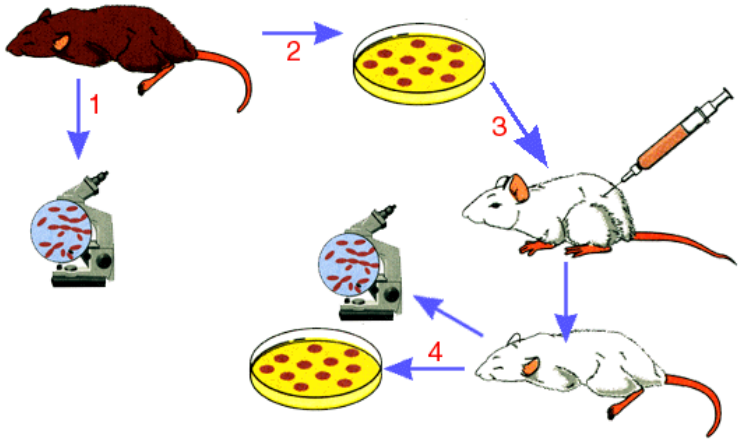
Name: _____

Random Facts to Know for the Biology SOL

The Germ Theory and Koch's Postulates:

- The **germ theory** of disease states that some diseases are caused by **microorganisms**. These small organisms, too small to see without magnification, invade humans, animals, and other living hosts. Their growth and reproduction within their hosts can cause a disease.
- **"Germ"** may refer to a virus, bacterium, protist, fungus, or prion (an infectious protein). Microorganisms that cause disease are called **pathogens**, and the diseases they cause are called **infectious diseases.**
- Even when a pathogen is the principal cause of a disease, environmental and hereditary factors often influence the severity of the disease, and whether a particular host individual becomes infected when exposed to the pathogen.
- Experiments related to the germ theory were conducted by **Robert Koch,** who isolated the bacteria Vibrio cholera, the cause of cholera, from water taken from Germany's Elbe River, thus proving the relationship between polluted water and this disease. Koch went on to formulate an established set of procedures to isolate and identify the microorganism causing a particular infectious disease. The following four steps, which are still used today, are known as **Koch's Postulates:**



Postulate 1: A specific organism must always be observed in association with the disease.

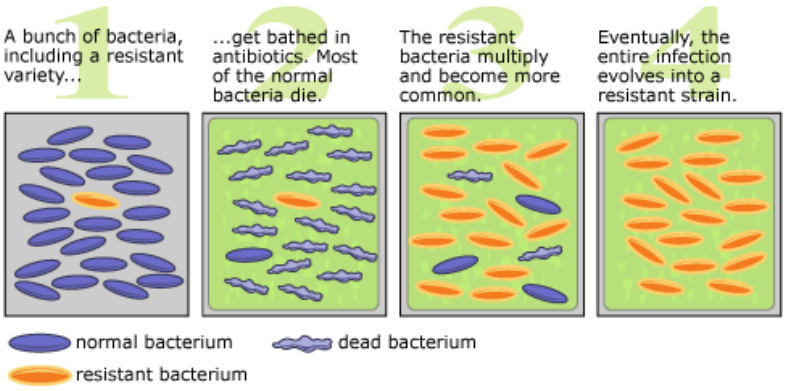
Postulate 2: The organism must be isolated from an infected host and grown in pure culture in the laboratory.

Postulate 3: When the organism from the pure culture is inoculated into a susceptible host organism, it must cause the disease.

Postulate 4: The infectious organism must be re-isolated from the diseased organism and grown in pure culture.

Evolution of Antibiotic Resistance:

- Most bacteria are susceptible to antibiotics, but some are naturally resistant due to random, beneficial antibiotic-resistance mutations in their DNA.
- Susceptible bacteria are killed by antibiotics, but resistant bacteria survive and reproduce. This results in the increasing frequency of bacterial infections that cannot be successfully treated with antibiotics.



