Chapter 18 Viruses & Bacteria
Question: How are bacteria similar and how are they different from viruses?
18.1 Viruses
Zika Virus

Transmitted by mosquito bite

No treatment or vaccine is available

About 1 in 5 people infected will become ill

Symptoms normally last 2–7 days

Symptoms: fever, rash, joint pain, conjunctivitis (red eyes)

Illness is usually mild and death is rare

Mosquitoes known to transmit the virus are not present in Canada

Health Canada / Centers for Disease Control

CBC News
What is a virus?

- A virus is composed of nucleic acids enclosed in a protein coating and much smaller than bacteria.
What is a virus?

• Viruses are not considered to be alive. There are several reasons:
  – They do not grow & develop
  – They do not reproduce, only replicate by infesting a cell, which is called the host cell.
  – They do not carry out respiration like other cells.
Viral Structure

- A virus has an inner core of nucleic acid (RNA or DNA) and an outer protein coat called a **capsid**.
- The virus also has a tail and tail fibers which are used to attach to plasma membranes of cells.
Virus Replication

- Viruses have specific attachment proteins that allow them to infect a cell. This means they can only affect certain types of cells.
Virus Replication

• A virus replicates by releasing its nucleic acids into a cell and take over that cell’s genetic material.

• The cell will then create more nucleic acids for the virus in addition to their own information.
Death of Cells

- There are two cycles *(that we will look at)* for viruses.

- The **lysogenic cycle** is when the virus lays dormant in the cell, its genetic material being copied into new viruses.

- The **lytic cycle** is where the virus becomes active and the infected cells erupt and release more viruses.
Where Did They Come From?

• Scientists believe that viruses evolved from bacteria or other life.
• This is because they need other living things to infect in order to replicate.
18.2 Archaebacteria & Eubacteria
What is a bacterium?

• A bacterium is one single, very small cell.
• They are the simplest forms of life.
• They function just like other cells we have studied.
Why Do They Matter?

- They fix nitrogen for the nitrogen cycle.
- They are used in medicines and foods.
- Some do cause diseases.
DON'T ANYBODY TOUCH THAT CHIP YET! 1...2... 3...4...

TOO LATE.
Question: How are bacteria similar and how are they different from viruses?
15.1 Natural Selection & the Evidence for Evolution
Evolution & Darwin

• Charles Darwin is credited as the father of evolution.
• **Evolution** is the gradual changes in adaptations of species over time.
Bonus on Darwin

Darwin lived from 1809-1882 and during his trips to the Galapagos he learned much. He also developed a great hatred for slavery.

He did not publish his findings for 20 years.

He was a religious man for most of his life and was not an atheist.

He formed the Gourmet Club, which was made for the purpose of eating rare and exotic beasts.
Neat

- Very badly seasick. Spent more time on islands than boat because of this.
- Delayed publication for fear of the reception. Waited over 20 years.
- Alfred Russel Wallace almost beat him to it. This is what got Darwin working hard to publish. Both are credited with the discovery but Darwin more so.
Neat

- Pros and cons list to decide on marriage. Cons “no reading in the evening” and “less time for self”. Pros include companionship “better than a dog anyhow”
- Had 10 kids, though two died at a young age.
- Became sick with various illnesses many times later in life. Thought to be caused by stress from his discovery.
- When first revealed, nobody cared about his ideas. Many big groups for science declared that the year of his publication “nothing significant” had been released that year.
Darwin’s Voyage

- Darwin traveled to the Galapagos Islands, a group of small islands that are each isolated from each other completely.
- He found animals and plants on each island that were similar to species found elsewhere, but distinctly different.
Artificial Selection

- Darwin knew that traits were passed on from parents to offspring.
- When humans bred animals or plants to pass on certain traits, he called this artificial selection.
Natural Selection

• Darwin believed that in nature, natural selection occurred. This is when the following are true:
  – There are more offspring produced than can survive.
  – The species have variation
  – The species with favorable traits succeed and pass on those traits.
Evidence of Evolution: Fossils

- Fossils show us structural similarities and evolutionary progress made over time.
- Fossil records are often incomplete and do not show the whole picture.
Evidence of Evolution: Adaptations

- Organisms over time adapt and change to fit their niche and environment over many generations.

