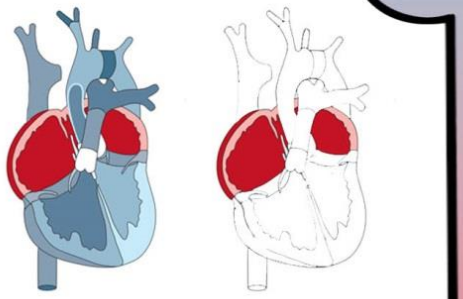
before the baby is conceived. | (during the first 10 weeks of pregnancy.) | during weeks 28-34 of pregnancy. | after the baby is born.

Would you expect the nutrition a baby experienced in the womb to contribute to heart disease in adulthood – for example, when the baby grows up to be 65 year old man? What information from the cards supports your choice?

Yes. Improperly developed parts of the heart can become damaged even more with long-term stress. If the atria, valves and ventricles do not develop properly, they can wear out or get further damaged. Stroke, heart failure and death may occur

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

ATRIA



Function
The atria collect blood from the body and lungs before the blood is passed through valves to the ventricles. The atria has sensors on its walls to maintain blood flow. The pacemaker system that regulates heartbeat is also in the atria.

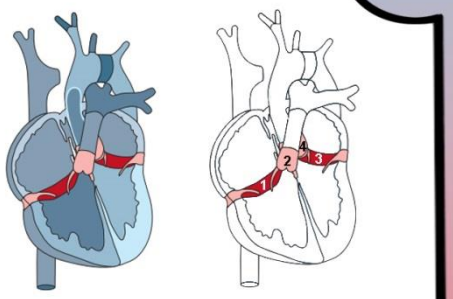
Consequences of improper development
Heart pacemaker may not form properly, so the heart may beat too fast, slow, or iregularly (arrythmia). Stroke and heart failure can occur.

Critical Developmental Time

Week	6	7	8	9	10
Day	48		56		

Adapted from Srivastava and Olson, 2000; Dhanantwari et al., 2009

VALVES



Function
The heart has four valves that open and close to allow heart chambers to refill with blood between heart beats.

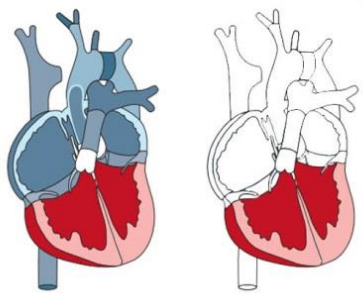
Consequences of improper development
Valves may not open and close properly, so blood "leaks" between chambers. This can stress the valves over time, resulting in damage. Death can result if the heart cannot pump enough blood.

Critical Developmental Time

Week	6	7	8	9	10
Day	50			66	

Adapted from Srivastava and Olson, 2000; Dhanantwari et al., 2009

VENTRICLES



Function
The ventricles are responsible for pumping blood throughout the body. Their walls are thick and powerful.

Consequences of improper development
Poor ventricle formation has been linked to a severe form of heart disease later in life. The ventricles have to work extra hard to pump blood and can become stiff and weak over time, resulting in heart failure.