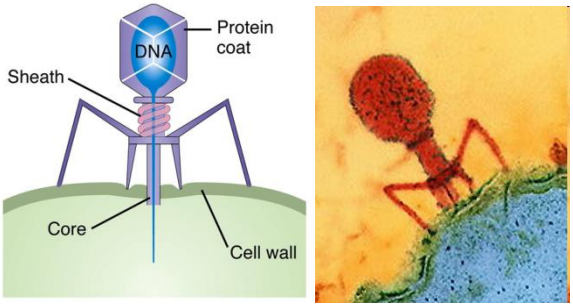
Viruses:

Is a virus a living thing?

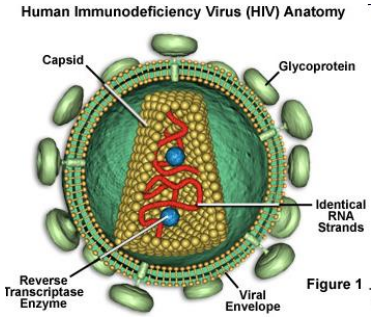
- Scientists have debated this question over the years, but most scientists believe the answer is no… for a few reasons
- Viruses are not true cells. They typically consist of a **protein coat (aka capsid)** surrounding **genetic material**, which is either DNA or RNA (both nucleic acids). They may or may not have a membrane outside their protein coat.
- Another name for a virus is a **phage.**

Example Virus Structures

- T4 Bacteriophage – Only infects bacterial cells.



- HIV Virus - Like the T4 Bacteriophage, the basic structure of this viruses is a protein coat surrounding genetic material. However, this virus looks a little different because it is encased in a membrane called the viral envelope.



How does a virus reproduce?

- Another reason viruses are not considered living is that they cannot reproduce by themselves. They can only replicate themselves to create "baby viruses" when they are inside a **host cell**. They must also use the host cell's **enzymes** (ex: DNA polymerase) to make a copy of their genetic material and transcribe and translate their capsid proteins.

1) The two viral reproductive cycles are called the lytic cycle and lysogenic cycle (see comparison to the right and on the next page)

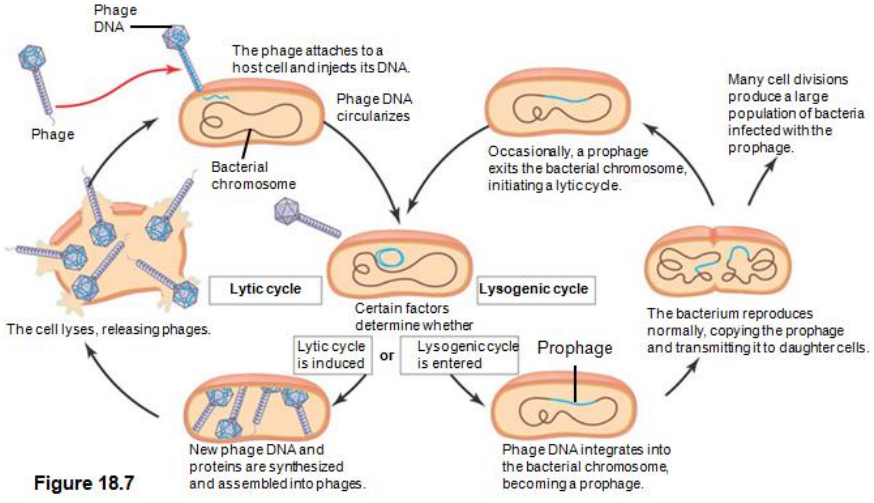


Figure 18.7

Lytic Cycle (active reproduction)	Lysogenic Cycle (dormancy)
-Type of reproduction that results in the death of the host cell -Virus injects DNA into the host cell -Takes over the enzymes (ex: DNA and RNA polymerase, ribosomes, etc.) to make copies of viral DNA and capsid proteins immediately -Progeny (baby) viruses are assembled -Cell is lysed (cell membrane and cell wall are digested / broken), which releases multiple copies of the virus	-Does not destroy the host cell -Viral DNA is incorporated into host DNA and replicates along with the host DNA -The incorporated viral DNA is called a prophage or provirus -Can stay in host DNA for years -Certain conditions can cause prophage to leave host DNA and enter lytic cycle

Although controversial at first, the germ theory of disease proposed that microorganisms were the cause of many diseases. Which of these was a result of the general acceptance that microorganisms cause disease?