- Examples include things like mimicry, blindness in cavern fish, camouflage, and many more.
Evidence of Evolution: Adaptations

• Structural adaptations take millions of years to change sometimes, however physiological (internal/chemical) changes occur much more quickly.

• *Example: Penicillin was discovered about 80 years ago and killed many kinds of bacteria. Today, penicillin no longer affects as many species of bacteria. They evolved to prevent death from penicillin.*
Evidence of Evolution: Anatomy

- Many animals across the world have similar body parts and layout.
- Structures that have a common evolutionary origin are called **homologous structures**.
Evidence of Evolution: Anatomy

• Structures that are not evolutionarily linked but have a common function are called **analogous structures**.

• Structures that no longer serve its original purpose but was probably useful to an ancestor is a **vestigial structure**.
Precious Life!
Whoops that was an lizard...
Whoops that was a fish...
WHICH EMBRYO IS HUMAN?

*EMBRYOS PICTURED ARE APPROXIMATELY AT THE SAME DEVELOPMENTAL STAGE. NOT DRAWN TO SCALE.

BONUS: NAME THAT EMBRYO

SCI-ENCE.ORG
Evidence of Evolution: Embryology

- It is easy to see the differences between adult animals, but when they are embryos they look remarkably similar.
- Embryos also develop similar structures at similar times.
Evidence of Evolution: Biochemistry

- Biochemistry provides strong evidence, as all creatures share the same DNA, ATP, and enzymes among other things.
Arguments Against/Misunderstandings
The Misconceptions: Why are there still ______________

If we evolved from monkeys

Then why are there still still monkeys
Gray wolf
(Common ancestor)

Europe

North America

China

India

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Orangutan: 48 chromosomes (24 pairs)
Gorilla: 48 chromosomes (24 pairs)
Chimpanzee: 48 chromosomes (24 pairs)
Bonobo: 48 chromosomes (24 pairs)
Human: 46 chromosomes (23 pairs)

Present
3 million years ago
Extinct common ancestor of chimpanzee and bonobo
6 million years ago
Extinct common ancestor of chimpanzees (including bonobo) and human
8 million years ago
Extinct common ancestor of gorilla, chimpanzees, and human
13 million years ago
Extinct common ancestor of orangutan, gorilla, chimpanzees, and human
Misconceptions: It’s just a theory!!
A theory is just an explanation for what we observe!

When they say:

Evolution is just a theory.

I hear:

I don't know the correct meaning of words.
Misconceptions: Evolution only makes stuff better/bigger/etc
Why did they get smaller? If evolution happened wouldn’t they become better and better???
sometimes, evolution sucks
7 MILLION YEARS AGO
Ape

2 MILLION YEARS AGO
Homo habilis
Height: 152cm

1 MILLION YEARS AGO
Homo erectus
Height: 165cm

500,000 YEARS AGO
Early homo sapiens

NOW
Homo sapiens
Average height: 177cm

3006
Human race reaches its peak.
brown skin tone. Average height:
200cm. Will live for 120 years.
Misconceptions: Evolution can happen in one lifetime/generation
It takes a loooooong time!

... then he yelled "evolution!" and simply jumped out ...

Humans & Cheese
Bottom Line

It Happens!
15.2 Mechanisms of Evolution
Population Genetics

• Individual living things do not evolve.
• Instead, populations evolve over time.
Population Genetics

- Populations evolve through natural selection and changes in the gene pool. The gene pool is all the different alleles (traits) available to a species at one time.

- How often an allele shows up is its allelic frequency.
Population Genetics

• When a frequency of alleles remains the same over many generations, it is known as genetic equilibrium.