Critical Developmental Time

Week	6	7	8	9	10
Day	52			64	

Adapted from Srivastava and Olson, 2000; Dhanantwari et al., 2009

TASK CARD E

Name: Group #

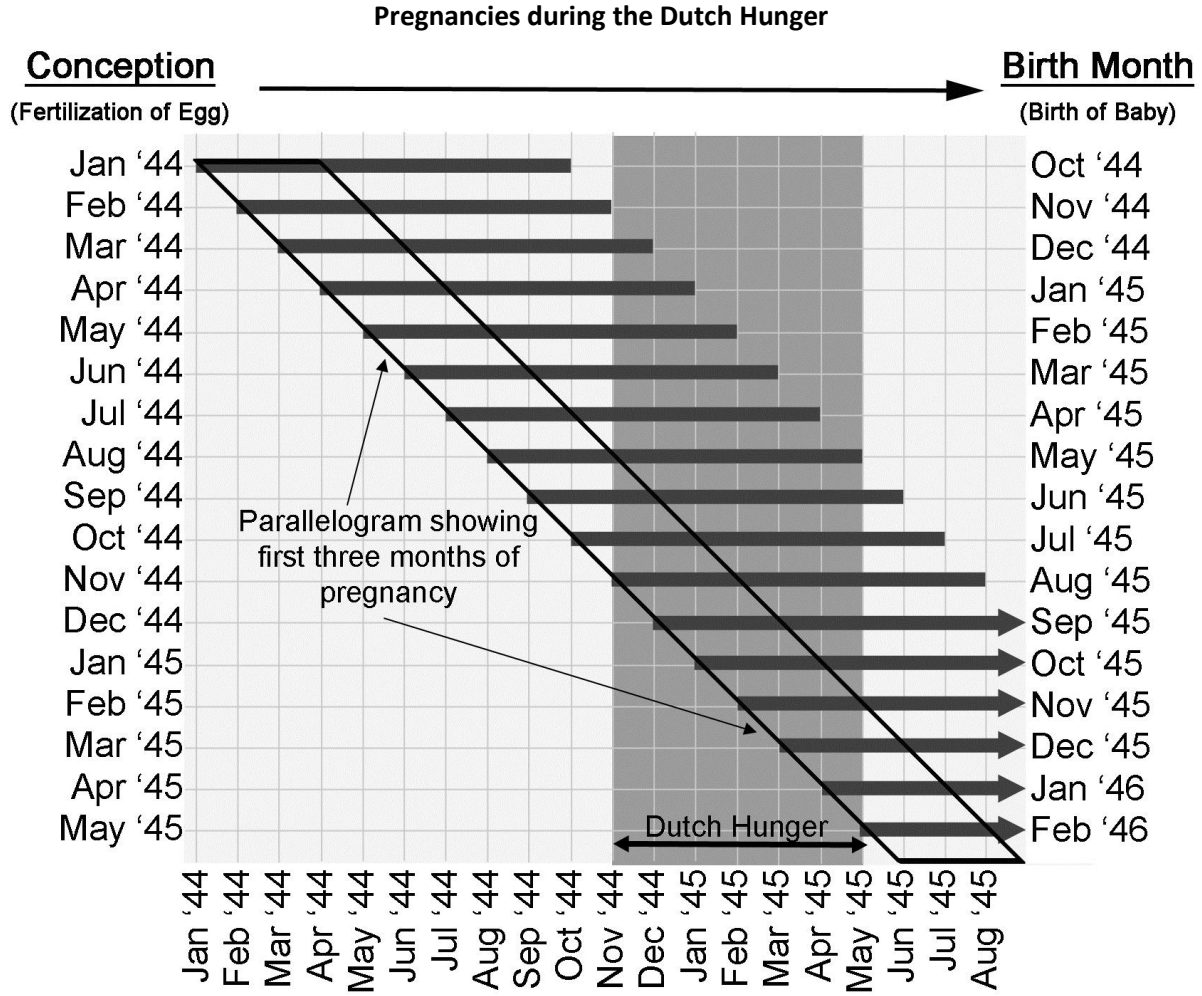
Dutch Hunger Pregnancy Diagram

Job Title - Pediatrician

Job Description: You study the development of babies and how their mother's health affects their baby's growth during pregnancy.

Description of Data:
During World War Two there was a severe food shortage known as the "Dutch Hunger". This diagram plots the pregnancies during that time and shows where in the pregnancy the "Dutch Hunger" occurred.

This symbol \ shows the time in the pregnancy that the babies are most affected by their mother's diet. This happens during the first three months of pregnancy (also known as first trimester). During this time all of their major organs are forming and organs fail to grow properly if they don't get the nutrients they need.



Your Task: Use the steps on the other page to analyze which pregnancies may be most affected by the food shortage.

TASK CARD E

Name: Group #

Step 1) First, you need to know how to read the graph. The dark horizontal bars represent the time in the womb for babies. Look under "Conception" for "Jan 1944". Follow the diagram across to the right to "Birth Month". If a baby is conceived in Jan 1944, when would it be born?

Month **Oct** Year **'44**

Step 2) Look under "Birth Month" for "Apr 1945". Follow the diagram back over to the left to find out the month of "Conception". For a baby born in April of 1945, when was it conceived?