- **A** The development and use of antibiotics
- **B** The belief in spontaneous generation
- **C** The link between viruses and RNA
- **D** The proof of a supernatural cause for illnesses

What do viruses need to reproduce?

- **A** Other viruses
- **B** Host organisms
- **C** A nutrient medium
- **D** An enzyme solution

One student in a class becomes sick with a fever and cough. Two days later, three other students in the same class become sick with the same symptoms. This is evidence that the illness is *most* likely caused by —

- **A** cold weather
- **B** a pathogen
- **C** a genetic mutation
- **D** nutritional deficiencies

In 1847, a scientist noted that when physicians washed their hands before they had contact with their patients, there was a decreased number of infections. This was one of the first clues that —

- **F** bacteria generate spontaneously on hands
- **G** physicians deliberately infected patients
- **H** bacteria are present in water
- **J** substances such as bacteria may cause diseases

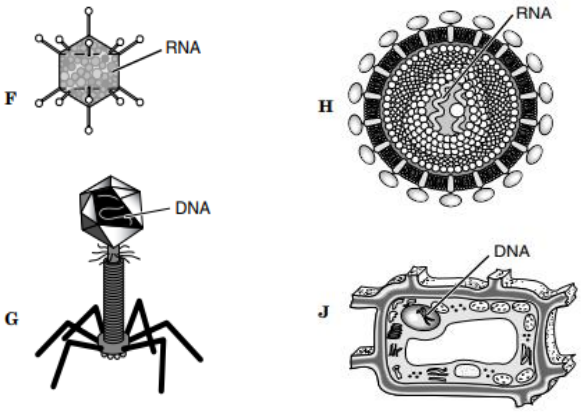
The German physician Robert Koch provided evidence to support the germ theory of infectious disease. Koch isolated bacteria from a cow with anthrax, then injected the bacteria into a healthy mouse. To support germ theory, what must have happened to the healthy mouse?

- **F** It became sick.
- **G** It spread smallpox.
- **H** It produced antibiotics.
- **J** It became immune to viral infections.

Which feature do viruses have in common with animal cells?

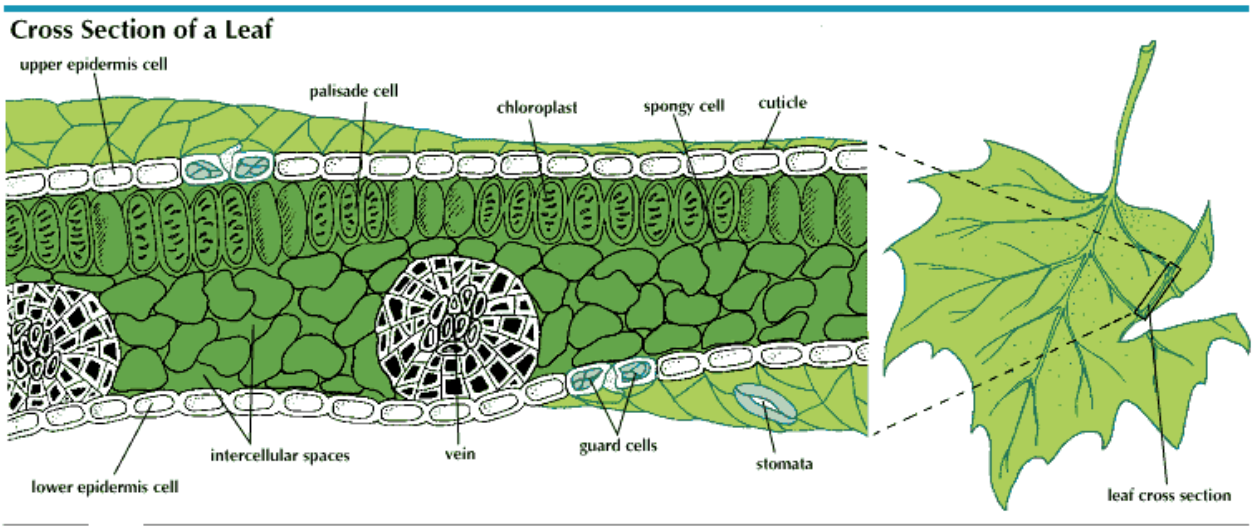
- **A** Ability to form proteins at the ribosomes
- **B** Existence of lipids in cell membranes
- **C** Presence of a genetic code in nucleic acid
- **D** Production of energy by a mitochondrion

