

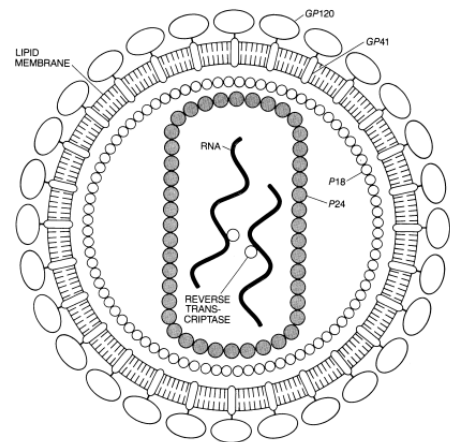
**Test of Knowledge of and Ability to
Use Core Ideas in Biology**

Name: _____
ID #: _____
Teacher: _____
Period: _____ Date: _____

Cell Theory

As a child, you probably received several vaccines. Vaccines are injections of parts of viruses that allow the human body to more easily develop a defense against a disease. Thanks to vaccines, many devastating diseases of the past such as small pox and measles are now rarely encountered because the body can defend itself from the viruses that cause such diseases.

Each virus has a unique structure. However, viruses in general share certain characteristics. They have a nucleic acid inner core of RNA or DNA surrounded by an outer coating called a capsid. Larger viruses, like the HIV virus (pictured at right), have an additional surrounding layer called an envelope that is composed of many of the same components that make up the membrane of a cell. Unlike a cell, a virus cannot replicate without first entering a "host" cell.



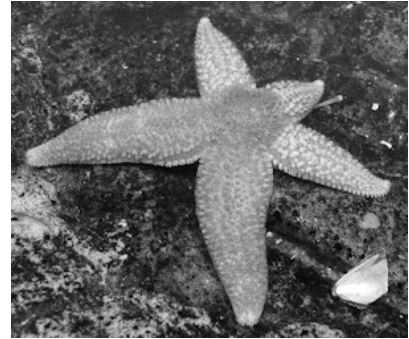
Biologists have been questioning whether or not a virus is actually a cell for many years.

1. **Describe** the three basic principles of cell theory.

2. **Use** your knowledge of cell theory to **explain** why the virus **is or is not** a cell.

Mitosis

Starfish prey on abalone, a type of mollusk. Humans who harvest abalone must compete with starfish for the shellfish delicacies. At one time it was common practice for abalone fisherman to try to reduce the number of starfish by catching them, cutting them up and dumping the starfish pieces back in the sea. The fishermen, however, were inadvertently increasing the number of starfish when they cut them up and dumped them back into the sea. The fragmentation of starfish is a form of asexual reproduction. If a part of an arm breaks off, the starfish not only regenerates the arm but the broken piece of arm can grow into an entire new starfish. This asexual reproduction of starfish is accomplished through **mitosis**. Scientists have labeled these starfish as clones of one another



3. **Describe** the process and end products of mitosis

4. **Use** your understanding of mitosis **to explain** why these starfish are considered to be clones.

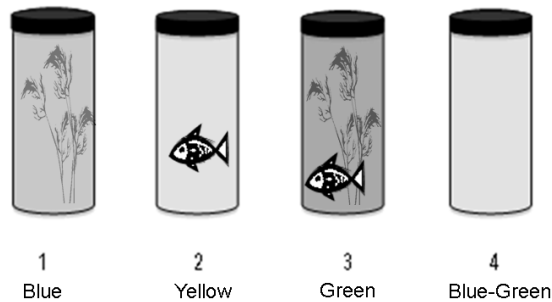
Photosynthesis and Cellular Respiration

Four test tubes are filled with 50 ml of spring water and 3 ml of Bromthymol Blue (BTB). BTB is an indirect indicator of Carbon Dioxide (CO₂). It changes from blue to green to yellow as CO₂ lowers the pH of a solution. A change to yellow indicates a larger quantity of CO₂ than a change to green.

The following items were then added to each test tube:

Test Tubes	Contents	Initial Color of the BT Blue
1	1 Sprig of Sago Pondweed (a plant found in ponds and lakes)	Blue-Green
2	1 Freshwater Fish	Blue-Green
3	1 Sprig of Sago Pondweed and 1 Freshwater Fish	Blue-Green
4	Nothing (this is a negative control)	Blue-Green

The test tubes were then sealed. Next, the test tubes were placed near a light source. After five hours, some of the test tubes changed color and some did not (see below).



