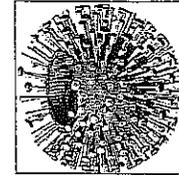
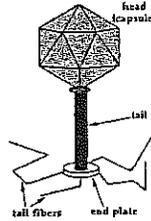
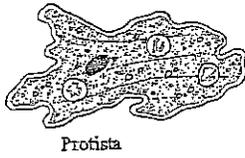
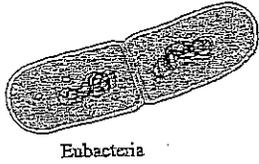


# TOPIC 1: BIODIVERSITY

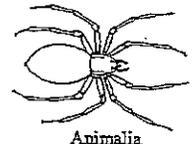
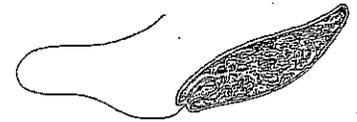
- Compare and contrast a cell and a virus



- Viruses require a host cell for reproduction
- Viral nucleic acid (DNA or RNA) takes over host cell's machinery
- Genetic code (DNA) is same for viruses and cells

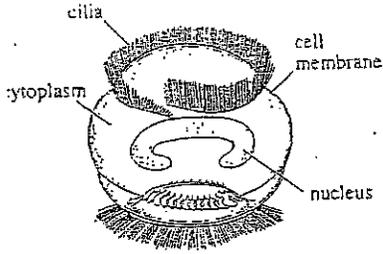
Classification of Living Things

DOMAIN	Bacteria	Archaea	Eukarya			
KINGDOM	Eubacteria	Archaeobacteria	Protista	Fungi	Plantae	Animalia
CELL TYPE	Prokaryote	Prokaryote	Eukaryote	Eukaryote	Eukaryote	Eukaryote
CELL STRUCTURES	Cell walls with peptidoglycan	Cell walls without peptidoglycan	Cell walls of cellulose in some; some have chloroplasts	Cell walls of chitin	Cell walls of cellulose; chloroplasts	No cell walls or chloroplasts
NUMBER OF CELLS	Unicellular	Unicellular	Most unicellular; some colonial; some multicellular	Most multicellular; some unicellular	Multicellular	Multicellular
MODE OF NUTRITION	Autotroph or heterotroph	Autotroph or heterotroph	Autotroph or heterotroph	Heterotroph	Autotroph	Heterotroph
EXAMPLES	<i>Streptococcus</i> , <i>Escherichia coli</i>	Methanogens, halophiles	<i>Amoeba</i> , <i>Paramecium</i> , slime molds, giant kelp	Mushrooms, yeasts	Mosses, ferns, flowering plants	Sponges, worms, insects, fishes, mammals



- **Species** = group of organisms that reproduce together and produce fertile viable offspring
- Relationships between species can be shown by:
  - **Molecular data** (compare DNA, RNA, amino acid sequences of proteins)
  - **Behavior**
  - **Comparative Anatomy**
- **Domain** (3 – Archaea, Bacteria + Eukarya)
  - **Kingdom** (6 – Archaeobacteria, Eubacteria, Protista, Fungi, Plantae, Animalia)
    - **Phylum**
      - **Class**
        - **Order** ← **FAMILY**
          - **Genus**
            - **Species**

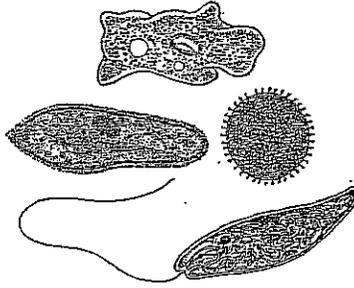
1. The diagram below represents *Trichodina*.



*Trichodina* is a eukaryotic organism that attaches itself to fish and eats bacteria. Which of the following distinguishes *Trichodina* from all prokaryotes?

- A. *Trichodina* is unicellular.
- B. *Trichodina* has a nucleus.
- C. *Trichodina* has cytoplasm.
- D. *Trichodina* is heterotrophic.

2. The diverse organisms shown in the diagram below belong to the same Kingdom.

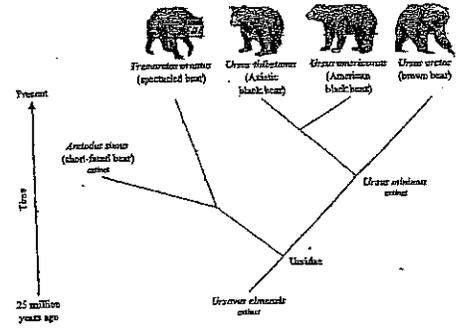


To which Kingdom do these organisms belong?

- A. Animalia
- B. Fungi
- C. Plantae
- D. Protista

3. A student researching bears found the chart below in a textbook. The chart shows the classifications of several types of bears.

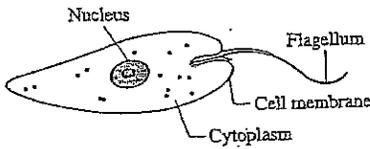
A student researching bears found the chart below in a textbook. The chart shows the classifications of several types of bears.



Which of the following conclusions is best supported by the data given in this chart?

- A. Modern bears evolved from species that are now extinct.
- B. The short-faced bear was the ancestor of the Asiatic black bear.
- C. Present day bear species are more closely related than their ancestors were.
- D. Natural selection favored the brown bear over the American black bear.

4. The diagram below represents a single-celled organism.



Which labeled part identifies this single-celled organism as eukaryotic?