Which of these could *not* be a virus?



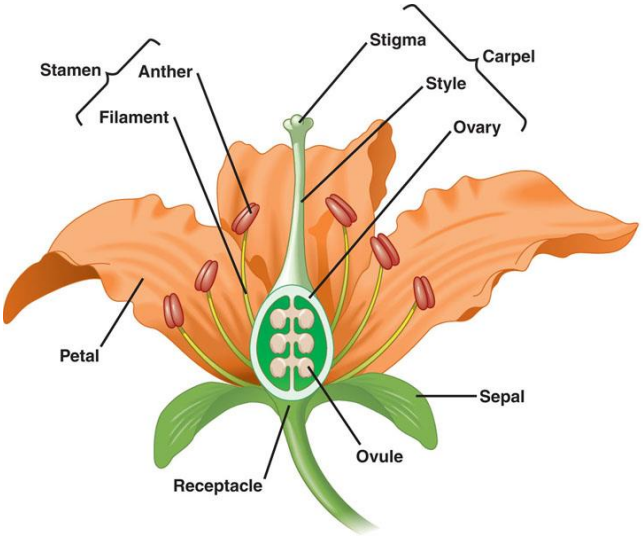
Plant Anatomy:

- **Root system** – used to anchor the plant and absorb water / nutrients (ex: nitrates and phosphates) from the soil.
- **Stem**—used to transport water up from the roots to the leaves by capillary action and to transport sugars created during photosynthesis from the leaves throughout the rest of the plant. There are two types of "vascular tissue" (tubes) in the plant to transport materials—**xylem** to transport water and **phloem** to transport sugars.
- **Leaves**—used to capture sunlight to create glucose (photosynthesis) and to take in carbon dioxide / release carbon dioxide through holes on the underside of the leaf called **stomata.** Water also evaporates out of the leaf through the stomata in a process called **transpiration.**
- **Epidermis** covers the outer surface of the leaves and stem, providing a protective layer.



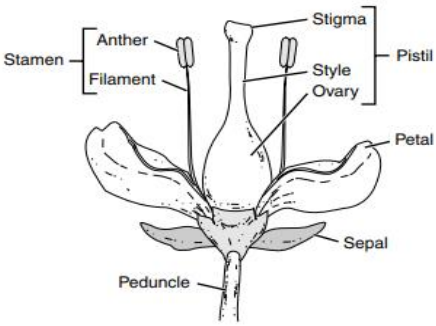
Angiosperms vs. Gymnosperms:

- Angiosperms and gymnosperms (aka Conifers) are two types of vascular plants (i.e. plants with stems, and therefore vascular tissue)
- A **gymnosperm** is a vascular plant that produces seeds lacking an outer fruit. Normally these seeds are contained in **cones.** An example of a gymnosperm is a pine tree.
- An **angiosperm** is a vascular plant that produces seeds located inside a **fruit.** This type of plant also has flowers where pollination occurs when the male gamete (**pollen**) detaches from the male part of the flower (**anther**), attaches to the female part (**stigma**), and travels through the stigma into the **ovary** to fertilize the **egg.** Fruits are ripened / mature ovaries with fertilized eggs (i.e. seeds).