• This balance in the gene pool is also known as ***Hardy-Weinberg Equilibrium***.
Changes In Equilibrium

• If a species is at genetic equilibrium, it is not evolving, just staying the same.
• Mutations can disrupt that equilibrium, but there are other mechanisms of evolution that help as well.
Changes In Equilibrium

- **Genetic drift** greatly disrupts equilibrium.
- **Genetic drift** is a change in allelic frequency by chance events.
Gene Flow ↑
Natural Selection Methods

- Natural selection is how we know evolution works. There are three types of natural selection.
  - Stabilizing
  - Directional
  - Disruptive
Natural Selection Methods

• **Stabilizing selection:** This type of natural selection favors the most average, or normal type of organisms in the population.
Natural Selection Methods

- **Directional selection**: This occurs when natural selection favors one of the extreme traits.
Natural Selection Methods

- **Disruptive selection**: This occurs when natural selection favors both extremes and usually eliminates the normal.
Evolution of A Species

• When a new species is formed through evolution it is known as speciation.
• This occurs when members of two similar populations can no longer interbreed to produce fertile offspring.
• *Let’s look at a few ways speciation can occur...*
Evolution of A Species

- **Geographic isolation**: When a large population is physically separated into two or more populations.
Evolution of A Species

- **Reproductive isolation**: occurs when formerly interbreeding organisms can no longer mate and produce fertile offspring.

- **Two examples**: mating season and DNA
Evolution of A Species

• There are two theories for how fast evolution happens.

1. **Gradualism**: idea that species originate through many small, and slow adaptations.

2. **Punctuated Equilibrium**: speciation occurs in rapid bursts (~10,000 years) with long periods of genetic equilibrium in between.
Patterns of Evolution

- **Divergent evolution** is the type that most people usually think of.
- **Divergent evolution** is when a species that once was similar changes to become increasingly different.
Patterns of Evolution

- **Convergent evolution** is when two unrelated species evolve to become very similar.
- This happens because both had similar environments and pressure from natural selection.
1. Fill in the following table. Mark an "X" if an organism has the trait.

<table>
<thead>
<tr>
<th></th>
<th>cells</th>
<th>legs</th>
<th>Exactly 6 legs</th>
<th>wings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spider</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpenter Ant (black)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Add each of these organisms to the cladogram below: worm, spider, ant, fly

3. USING complete sentences, explain why you put each organism where you did on the cladogram.

4. On the cladogram above, add traits from the chart that make the organisms different from each other.

5. According to your cladogram, which two species are more closely related: worms and spiders or worms and ants? How do you know?

6. According to your cladogram, what species are flies most closely related to? How do you know?
7. Fill in the following table. Mark an "X" if an organism has the trait.

<table>
<thead>
<tr>
<th></th>
<th>hair</th>
<th>legs</th>
<th>opposable thumbs</th>
<th>eyes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snake</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monkey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lizard</td>
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</tr>
</tbody>
</table>

8. Add each of these organisms to the cladogram below: human, snake, gorilla, lizard

9. USING complete sentences, explain why you put each organism where you did on the cladogram.

10. On the cladogram above, add traits from the chart that make the organisms different from each other.

11. According to your cladogram, which two species are more closely related: humans or snakes or humans or monkeys? How do you know?

12. According to your cladogram, what species are gorillas most distantly related to? How do you know?
Write definitions to the following words from 15.2 (words found on page 404):

Gene pool, allelic frequency, genetic equilibrium, genetic drift, stabilizing selection, directional selection, disruptive selection, speciation, geographic isolation, reproductive isolation, polyploidy, gradualism, punctuated equilibrium, divergent evolution, convergent evolution (15 words total)
Write definitions to the following words from 15.1 (words found on page 393):

Evolution (found in glossary), artificial selection, natural selection, mimicry, camouflage, homologous structure, analogous structure, vestigial structure, embryo
Evolution by Natural Selection

Adapted from the University of California, Los Angeles Life Sciences 1 Demonstration Manual
Copyright 2005 by Jennifer Doherty and Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania

(?) What are some differences you have noticed in the size and shape of dogs in your neighborhood?

(?) Do their differences make them better at some things, but not well-suited for others?

What would happen if the world suddenly changed, so the only thing that dogs could eat was deer and there was absolutely no way for a dog to eat it if it wasn’t big or strong enough to catch and kill a deer? Most likely, smaller dogs would die off and the bigger ones would survive and reproduce. After a while, instead of a population of dogs of all sizes, most of the dogs in the population would be big dogs.