- A. nucleus
- B. flagellum
- C. cell membrane
- D. cytoplasm

5. Which characteristic is most responsible for the classification of plants and fungi into separate Kingdoms?

- A. method of reproduction
- B. mode of locomotion
- C. mode of nutrition
- D. size of cells

6. Scientists have discovered a new type of organism. To assign the organism to a Domain and Kingdom, the scientists most need information about which of the following?

- A. the organism's cell structure
- B. the organism's population size
- C. the organism's social behavior
- D. the organism's reproductive rate

The box below lists characteristics of a newly discovered organism.

Characteristics of New Organism
Eukaryotic Multicellular Photosynthetic

- a. Classify this organism into the appropriate domain.
- b. Classify this organism into the appropriate kingdom.
- c. Describe how each of the characteristics listed in the box makes it possible to classify this newly discovered organism.

are the only exclusively multicellular and photosynthetic kingdom. Domain Eukarya. Kingdom Plantae. Plants have cells with nuclei which places them in Domain Eukarya. Plants

Answers  
1.B 2.D 3.A 4.A 5.C 6.A

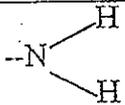
## Topic 2: The Chemistry of Life

1.1 Recognize that biological organisms are composed primarily of very few elements.

- SPONCH (the six most common elements) sulfur-phosphorous-oxygen-nitrogen-carbon-hydrogen

1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, and nucleic acids).

- Carbon is the backbone of all organic compounds (covalent, 4 bonds –single double, triple, chains)

Structure	Biomolecule	Elements	Monomers	Functions	Examples
	Carbohydrate	CHO	Monosaccharides	Energy	Glucose Sucrose Starch
	Lipid	CHO	Glycerol + 3 fatty acids = triglyceride	Insulation Energy reserve Plasma membrane	Fats/oils Waxes Phospholipids
	Protein	CHONS	Amino Acids	Enzymes Support Transport defense/ hormones	Keratin carrier proteins insulin/antibodies
	Nucleic Acid	CHONP	Nucleotide	Carry & transmit genetic information ATP	DNA RNA

1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, which have an effect on enzymes.

### Enzymes

- Proteins made of amino acids; -ase ending
- Organic catalyst= speed up chemical reactions without being changed or used up [but can be denatured]
- Factors that affect enzyme reactions
  - **pH** (0-6 acidic 7 neutral 8-13 basic): each enzyme has an optimal pH at which it works best
  - **Temperature**: as temp raises; enzyme activity increases  
as temp lowers; enzyme activity decreases
  - **Substrate concentration**: more collisions between molecules and enzymes; the higher the rate
  - **Enzyme concentration**: the more enzymes present; the higher the rate

### Sample Multiple Choice

1.

The following statements all apply to one element:

- used by plants in photosynthesis
- found in carbohydrates, proteins, and lipids
- recycled by decay and burning
- required element in all organic molecules

What is this element?

- carbon
- nitrogen
- phosphorus
- sulfur

2. The table below provides information about the composition and function of four important molecules in living organisms.

Molecule	Composition	Function
1	amino acids	reaction catalyst
2	fatty acids	membrane component
3	monosaccharides	energy source
4	nucleotides	genetic information

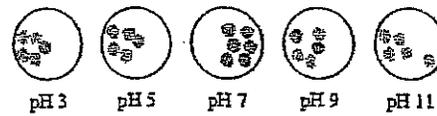
Which of the molecules in this table is a carbohydrate?

- 1
- 2
- 3
- 4

3. The reaction catalyzed by the bacterial enzyme  $\beta$ -galactosidase forms a dark-colored end-product when the cells are grown on a particular agar medium. As more product is formed, the cells become darker.

Students performed an experiment to determine the optimum pH for activity of this enzyme. Their results are shown in the illustration of bacterial colonies below.

Bacterial Colony Color as a Function of pH

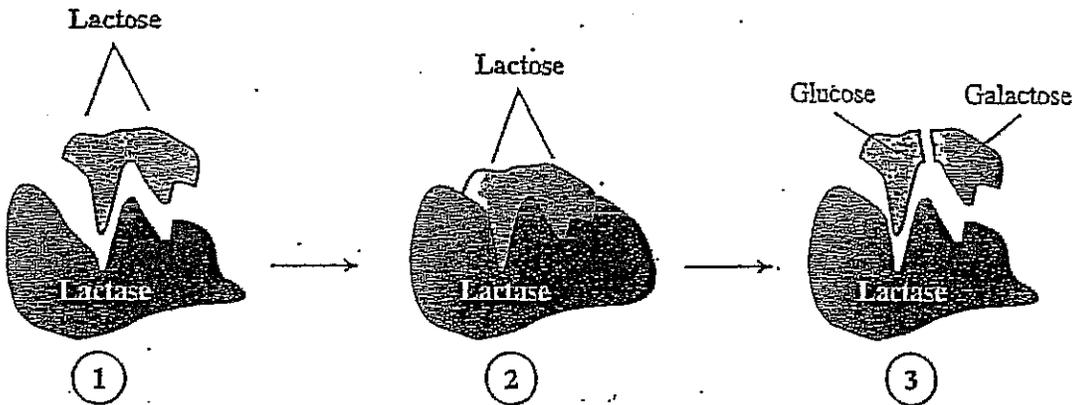


Based on these data, the students should conclude that  $\beta$ -galactosidase functions best at which pH?

- A. 5
- B. 7
- C. 9
- D. 11

### Sample Essay

The diagram below illustrates a biochemical process that occurs during digestion in the small intestine of a human.



Lactose is a disaccharide milk sugar that is made of the monosaccharides glucose and galactose. Some adults have difficulty digesting lactose due to their bodies' inability to manufacture lactase.