In plants, gymnosperms have cones and angiosperms have flowers. Both of these plant structures are specialized for —

A sexual reproduction
B food production
C water absorption
D photosynthesis



In which part of the flower does fertilization take place?

F Stamen
G Pistil
H Petal
J Sepal

Gymnosperms (a group of plants including conifers) and angiosperms (flowering plants) share many traits but are classified in separate groups. Which is a difference between gymnosperms and angiosperms?

F Only angiosperms form wood.
G Only gymnosperms reproduce with spores.
H Only angiosperms produce seeds within fruits.
J Only gymnosperms have vascular tissue.

What is genetic technology?

Genetic technology is used to remove DNA from cells, study it, and alter it. When scientists alter DNA and put it into an organism's cells, this is known more specifically as **genetic engineering.**

******Make sure to study your DNA Fingerprinting Tutorial and Practice Problems from Unit 6******

Determining the sequence of the human genome

The full set of genes or genetic material found in one cell of an organism is called that organism's **genome**. Large groups of scientists worked collaboratively over many years to determine the full sequence of bases in the human genome. This major project was called the **Human Genome Project.**

- In addition to sequencing the human genome, scientists also determined the locations of major genes on human chromosomes to create a genetic map of the chromosomes. Remember, genes are sequences of bases on DNA that code for the creation of a polypeptide and determine a particular trait within the cell or organism as a whole. The human genome has about 20,500 genes and three billion base pairs.

- The Human Genome Project was completed in April 2003 and its results were published in the major **scientific journal** *Nature.* When scientists publish their results in a research article, the article must be submitted to a journal (or multiple journals) for review. A process called **peer review** is used, in which other scientists evaluate the methods used in the research and question the legitimacy of the results and conclusions. If the article is deemed legitimate, it may be accepted by the journal and published.

- The potential applications (uses) of the Human Genome Project are wide-ranging. The project can be used to identify genes that can cause genetic diseases when mutated. It can also be used to develop treatments such as gene therapy (discussed later in the notes) that target a particular mutated gene sequence.

- Scientists are currently working on sequencing the genomes of other species, particularly those that are often used as study organisms in the lab (ex: mice, fruit flies, worms). We can compare human DNA to the DNA of other species to determine similarities and differences. We can use these similarities and differences to determine how closely related we are to other species (more similarities = more closely related). Humans share about 99% of their genome with chimpazees. That does not mean that we evolved from apes! It simply means that we share a recent common ancestor.

How can DNA be modified?

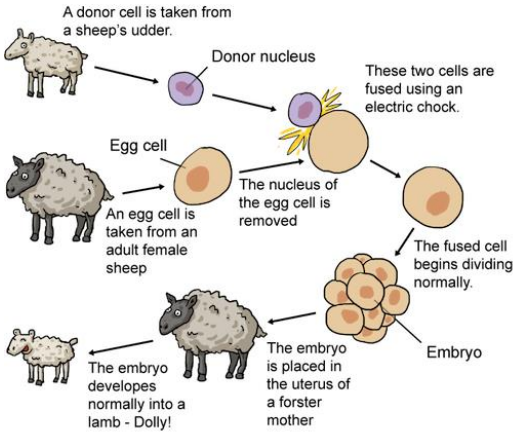
Scientists have developed techniques to modify/alter/manipulate DNA. Three techniques we are going to be discussing are cloning, the creation of recombinant DNA, and the creation of transgenic organisms.

When scientists **clone** a whole organism, they can use a technique called **somatic cell nuclear transfer.** This is how scientists cloned Dolly the sheep in 1996.

- During somatic cell nuclear transfer, a nucleus is removed from a somatic cell (a body cell).