Month **Jul** Year **'44**

Step 3) The parallelogram ╲ represents the first 3 months of a pregnancy when organs are forming. For a baby born in Feb 1946, when did these first 3 months of organ development occur?

From [Month **May** Year **'45** to [Month **Aug** Year **'45**]

Step 4) Move your finger up the parallelogram ╲ to answer the following: Which babies were most affected by the Dutch Hunger in their first three months of development?

A. Earliest possible birth month for a baby who had its first three months of development entirely during the Dutch Hunger. Month **Aug** Year **'45**

B. Latest possible birth month for a baby who had its first three months of development entirely during the Dutch Hunger. Month **Nov** Year **'45**

Step 5) Below are listed five birth months. Assuming that the first trimester is most sensitive to lack of food, use the diagram to decide which baby you think might be most sensitive to the Dutch Hunger.

Jan 1945 Jul 1945 (Oct 1945) Dec 1945 Feb 1946

What information from the diagram supports your choice? **This baby had its first trimester entirely during the Dutch Hunger. The first and last options were completely before or after. The Jul and Dec 1945 babies only had some of their first trimester exposed to famine.**

Final Analysis

You have important information to add to the investigation about the health problems that the Dutch Hunger babies have in later life. As a group, determine:

Which babies would you expect to be most sensitive to the Dutch Hunger food shortage (Circle one)?

A) Babies born before the famine but were undernourished as newborn infants.
(B) Babies whose first trimester overlapped the famine even if they were born after the famine.
C) Babies whose mothers were pregnant any time during the famine.
D) Babies born soon after the famine started.

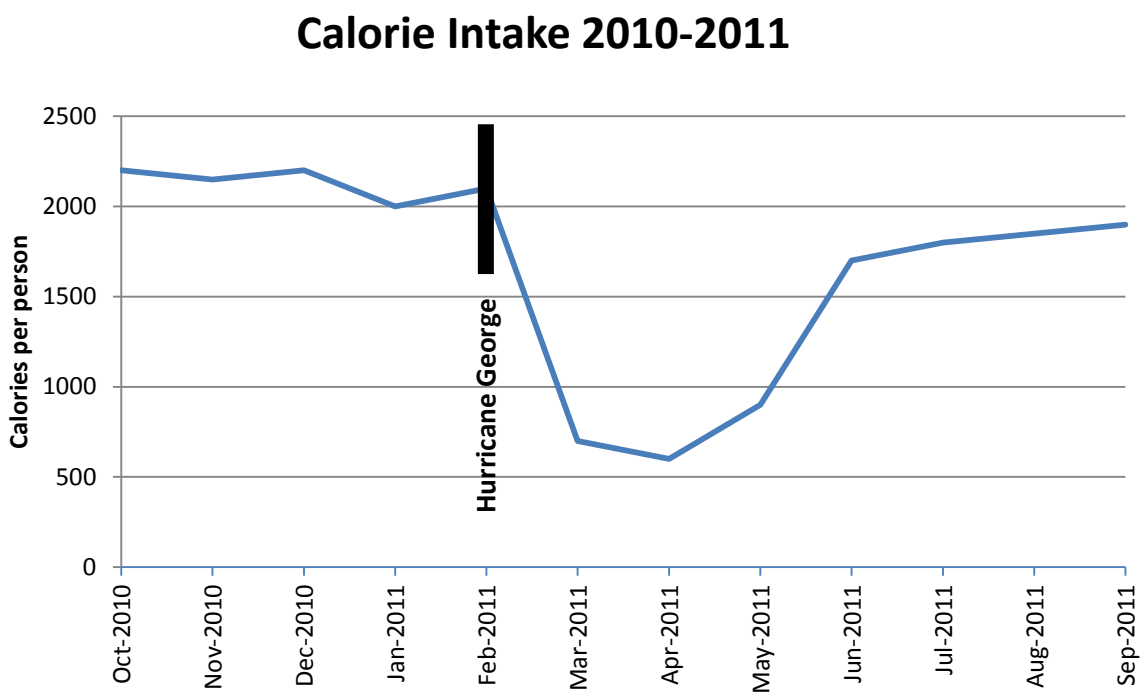
Babies expected to be most sensitive to the Dutch Hunger food shortage were born between
Month **Aug** Year **1945** to Month **Nov** Year **1945**

You will be sharing this information with the other students in your 'home group' and it will become part of the Final Analysis for your 'home group'. Make sure what you wrote above is very clear and completely explains what you have learned. Is what you said clear enough? Will it help the other students understand the data?