- a. What type of molecule is lactase? Explain how you made this identification.
- b. Explain the role of lactase in this reaction, and why people whose bodies cannot manufacture lactase have difficulty digesting dairy products.

Essay: a. Lactase is an enzyme. It breaks down a disaccharide into two monosaccharides. The enzyme does not get used up in the reaction. b. The disaccharide lactose is commonly found in dairy products. Lactose needs a specific enzyme called lactase to break it down. People who do not have the enzyme lactase to break down the disaccharide can not digest the dairy product.

## Topic 3: Ecology

6.1 Identify the factors (birth, death, immigration, emigration) that influence population size.

Stable populations occur when as many individuals enter and leave at the same rate

o Immigrants: move into (+) or birth (+)

Emigrants: leave (-) or death (-)

6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.

Speciation: Change in a species over time

Extinction: total disappearance of a species (or group)

- Natural disasters
- Climate change (global warming increasing CO<sub>2</sub> levels)
- Human activity (cutting down forests, loss of habitat due to construction)
- Intro of non-native or exotic species (unbalances the food pyramid)

6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how symbioses (predation, parasitism, and mutualism) add to the complexity of biological communities.

### Types of symbiosis

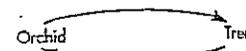
1. mutualism: both organisms benefiting
2. competition: contending for same resources
3. commensalism: one benefiting the other unaffected
4. parasitism: one benefiting the other harmed

### Examples

The ant keeps predators away from the acacia tree.



The acacia provides shelter and food for the ant.



The tree provides nutrients and a suitable location for the orchid living on it.

The cow eats grass.



The sheep eats some grass.

2



The dog provides nutrients and shelter for the tapeworm living in its intestine.

4

### Food Web

Producers: make food from the sun (plants, algae)

Consumers: organisms that feed off another organism

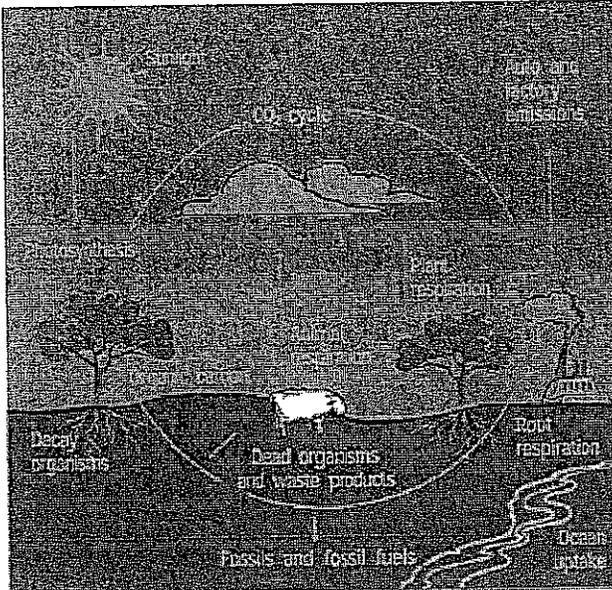
Decomposers: organisms that break down organic matter and recycle nutrients (bacteria, fungi)

6.4 Explain how biotic and abiotic factors cycle in an ecosystem (carbon, oxygen, nitrogen, and water).

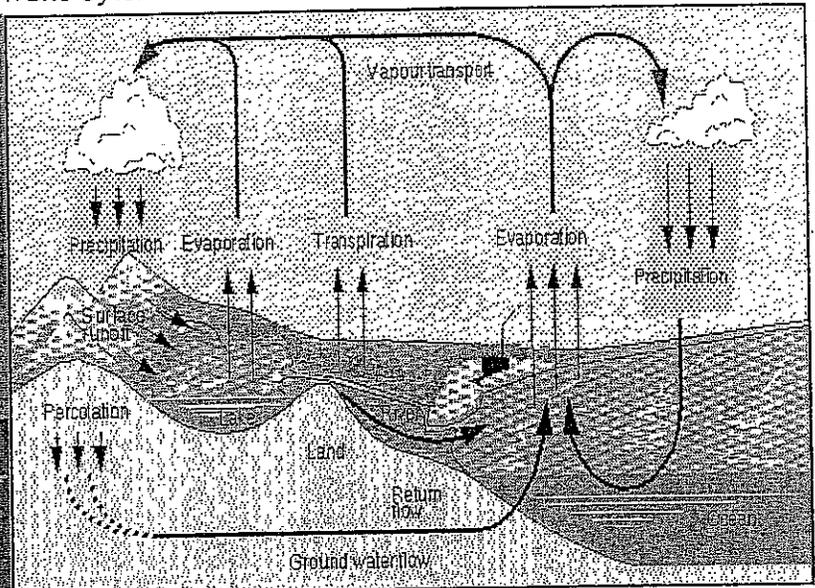
Biotic: factors that are living (animal, plants, fungi, microorganisms)

Abiotic: non-living elements of an ecosystem (air, water, soil, weather)

### Carbon Cycle

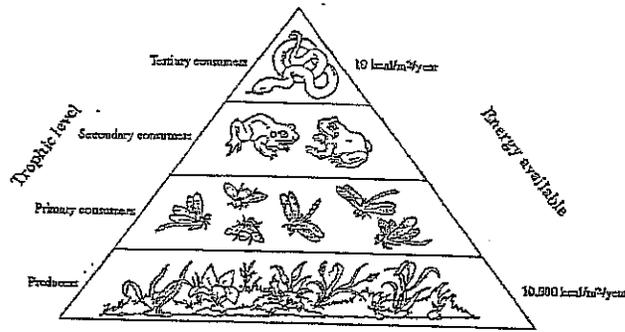


### Water Cycle

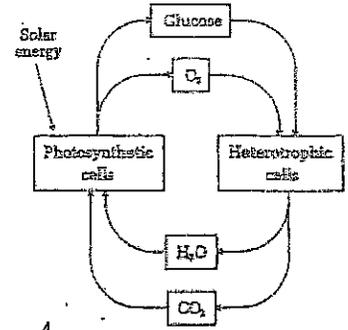


Approximately how much energy is available to the secondary consumers in this energy pyramid?