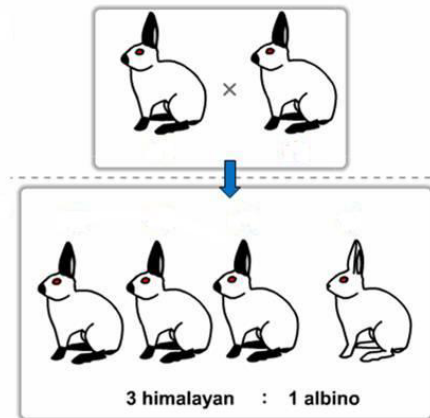
5. **Describe** the process of *Photosynthesis*

6. **Describe** the process of *Cellular Respiration*

7. **Use** the processes of *photosynthesis and cellular respiration* to **explain** the observed changes in the color of the water found inside the various test tubes.

Patterns of Inheritance

Two Himalayan rabbits mated and produced five offspring. Three of those offspring are Himalayan and one is solid white (see below).



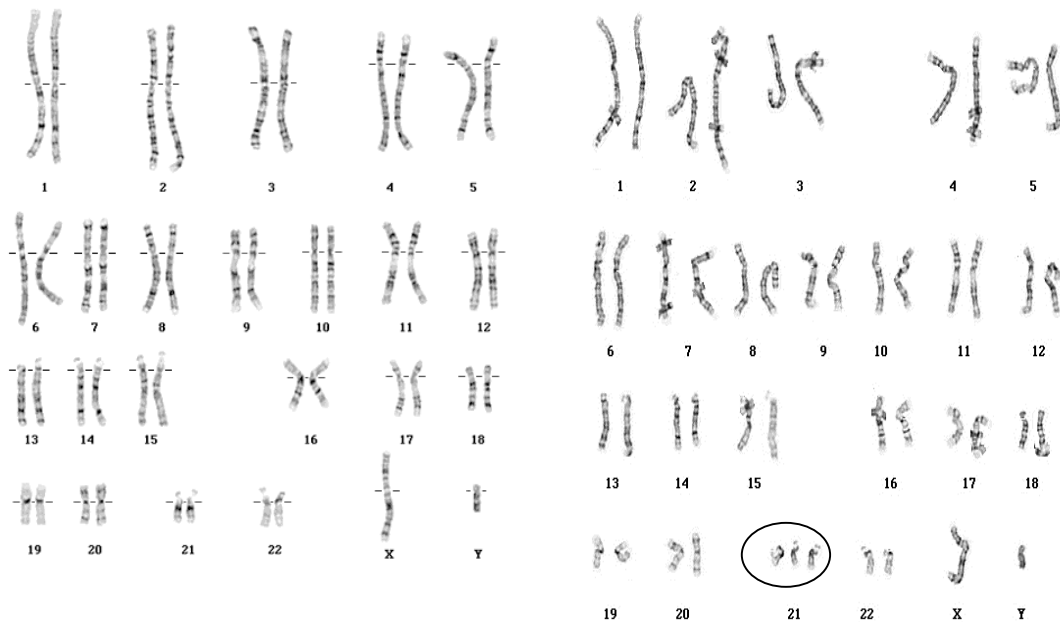
Biologists have used the principles of *Mendelian Inheritance* to explain similar observations in other contexts.

8. **Describe** the basic principles of *Mendelian Inheritance*.

9. Use the principles of *Mendelian Inheritance* to **explain** how two Himalayan rabbits can produce offspring that have solid white fur.

Meiosis

Aneuploidy describes a condition where one or more chromosomes are missing from or added to the normal chromosome number. Down syndrome is the most common form of aneuploidy found in humans. In humans it has an incidence rate of about 1 in 800 births for women of 30 to 31 years of age (the rate increases rapidly with maternal age). For many years it was believed to be solely associated with age of the mother, but it has been suggested that there are many contributing factors. Below are the karyotypes of a normal person and of a person with Down's syndrome.



Normal Human Male

Male with Down's Syndrome

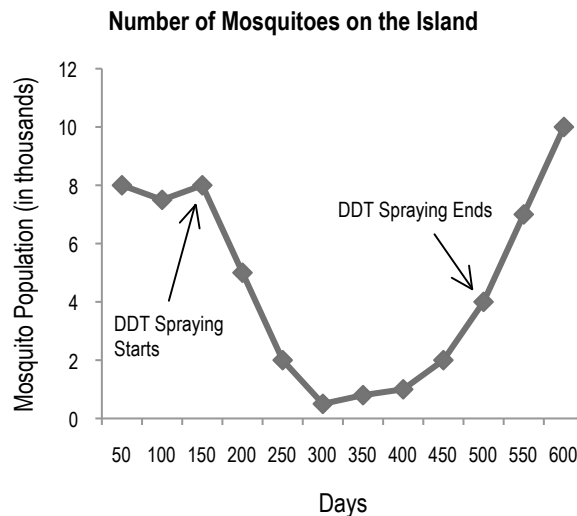
Biologists use the concept of meiosis to explain this phenomenon.