Name: Group #

Hurricane George and Costa Blanca

Hurricane George strikes the (fictional) island of Costa Blanca in early February of 2011. The typical food supply was mostly wiped out and, due to its remoteness and debris in surrounding waters, it takes a few months for relief supplies to restore the food supply for the residents. Here is a graph of the number of calories per person per day consumed over that period of time.



1. Use what you have learned to explain what we might expect 50 years after Hurricane George and the resulting food supply shortage (famine) in Costa Blanca. Who might you expect to show heart disease in later life?

Student examines the pattern of the data shown in the graph above and combines it with what was learned in the lesson to predict health impacts of stress in the womb. The student should identify that a baby in the womb would be predicted to show health effects 50 years later, particularly one in the first trimester of pregnancy when the food shortage occurred.

2. Explain how environmental stressors (such as famine) experienced by a person in the womb could cause a health effect in an adult?

Organ development is being formed during pregnancy. An organ that doesn't form properly during development will not be able to function as well later in life.

3. What other natural or human-made events might impact the health of a population?

Crop failures from severe cold or drought periods. Global warming effects on crops or animals. War-time stress on food supply. Virus or some other issue that limits food supplies from reaching an area. Tsunami or earthquake, etc. Goal here is to get student thinking about environmental issues that could affect population-level health

Name: Group #

Standards Assessed in the Hurricane George Summative Assessment

From *The Next Generation Science Standards*

Disciplinary Core Ideas

(MS-LS2-4.) Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Science and Engineering Practices

(MS-LS1-3) Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.

(MS-LS1-4) Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

From *Common Core State Standards*

Literacy in History/Social Studies

- CCSS.ELA-LITERACY.RH.6-8.7 -- Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

Science and Technical Subjects

- CCSS.ELA-LITERACY.WHST.6-8.9 -- Draw evidence from informational texts to support analysis, reflection, and research.

Writing

- CCSS.ELA-LITERACY.W.6.1.A -- Introduce claim(s) and organize the reasons and evidence clearly.
- CCSS.ELA-LITERACY.W.7.1-- Write arguments to support claims with clear reasons and relevant evidence.
- CCSS.ELA-LITERACY.W.8.1 -- Write arguments to support claims with clear reasons and relevant evidence

Scoring Rubric for Hurricane George Summative Assessment

Question	Exemplary (4)	Accomplished (3)	Developing (2)	Beginning (1)	Score
1) Prediction of who may show heart disease	The student identifies that a baby in the womb would be predicted to show health effects 50 years later, particularly one in the first trimester of pregnancy when the food shortage occurred	The student identifies that a baby in the womb would be predicted to show health effects 50 years later,	The student identifies that a baby would be affected.	No clear understanding connection to the lesson.	
2) Mechanism for environmental stressors affecting health of the adult	The student identifies that organ development is being formed during pregnancy. An organ that doesn't form properly during development will not be able to function as well later in life.	The student identifies that organ development is occurring during pregnancy. No outcome is provided to influence adult health.	The student identifies that babies are sensitive to stress.	No clear understanding connection to the lesson.	
3) Other examples of events that cause stress	The student identifies 3 examples that span different types of human and man-made disasters or events	The student identifies 1-2 examples that span different types of human and man-made disasters or events	The student identifies 1-2 examples that are all similar to the hurricane or famine example, but without further elaboration	The student identifies the same examples provided, i.e. the hurricane or famine, without further elaboration	

Example Scoring: 10-12 = A; 8-9 = B; 6-7=C; 4-5=D; 0-3=F

Name: Group #

Bees and Berries

A group of students noticed bees around new berry plants growing in their school garden. They decide to study whether bees may be pollinating the flowers on berry plant. They count ten plants in the school's garden. Each week, starting in March, they recorded the number of flowers in bloom on the plants, the number of bees visiting the plants, and the number of ripe fruit on the plants. Of course, at first there was no ripe fruit and later there were no flowers in bloom. Two students continued their work over the summer. Here is a table of their results:

	Week Number	Number of plant flowers	Number of bees present	Number of berries ripe
3/1	1	0	0	0
3/8	2	0	0	0
3/15	3	0	0	0
3/22	4	0	0	0
3/29	5	0	0	0
4/5	6	0	0	0
4/12	7	7	2	0
4/19	8	14	4	0
4/26	9	21	6	0
5/3	10	35	11	0
5/10	11	49	15	0
5/17	12	70	21	0
5/24	13	75	23	0
5/31	14	65	20	0
6/7	15	53	16	2
6/14	16	31	9	7
6/21	17	7	2	15
6/28	18	0	0	29
7/5	19	0	0	45
7/12	20	0	0	36
7/19	21	0	0	19
7/26	22	0	0	12
8/2	23	0	0	7
8/9	24	0	0	4
8/16	25	0	0	0
8/23	26	0	0	0
8/30	27	0	0	0

Use their data to answer the following questions:

1) How many weeks does it take for the fruit of this plant to go from flower to ripe fruit? Explain how you used the data to estimate this.

It takes between 7-9 weeks to go from flower to ripe fruit. Approximately 9 weeks in the beginning of the season and 7 weeks toward the end of the season, perhaps because of warmer weather. This was estimated by counting the weeks between flowers to ripe berries.

2) If warm weather triggers bees to come earlier but does not affect the flowering of the plant as much, how might climate change affect the berry production of these plants?

If the bees came early and survived the whole season, then berry production would stay the same, but if bees only came for the same 11 weeks, then there would be a decrease in berry production because the bees would arrive but there would be no flowers to pollinate. If the flowers aren't pollinated, then there would be no berries.

3) Bees are responsible for pollinating 15-30% of all food that United States consumers eat (Roach, 2004). Their numbers have dropped by half in the last 60 years. If their numbers continue to decline, what would you expect to happen to the United States food supply?

Less bees would result in fewer crop flowers getting pollinated, which means less food would be produced.

4) For a family who got *all* of their food from bee-pollinated crops, how might a large decline in bees affect their family's health now and in 50 years?

There would be less food available so the family members would likely experience weight loss. In extreme cases, a famine could result and women who may be pregnant at the time could have a baby whose organs didn't form properly, especially if in the first trimester, resulting in increased risk for heart disease later in life.

Standards Assessed in the Bees and Berries Summative Assessment

From *The Next Generation Science Standards*

Disciplinary Core Ideas

(MS-LS2-4.) Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Science and Engineering Practices

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Scoring Rubric for Berries and Bees Summative Assessment

Question	Exemplary (4)	Accomplished (3)	Developing (2)	Beginning (1)	Score
1) Weeks for fruit to flower	The student identifies the range in weeks and describes how the range was calculated.	The student identifies an exact week number and describes how the data were used to estimate the weeks.	The student identifies the incorrect numbers of weeks or does not describe how the data were used to estimate.	Incorrect number of weeks and no reasoning	
2) Bees arrive early; flowers stay the same	The student identifies a possible decline in berry production and describes flower pollination timing as why this would be the case. Identifies alternate scenario as well.	The student identifies a decline in berry production and describes flower pollination timing.	The student incorrectly identifies the direction of the berry production, but describes rationale for bees pollinating flowers for berry production.	The student does not tie together bees and pollination with berry production.	
3) Bees affecting US food supply	The student identifies that less bees would result in fewer crop flowers being pollinated, so less food would be produced.	The student identifies that less bees would result in fewer crop flowers being pollinated. Incorrect description of effect on food supply.	The student identifies that less bees would result in fewer crop flowers being pollinated. No description of effect onfood supply.	The student does not address bee numbers, pollination or food supply.	
4) Bees affecting human health now and in future	The student describes short and long-range health issue scenarios. Describes food restriction effects now (like weight loss or lack of food) and how food restriction during pregnancy might affect future health through organ formation, especially during first trimester.	The student describes possible short and long-range health issue scenarios. Describes that pregnancy might affect future health through no discussion of effects of nutrition on organ formation.	The student describes only short or long-range health issue scenarios. Minimal detail provided	The student does not adequately describe health issues and provides no justification for the answer.	

Example Scoring: 13-16 = A; 9-12 = B; 5-8=C; 5-7=D; 0-4=F