- A. 10 kcal/m<sup>2</sup>/year
- B. 100 kcal/m<sup>2</sup>/year
- C. 1,000 kcal/m<sup>2</sup>/year
- D. 5,000 kcal/m<sup>2</sup>/year



### Oxygen Cycle

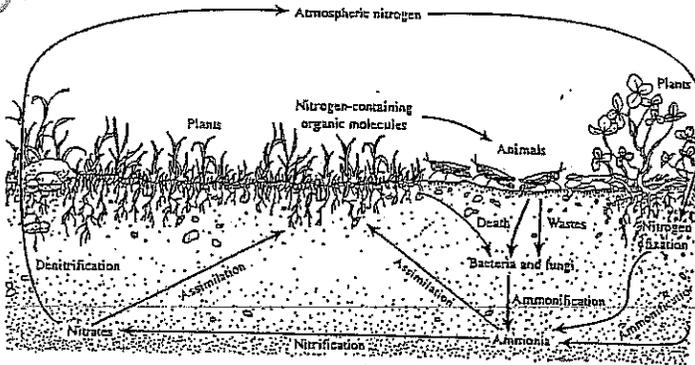


4.

In one of the steps of the carbon cycle, a person exhales a molecule of carbon dioxide (CO<sub>2</sub>) into the atmosphere. Which of the following is most likely to happen next to the atom of carbon in this molecule?

- A. It may be used as part of a sugar in a plant.
- B. It may become part of a protein in an animal.
- C. It may be consumed as a fossil fuel is burned.
- D. It may be decomposed into carbon and oxygen by a bacterium.

The diagram below shows the nitrogen cycle.



3.

Along the Pacific coast of North America, there are at least seven subspecies of *Ensatina eschscholtzii* salamanders. All of them descended from a common ancestral population. As the species spread, subpopulations adapted to their local environments.

Which of the following must have increased as a result of these adaptations?

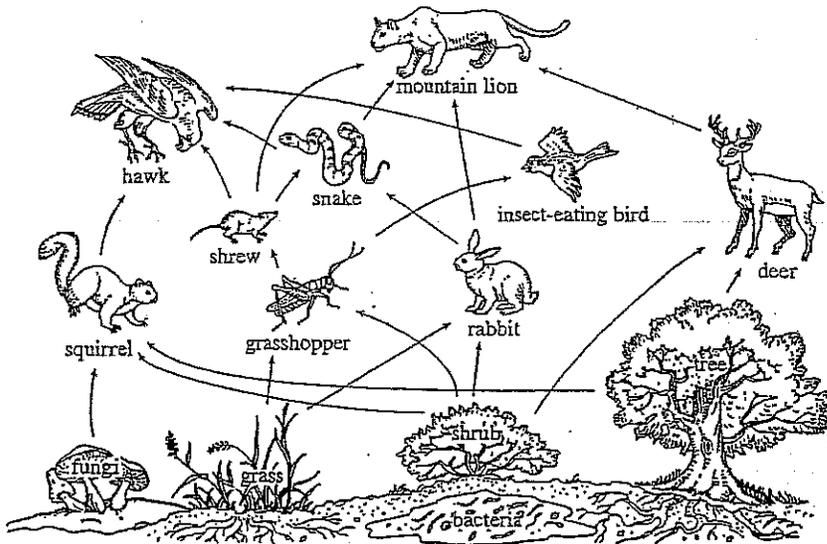
- A. the number of chromosomes in each salamander
- B. the size of each salamander in the total population
- C. the biodiversity of the total salamander population
- D. the number of offspring produced by each salamander

At which labeled point in the nitrogen cycle is nitrogen converted to a form that plants can use?

- A. assimilation
- B. death
- C. denitrification
- D. nitrogen fixation

### Essay Question

The diagram below shows a food web.



Members of this forest community get materials they need to survive from the ecosystem. These materials are constantly being recycled.

- a. Explain the role of grass in this food web, and include in your response why it is at the bottom of the web.
- b. What is the role of the grasshopper in this food web?
- c. Explain what would happen to the population of snakes if the rabbits were suddenly removed from this ecosystem.
- d. Explain what would happen to the grasshopper population if the insect-eating birds were suddenly removed from this ecosystem.

Ans: Essay B. 2. D 3. C 4. A

- a. The role of grass is a producer because it makes food using the sun's energy. It is on the bottom of the food web because it supports (give energy) to all the first order consumers.
- b. The grasshopper is a first order consumer. It eats the producers but is eaten (gives energy to) by the second order consumers like the shrew and the bird.
- c. The snake population would decrease if one of its prey, the rabbit population, was removed. The snake could only feed on the shrews, which would not sustain or provide enough energy for the current population. The grasshopper population would increase if one of its predators like the bird were removed from the ecosystem.