10. **Describe** the process and end products of meiosis.

11. **Use** your understanding of meiosis to **explain** the presence of the extra chromosome.

Mechanism of Evolution

After World War II, the insecticide DDT was used liberally to control populations of various insect pests, including malaria-spreading mosquitoes. Scientists have since discovered that some mosquitoes are resistant to DDT. Mosquitoes that are resistant to DDT are able to make an enzyme called esterase, which breaks down DDT into a harmless chemical. Non-resistant mosquitoes either do not produce this enzyme or produce it in very low amounts. The graph below shows a population of mosquitoes on a tropical island. The island was sprayed with DDT over a period of several months. Measurements of the number of mosquitoes on the island every 50 days resulted in the information shown on the graph below.



Biologists have used the theory of *Natural Selection* to explain similar observations in other contexts.

12. **Describe** the process of *Natural Selection*.

13. **Use** the process of *Natural Selection* to **explain** the change in the size of the population of Mosquitoes over time on this tropical island.

Macroevolution

Figure 1 below is a suggested evolutionary tree for the African Great Apes. The arrangement of this pathway is based on genetic information taken from the mitochondria of the various apes.

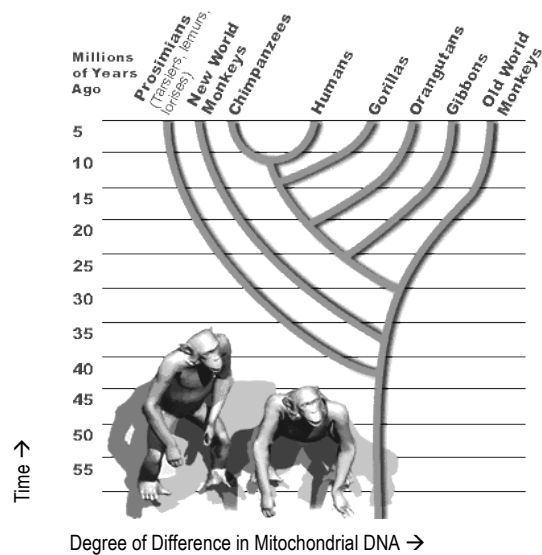


Figure 1. A hypothesized evolutionary lineages of the African Great Apes

Figure 2 shows a PCR analysis of genomic DNA below from human, chimpanzee, orangutans, and gorilla.

Human	ARG	ARG	ARG	LYS	HIS	GLU	VAL	GLY	VAL	VAL	LEU
Chimp	ARG	ARG	LYS	LYS	HIS	GLU	VAL	GLY	VAL	VAL	VAL
Orangutan	ARG	ARG	LYS	LYS	GLU	GLU	GLY	GLY	VAL	VAL	VAL
Gorilla	PRO	ARG	LYS	LYS	GLU	GLU	VAL	VAL	VAL	VAL	VAL

Figure 2. PCR analysis of genomic DNA from humans and African great apes.

14. **Describe** the process of *speciation*.

15. **Use** what you know about the process of speciation to **explain** degree of relatedness between the various species, the common ancestors of each, and the time when the speciation took place.

Biological Species Concept

Two bears are found in the Northern United States, grizzly bears and polar bears. These two bears look very different: grizzly bears (Figure 1) are a large type of brown bear (*Ursus arctos*), with a very prevalent hump on their back and polar bears (Figure 2) are a large white bear. These two genetically similar bears occupy very different niches. Grizzly bears tend live and breed on land, while polar bears prefer to live on the water and ice.



Figure 1. A Grizzly Bear



Figure 2. A Polar Bear



Figure 3. Current and Historic Grizzly Bear Distribution in North America

Recently, biologists have found that grizzly bears are moving into what was traditionally understood to be polar bear habitat (extreme Northern Canada - before 1996 there was no evidence of grizzly bears in this area). There have been three confirmed sightings of wild hybrids, a cross between polar bears and grizzly bears. These hybrids are creamy white in color—like a polar bear, a humped back and brown patches around its eyes, nose and back—like a grizzly bear. The behavior of these hybrid bears appears more like a polar bear than a grizzly. For example, they toss toys around as polar bears do with their prey; they lay on the ground with their legs splayed just like polar bears.