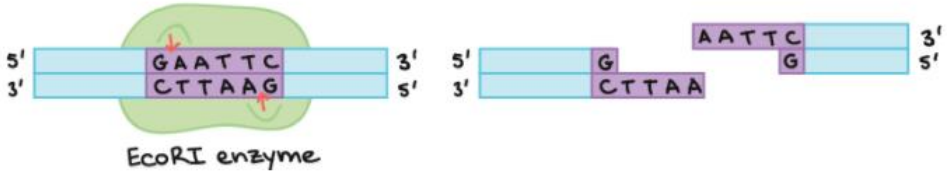
- This nucleus is then put in an egg cell that has been enucleated (i.e., had its nucleus removed). The egg is then carrying all the DNA from the organism that donated the somatic cell and does not need to be fertilized by a sperm.

- The egg is then put in the uterus of a surrogate mother and develops into a clone of the somatic cell donor (not the egg donor or surrogate mother).



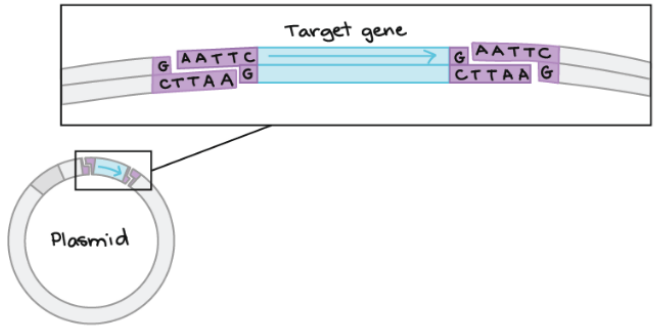
Scientists can mix DNA from different species. This mixed DNA is called **recombinant DNA.** Scientists often create recombinant DNA using a small circle of DNA from a bacterium called a **plasmid.** (The plasmid is separate from the bacterium's large circular chromosome).

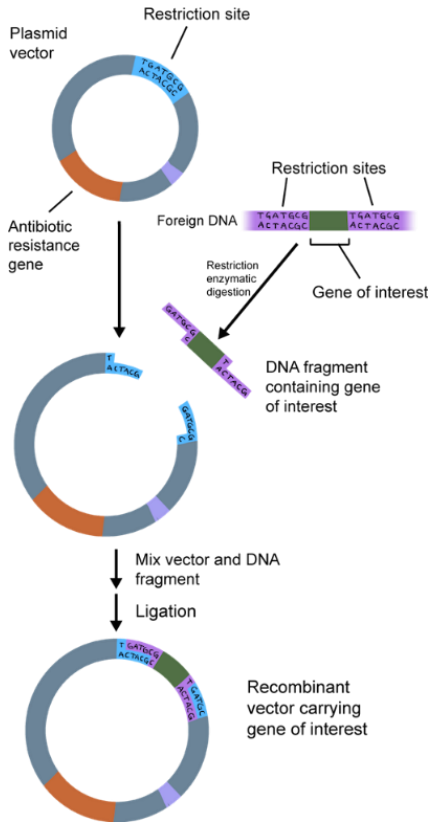
- Scientists must first extract (remove) the plasmid from a bacterium.
- Scientists then cut the plasmid DNA using a restriction enzyme. This creates single-stranded "overhangs" on the DNA called **sticky ends.**