## TOPIC 4: Cell Structure and Function

Organelle	Function
<b>Plasma Membrane</b>	Selective permeable; regulates what enters and exits cells
<b>Nucleus</b>	Contains DNA; controls cell activities
<b>Nucleolus</b>	Makes ribosomes
<b>Cytoplasm</b>	Jellylike substance that fills cell and supports organelles
<b>Golgi Apparatus</b>	Receives proteins from ER; packages, modifies and ships proteins
<b>Lysosome</b>	Contains strong enzymes; digests cell wastes, invading bacteria and old, worn out organelles
<b>Ribosome</b>	Makes proteins
<b>Vacuole</b>	Stores water, food + wastes, plants have one large, central one
<b>Cell Wall</b>	Made of cellulose in plants, provides support for cell
<b>Chloroplast</b>	Site of photosynthesis, plant + algae cells only, contains chlorophyll
<b>Mitochondria</b>	Site of cellular respiration, makes ATP
<b>Endoplasmic Reticulum</b>	Tube like structure that transports proteins and material throughout cell
<b>Cytoskeleton</b>	Microtubules + microfilaments that support cell and provide cell movement
<b>Centrioles</b>	Only in animal cells, move and sort chromosomes during mitosis
<b>Cilium/ cilia</b>	Numerous short, hair-like microtubules; beat in oar-like fashion to provide cell locomotion in Protists (paramecium)
<b>Flagellum/ flagella</b>	1 -2 long, whip-like microtubules that provide movement for Protists (Euglena)
<b>Pseudopod</b> (aka fake foot)	Projection of cell membrane and cytoplasm, used by amoebas for locomotion

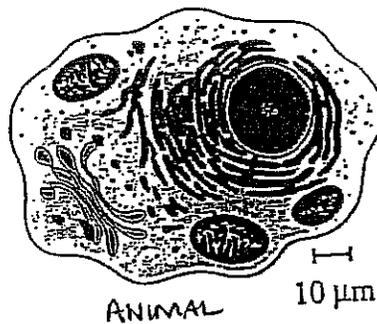
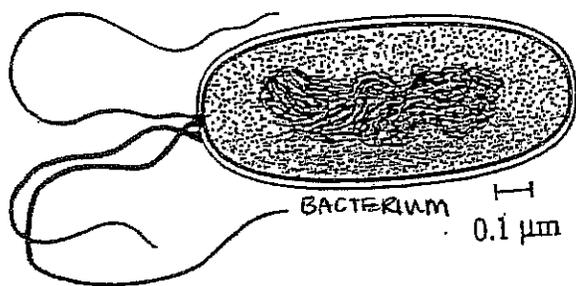
### Prokaryotic cells

Simple, small  
**BACTERIA**

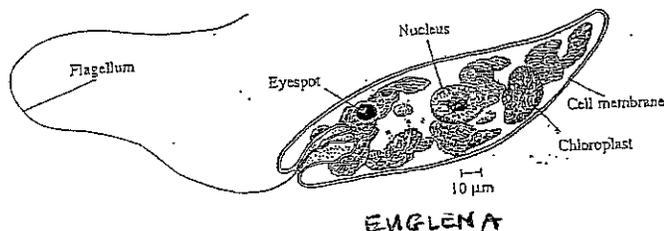
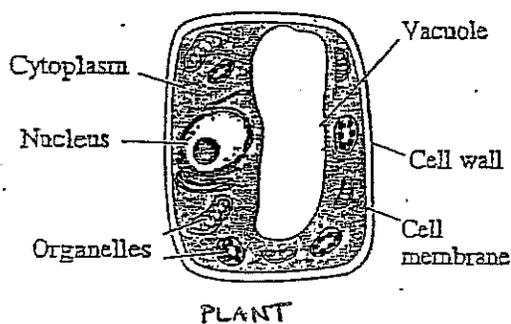
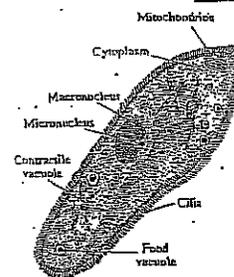
vs. **Eukaryotic cells**

complex, large  
everything else

Some typical cells:



The diagram below shows a paramecium.

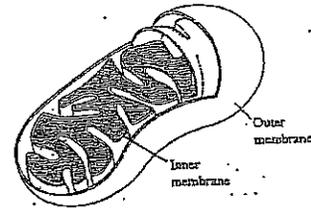
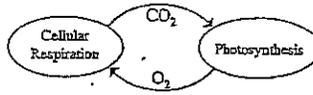
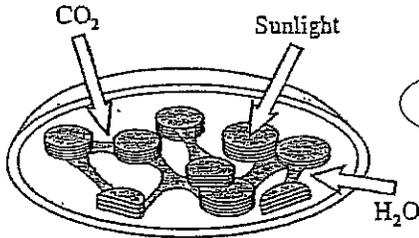


**CELLULAR TRANSPORT**  
**PASSIVE TRANSPORT** VS.  
 -No ATP (energy needed)  
 - HIGH to LOW concentration  
 - osmosis, diffusion + facilitated diffusion

**ACTIVE TRANSPORT**  
 - uses ATP  
 - LOW to HIGH concentration  
 - Endocytosis + Exocytosis

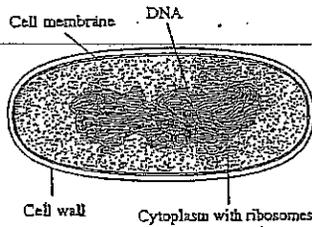
Photosynthesis:  
 (Chloroplast)  
 $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + H_2O$

Cellular Respiration:  
 (Mitochondria)  
 $C_6H_{12}O_6 + H_2O \rightarrow CO_2 + H_2O$



**MIC QUESTIONS**

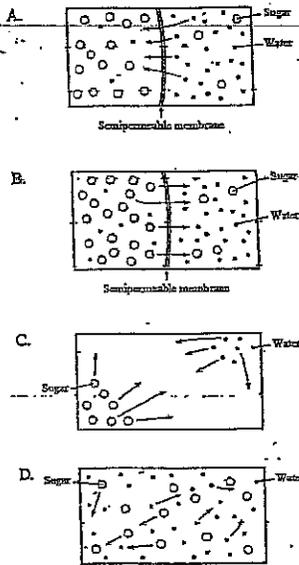
1. The diagram below shows the structure of the bacterium *Escherichia coli*, a prokaryote.