Biologists use the biological species concept to determine if two organisms are members of the same species.

16. **Describe** what is meant by the *biological species concept*.

17. According to the biological species concept, are grizzlies and polar bears one species or two different species? Use your knowledge of the biological species concept to **explain** your answer.

DNA Structure and Cladistics

The West Nile Virus (WNV) is a potentially serious illness; severe symptoms include fever, disorientation, coma, muscle weakness, vision loss, paralysis and potentially permanent neurological effects. However, 99% of those infected show little to no signs or symptoms of the disease. Those who have weakened immune systems such as young children and adults over 50 are especially vulnerable.

When WNV was first detected in the United States in New York City in 1999, researchers wanted to know where it came from and how it arrived (what kind of host). To propose answers to these questions, it is important to study the various isolated strains of the virus that have been found since this disease was first isolated in 1937. The figure below shows the DNA sequence of eight different strains of WNV

NY99	CCA	ACT	ACT	GT	GG	AG	TC	GC	AC	GG	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT									
ISRAEL98	CCA	ACT	ACT	GT	GG	AG	TC	GC	AC	GG	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT									
MOROCCO96	CCA	ACC	ACT	GT	T	G	AG	T	C	A	T	GG	T	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT						
ITALY98	CCA	ACC	ACT	GT	GG	AG	TC	GC	AC	GG	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT									
SAFRICA99	CCA	ACC	ACT	GT	GG	AG	TC	GC	AC	GG	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT									
ROMANIA96	CCA	ACC	ACT	GT	GG	AG	TC	GC	AC	GG	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT									
TAJKISTAN99	CCA	ACC	ACT	GT	GG	AG	TC	GC	AC	GG	AA	CT	CT	CC	AC	AC	AG	TT	GG	A	GCC	ACT	CAG	GC	AG	GG	AG	ATT									
MADAGASCAR88	CCG	AC	G	ACT	GT	T	G	AA	T	C	T	CA	T	GG	C	AA	T	T	A	T	T	CA	AC	AC	AG	TT	GG	G	GCC	ACC	CAG	GC	T	GG	A	AG	ATT

Once the researchers identified the DNA sequence of the eight strains, they used this information to determine the source of the New York strain of West Nile virus (NY99) based on the concepts of DNA structure and cladistics

18. **Describe** the structure of DNA

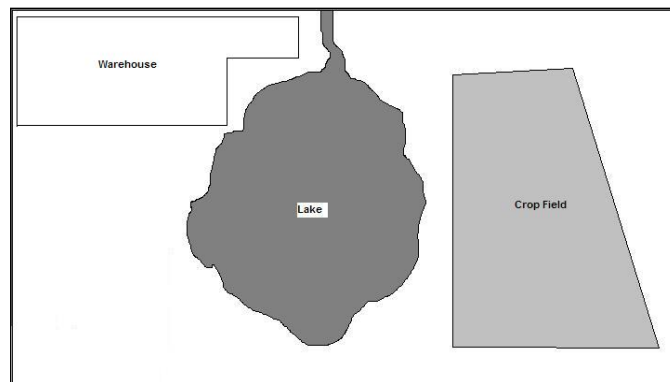
19. **Describe** the concept of cladistics

20. **Use** the concept of DNA structure **to explain** what the A, T, C, and G in the figure above represents (both in name and in structure).

21. **Use** the concept of cladistics **to explain** the most likely source of the NY99 strain of WNV.

Interdependence

A local lake receives water from a river close by, which has several species of fish and plants that living in it for many years. A few years ago, a farmer created a field close by the lake so he/she could make some more money by growing extra crops. To get the most growth out of the field, the farmer began spraying nitrogen-rich fertilizer on the field. Last year, another company bought the land on the other side of the lake and built a warehouse on the property close to the river. The construction of the warehouse involved disturbing a lot of the natural surroundings. Many of the chemicals used during construction were washed away by rain into the river. For the past 8 months, the fish and plant populations in the lake have decreased quickly. At the same time, there has been a large increase in the amount of algae growing in the lake.



Biologists have used the idea of nutrient cycles to explain similar events in other contexts.

22. **Describe** the concept of *nutrient cycles*.

23. **Use** the concept of nutrient cycles **to explain** what could be causing the changes in the lake.