(?) Describe what is happening in figures 1, 2, and 3. Is the population of mice different in figure 3 than in figure 1? Explain why.

![Diagram of hand and feet]

1 Teachers are encouraged to copy this student handout for classroom use. A Word file, which can be used to prepare a modified version if desired, and Teacher Preparation Notes are available at http://secendip.brynmawr.edu/sci_edu/waldron/.
Living things that are well adapted to their environment survive and reproduce. Those that are not well adapted don't survive and reproduce. An adaptation is any characteristic that increases fitness, which is defined as the ability to survive and reproduce. What characteristic of the mice is an adaptation that increased their fitness?

(?) The table below gives descriptions of four female mice that live in a beach area which is mostly tan sand with scattered plants. According to the definition given for fitness, which mouse would biologists consider the fittest? ______________________

(?) Explain why this mouse would be the fittest.

<table>
<thead>
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<td>g</td>
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</table>

(?) If a mouse's fur color is generally similar to its mother's color, what color fur would be most common among the pups? ______________________

A more complete definition of fitness is the ability to survive and produce offspring who can also survive and reproduce. Below are descriptions of four male lions.

(?) According to this definition of fitness, which lion would biologists consider the "fittest"? ______________________

Explain why.

(Adapted from Michigan State University, Occasional Paper No. 91, Evolution by Natural Selection: A Teaching Module by Beth Bishop and Charles Anderson, 1985)

Suppose that Tyrone had genes that he passed on to his cubs that helped his cubs to resist infections, so they were more likely to survive to adulthood. These genes would be more common in the next generation, since more of the cubs with these genes would survive to reproduce. A characteristic which is influenced by genes and passed from parents to offspring is called heritable.

Over many generations heritable adaptive characteristics become more common in a population. This process is called evolution by natural selection. Evolution by natural selection takes place over many, many generations.
Evolution by natural selection leads to adaptation within a population. The term evolution by natural selection does not refer to individuals changing, only to changes in the frequency of adaptive characteristics in the population as a whole. For example, for the mice that lived in the beach area with tan sand, none of the mice had a change in the color of their fur; however, due to natural selection, tan fur was more common for the pups than for the mother mice.

In summary, a heritable characteristic that helps an animal or plant to have more offspring which survive to reproduce will tend to become more common in a population as a result of evolution by natural selection.

Questions

1. Explain why a characteristic which helps an animal to live longer will generally tend to become more common in the population as a result of evolution by natural selection.

2. Not all characteristics which contribute to longer life become more common in the population. Some characteristics contribute to long life, but not more offspring. For example, a female cat which is sterile and cannot have any offspring may live longer because she will not experience the biological stresses of repeated pregnancies. Explain why a characteristic like this which contributes to a long life, but with few or no offspring, would not become more common as a result of evolution by natural selection.

3. Natural selection is a simple concept that offers explanations for patterns seen in nature. The process follows three straightforward conditions. List the three conditions below and explain each one using an example in your answer. (Pages 126-132)
Write definitions to the following words from 18.1 and 18.2 (words found on page 475 and 296):

Virus, host cell, bacteriophage, capsid, lytic cycle, lysogenic cycle, provirus, retrovirus, chemosynthesis, obligate aerobes, obligate anaerobes, endospore, toxin
Disease Hunt

Directions: You will select a disease that is caused by a virus or bacteria and answer the following questions about it. DO NOT choose a disease caused by genetic mutations/errors.

1. What disease have you selected?

2. Is your disease caused by a virus or a bacteria (circle one)?

3. How do you contract this disease/What are common causes that allow someone to catch it?

4. What are the symptoms of your disease?

5. How long does it take for your disease to kill? If it does not kill, how long does it last before a body can fight it off?

6. What kind of treatment is there for your disease?

7. Does your disease have a cure? If so, what is it?
8. How common is your disease?

9. What are ways to prevent catching this disease (examples, hand washing, avoiding certain types of food, etc.)?

10. Is your disease contagious? If it is, how does it spread?

11. Draw/doodle a picture below of the virus/bacteria that causes your disease.