1. Which of the following distinguishes this bacterium from a eukaryotic organism?

- A. The bacterium is a unicellular organism.
- B. Ribosomes are found in the cytoplasm of the bacterium.
- C. The bacterium has both a cell membrane and a cell wall.
- D. DNA in the bacterium is always in contact with the cytoplasm.

2. Which of the diagrams below best represents the net movement of molecules in osmosis?



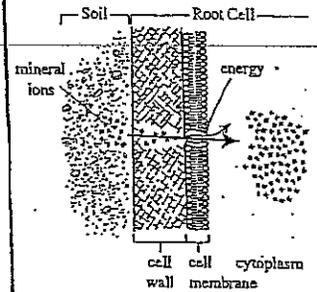
3. Four students attempted to classify organisms into the Plant and Animal Kingdoms. Their classifications are shown in the table below.

	Plants	Animals
Student 1	Eukaryotic cells	Prokaryotic cells
Student 2	Multicellular	Unicellular
Student 3	Cells have cell walls	Cells do not have cell walls
Student 4	Heterotrophic by absorption	Heterotrophic by ingestion

Which student's classification correctly separates organisms into these two Kingdoms?

- A. Student 1
- B. Student 2
- C. Student 3
- D. Student 4

4. The diagram below illustrates how plant root cells take in mineral ions from the surrounding soil.



1. Which of the following processes is illustrated?

- A. active transport
- B. diffusion
- C. osmosis
- D. passive filtration

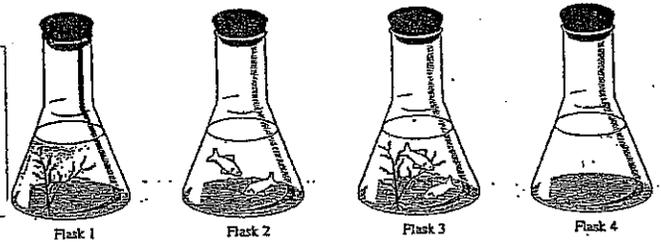
**OPEN-RESPONSE**

The box below shows a list of supplies that are available in a laboratory.

- four flasks with stoppers
- floodlight
- tap water
- graduated cylinders
- small aquarium plants
- four small fish
- bromthymol blue (a chemical indicator that changes color from blue to yellow as the level of carbon dioxide in a solution increases)

The class sets up an experiment with the four flasks as shown.

- Flask 1: 100 mL water, 1 mL bromthymol blue, plant
- Flask 2: 100 mL water, 1 mL bromthymol blue, 2 small fish
- Flask 3: 100 mL water, 1 mL bromthymol blue, 2 small fish, plant
- Flask 4: 100 mL water, 1 mL bromthymol blue



All four flasks are stoppered and placed under the floodlight.

- a. What color would the solution in each flask be after a few hours?
- b. Explain how the processes that have occurred in each flask result in the observed color of the bromthymol blue solutions.

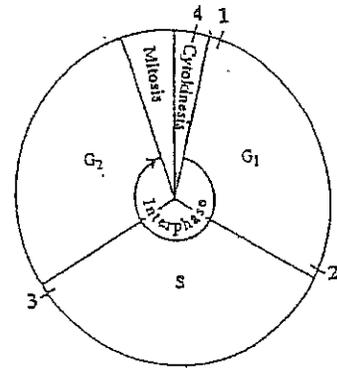
Flask 1 - no change; plants carry out photosynthesis, taking in any available CO<sub>2</sub>.  
 Flask 2 - turns yellow as fish carry out cellular respiration that releases CO<sub>2</sub>.  
 Flask 3 - no change; fish give off CO<sub>2</sub> but plants will take it in.  
 Flask 4 - no change; it is the control group has no organisms that will carry out respiration.

# 5: CELLULAR DIVISION

## Cell Cycle:

- A. Interphase
- G<sub>1</sub> - rapid growth and metabolic activity
  - S - growth and DNA synthesis
  - G<sub>2</sub> - growth and final preparations for division
- B. Mitosis
- C. Cytokinesis – division of the cytoplasm

1.



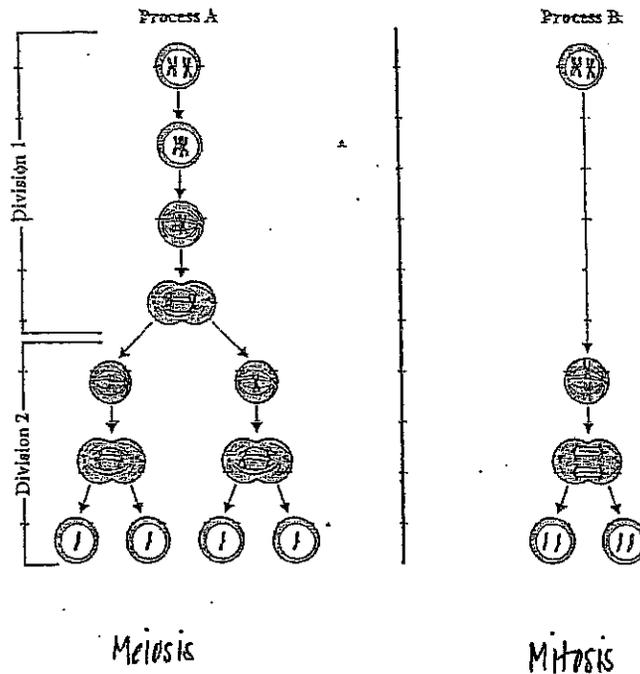
At which numbered point in the cell cycle will a cell contain the most DNA?