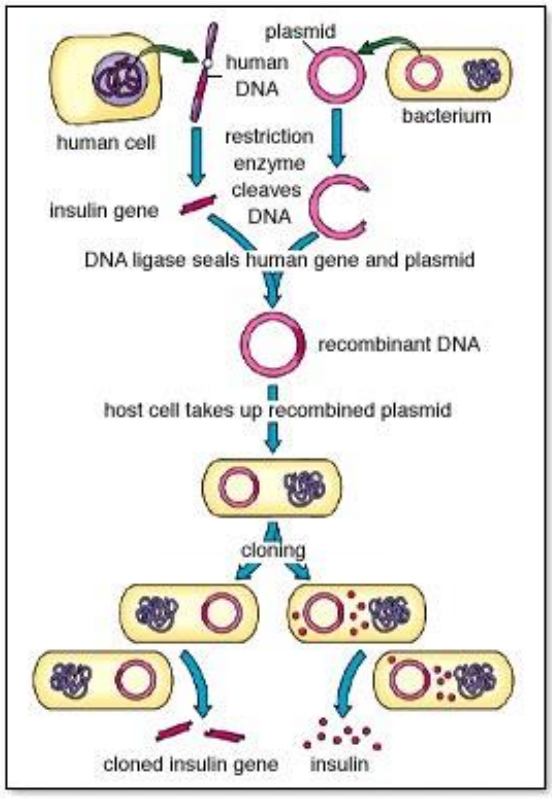


- Scientists then cut the DNA sequence they would like to insert into the plasmid using the same restriction enzyme. This creates sticky ends that are **complementary** to the sticky ends on the plasmid DNA.
- The bases on the sticky ends of the target sequence and plasmid DNA **hydrogen bond** with each other. They are fully sealed together using the enzyme **ligase.**

- An example of a DNA sequence we may want to put in a plasmid is the human insulin gene. Once we have put this gene into the plasmid, we can force bacteria to take the plasmid back in. Once the plasmid is inside the bacterium, the bacterium can replicate the plasmid DNA and the human insulin gene. It can also transcribe and translate the human insulin gene to create human insulin protein. The human insulin protein can then be extracted (removed) from the bacterium and used to treat diabetes!



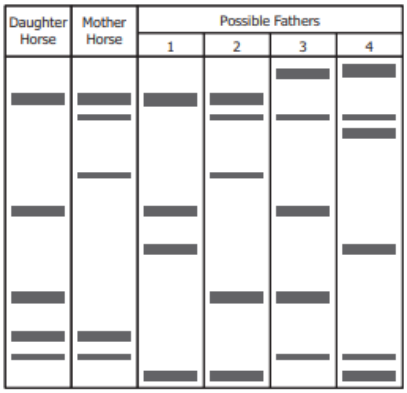




Scientists can use recombinant DNA to create **transgenic organisms**, which are organisms with DNA from two or more species. Transgenic organisms are a type of **genetically modified organism** (or GMO for short). Genetically modified organisms are organisms that have had their DNA altered in some way.

- An example of a transgenic organism is the spider goat (see image to the right), which is a goat that is able to make spider silk using a gene from a spider. Transgenic crops have also been created, which often contain genes that make them resistant to certain pests and herbicides.
- It is very difficult to create an adult transgenic plant or animal because the new DNA must be delivered to each cell of the multicellular organism. Often this is done by infecting the organism with a bacteria that carries a recombinant plasmid with the target gene. The genes that make the bacteria harmful to the organism have been removed.
- This method of using a bacteria (or virus) to deliver genes to the cells of an organism could be used during **gene therapy** to deliver a healthy version of a gene to a person with a genetic disease.

DNA Fingerprinting Experiment



The diagram shows DNA fingerprints from a daughter horse, the mother horse, and four possible fathers. Which horse is *most* likely the father?

F 1
G 2
H 3
J 4

The Human Genome Project was begun in 1988 by scientists from 13 nations as a worldwide effort to understand the sequencing of all of the DNA in the human body. What is one potential scientific benefit of this research?

F It will help to explain human cultural differences.
G It will create communication between research centers.
H It will help find the genes responsible for many diseases.
J It helps to classify man most accurately in the animal kingdom.

Medicines are being produced using recombinant DNA technology. For veterinarians, the use of this DNA technology will result in —

A decreasing the number of antibodies produced by pets
B altering the chromosomes of healthy pets
C making more treatments available for pets
D identifying new diseases spread by pets

Math

******Know how to determine the mean, median, mode, and range for a set of data. Also, be able to use basic math skills (see next page for examples)******

Bird Sightings at Willow Point

Date	# Sparrows	# Wrens	# Jays
May 12	43	12	10
May 13	54	13	8
May 14	44	11	13
May 15	52	14	9
May 16	47	10	10

Based on the data in the table, what is the difference between the mean number of sparrows and the mean number of jays observed at Willow Point between May 12 and May 16?

F 190
G 48
H 38
J 36

Which of the following is an example of a genetically engineered organism?