- A. 1  
B. 2  
C. 3  
D. 4

## Mitosis vs. Meiosis

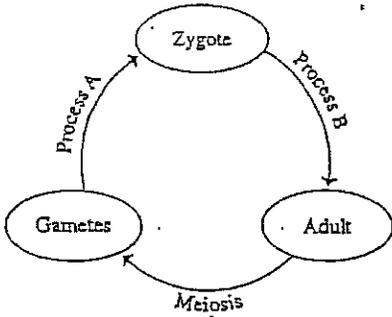
- Mitosis produces two diploid cells, and occurs in body cells (ex. muscle, skin, etc.)
- Meiosis produces four haploid cells, and occurs in gametes or sex cells (ex. egg and sperm)

The diagrams below illustrate two different types of cell division.



2.

The diagram below shows a generalized cycle in sexually reproducing animals.



What is Process A in this cycle?

- A. fertilization
- B. mitosis
- C. osmosis
- D. replication

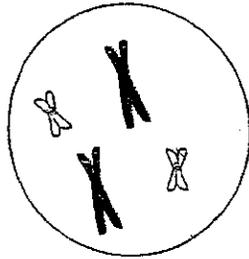
3.

A human zygote, like most other human cells, contains 46 chromosomes. How many chromosomes does a zygote receive from the mother?

- A. 0
- B. 23
- C. 46
- D. 92

4.

The figure below represents a cell that is entering mitosis.



This cell has recently completed the synthesis phase of the cell cycle and is in prophase of mitosis.

a. What happened in this cell during the synthesis phase in preparation for division?  
Explain the evidence for your answer.

b. In your Student Answer Booklet, draw the end products that will be formed when this cell completes mitosis.

c. Identify one function of mitosis in a multicellular organism.

- 1. C.
- 2. A.
- 3. B.
- 4. (A)

(A) DNA was copied. Sister chromatids are visible.



(C) Growth

## TOPIC 6: GENETICS

- Vocabulary: **Phenotype, genotype, heterozygous, homozygous**
- **Punnett Squares**

- **Mendel's Law of Segregation**

- Alleles for a trait are separated when gametes are formed

- **Dominant vs. Recessive (A Monohybrid Cross)**

P generation TT x tt

F<sub>1</sub> generation

	T	T
Tt	Tt	Tt
Tt	Tt	Tt

4/4 Tall

F<sub>2</sub> generation Tt x Tt

	TT	Tt
Tt	Tt	tt

3 Tall · 1 short

- **Incomplete Dominance**

- Red (RR) x White (rr) → pink flowers
- Pink (Rr) x Pink (Rr) → 1 Red (RR) : 2 Pink (Rr) : 1 White (rr)

- **Codominant Inheritance and Multiple Alleles**

- Example: Blood Types (A, B, and O alleles)
- Alleles A and B are codominant
- AO x BO

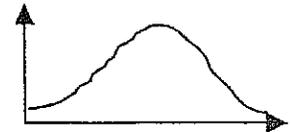
	A	O
AB	AB	BO
AO	AO	OO

PHENOTYPES :

1 · AB · 1A · 1B · 1O

- **Polygenic Inheritance** – two or more genes control a trait

- Examples: height, skin color, eye color
- Show a range of phenotype



- **Sex-Linked Traits** – some traits are carried on the X chromosome

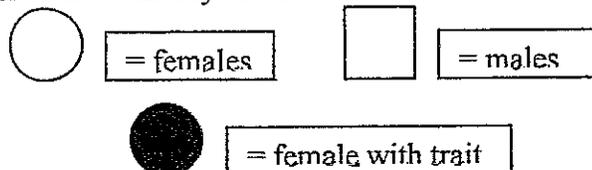
- Females can be carriers ( $X^G X^g$ )
- Males more likely to have these traits ( $X^g Y$ )
- Examples: Colorblindness, Hemophilia

- **Dihybrid Cross** – Independent Assortment

- alleles for genes on nonhomologous chromosomes are inherited independently (this creates variety in possible gametes formed)
- Example: RrGg can form 4 different gamete



- **Pedigrees** – show history of how alleles have been inherited in a family



Genetic information for a breed of chicken is shown below.

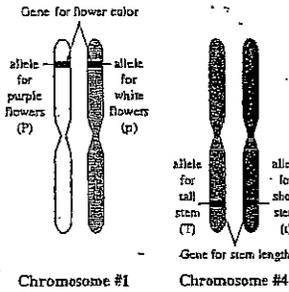


Types of Chickens with Different Feathers	
Genotype	Phenotype
FF	Normal (Normal feathers)
Ff	Frizzle fowl (Curly feathers)
ff	Feather shedder (Loses feathers easily)

Which of the following crosses of chickens will produce only Frizzle fowl offspring?

- Normal × Frizzle fowl
- Frizzle fowl × Frizzle fowl
- Normal × Feather shedder
- Feather shedder × Feather shedder

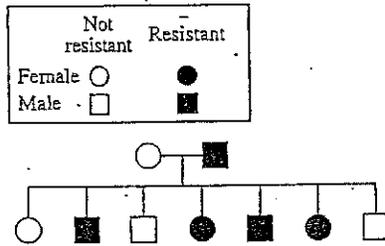
2. The diagram below shows the positions of the genes for flower color and stem length in a pea plant. The chromosomes represented below will replicate before meiosis.