F A plant that received external DNA to produce natural insecticides
G A new plant variety created by cross-pollination
H Seedless fruits resulting from grafting of one plant onto another
J A plant that naturally possesses medicinal properties

In a population of 120 oak trees, 25% of the population has oak wilt disease. What is the number of trees in this population that have oak wilt?

_____ **trees with oak wilt**

In 1893, a one-million acre area of the Grand Canyon National Forest Reserve was home to an estimated 3,000 Rocky Mountain mule deer. Cattle, sheep, and horses also roamed the reserve. In 1906, government hunters killed off hundreds of mountain lions, coyotes, and bobcats when the area was set aside as the Grand Canyon National Game Preserve. The number of Rocky Mountain mule deer rose to over 100,000 by 1923. What was the approximate density of the mule deer in 1923?

A 1 for every acre
B 1 for every 10 acres
C 1 for every 100 acres
D 1 for every 1,000 acres

G-G-T-A-C-A-G-A-T-C-T-T-A-A-G-C-A-A

In order to form recombinant DNA, scientists have found a way to cut a DNA segment using an enzyme named *Eco*RI. This enzyme cuts DNA wherever the sequence C-T-T-A-A-G occurs between the A and the G base. Which of these would result if *Eco*RI were used on the DNA in the diagram above?

A G-G-T-A-C-A-G / A-T-C-T-T-A-A / G-C-A-A
B G-G-T-A-C-A / G-A-T-C-T-T-A-A-G-C-A-A
C G-G-T-A-C-A-G-A-T-C-T-T-A-A / G-C-A-A
D G-G-T-A-C-A-G / A-T-C-T-T-A-A-G-C-A-A

Logic

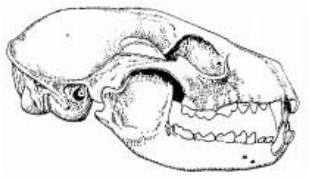
******Be able to use your basic logic skills!******

Which of the following is the *best* evidence that this bird is nocturnal?

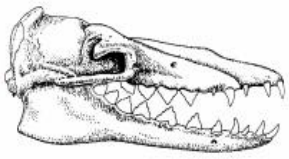
A The shape of its beak
B The size of its eyes
C The thickness of its feathers
D The length of its talons

Which skull belongs to a herbivore?

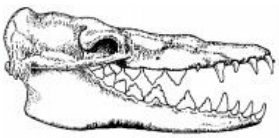
A



C



B



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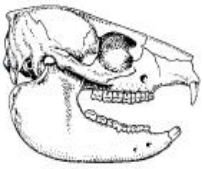


Scientists studied a flock of tundra swans that spent the winter along rivers in Virginia. The swans migrate in the spring to other locations. What would be the *best* way for scientists to distinguish between the birds they study in Virginia and flocks in the summer location?

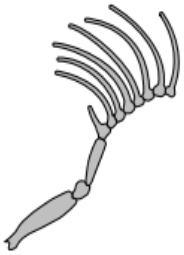
F Capture and put coded bands on the birds in Virginia, then record the bands seen on birds in the summer location
G Take detailed photographs of winter flocks in Virginia and summer flocks in other locations and compare photographs
H Follow the Virginia flock by vehicle on a daily basis
J Capture birds in the expected summer location and dissect them to find clues that show the birds were in Virginia during the winter

A certain virus causes a disease of the digestive system. What is the *most* likely source of this virus?

A Air
B Soil
C Water
D Insects

Increased surface area increases the number of molecules that can be collected from the air. According to this information, which beetle antenna is best adapted for chemically sensing the air?

F



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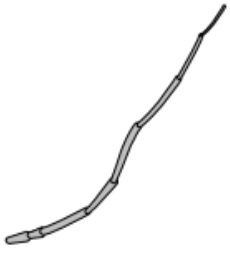

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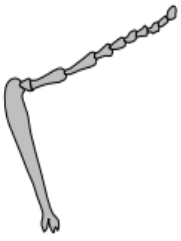

J