For these two genes, what is the maximum number of different allele combinations that can be formed normally in gametes produced from this cell?

- 2
- 4
- 6
- 8

3. The pedigree below shows the inheritance of fungal resistance in hollies.



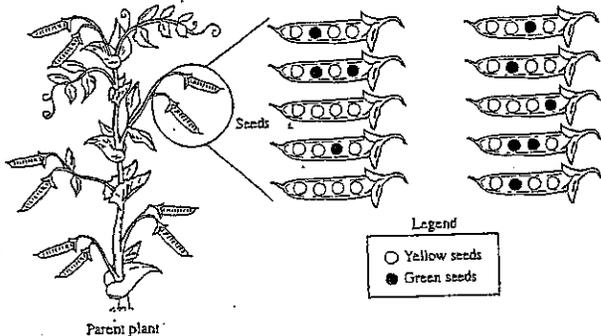
A dominant allele for a particular gene makes a holly bush resistant to a common fungus. In the pedigree shown, two hollies were crossed and seven plants were then grown from the seeds produced.

What are the most likely genotypes of these parent plants?

- RR × rr
- RR × Rr
- Rr × rr
- Rr × Rr

## OPEN-RESPONSE

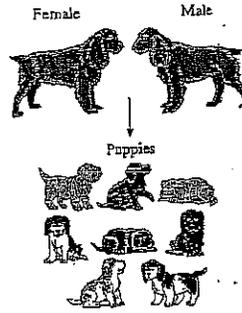
The drawing below shows a pea plant with two different colors of seeds (peas).



This pea plant was grown from a yellow seed, and self-pollinated to produce these seeds.

- What is the ratio of the phenotypes of the seeds on this plant?
- Based on the results shown above, what is the genotype of the parent plant? Explain your reasoning and use a Punnett square in your Student Answer Booklet to support your answer. Indicate the phenotypes of the possible offspring.

4. The picture below shows two dogs and their puppies.



The parent dogs are each heterozygous for two traits: fur color and white spotting. Both parent dogs are solid black. Their puppies, however, have four different phenotypes as listed below.

- solid black
- black with white spots
- solid red
- red with white spots

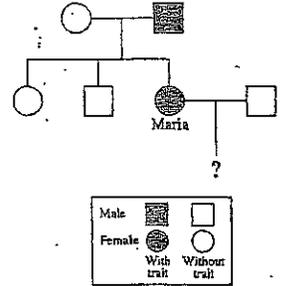
Which of the following explains how these parent dogs can produce puppies with these four phenotypes?

- The genes for these traits are sex-linked.
- The genes for these traits mutate frequently.
- The genes for these traits assort independently.
- The genes for these traits are on the same chromosome.

5. A rare inherited condition causes dwarfism and immunodeficiencies. Which of the following is the most likely cause of this condition?

- an excess of ATP
- a bacterial disease
- a mutation in DNA
- a parasitic infection

6. The pedigree below shows the inheritance of polydactyly in a family. Polydactyly is the trait of having more than five fingers on a hand.



Polydactyly is a dominant trait. In the pedigree, Maria and her father have polydactyly. What is the probability that Maria's child will have polydactyly?

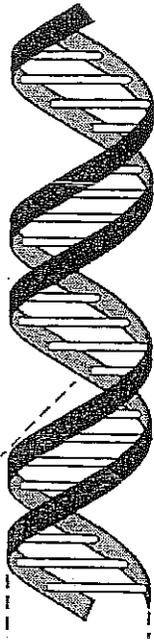
- 0%
- 25%
- 50%
- 100%

1. C 2 3. C 4. C 5. C 6. C  
Ratio 1. allow seeds : 1 green seed. The cross would be Yy x Yy since in this cross you same 3:1 phenotypic ratio in the offspring.

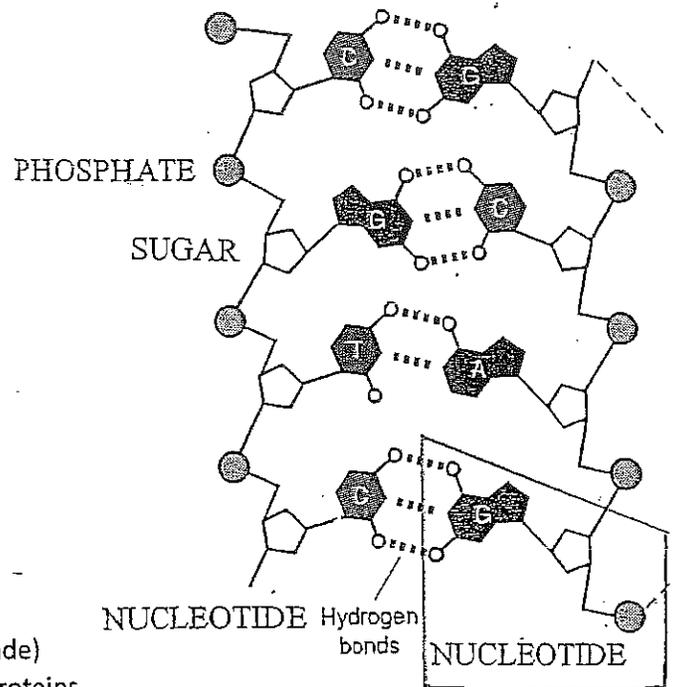
YY	Yy
Yy	yy

1 expect to get the

## Topic 7: Molecular Genetics (DNA)



The structure of DNA. On the left is a two-dimensional representation of the two complementary strands of DNA, showing the AT and GC base pairs. Note that the orientation of the two strands is antiparallel. On the right is the double-helix model of DNA, as proposed by Watson and Crick. The horizontal "rungs" represent the paired bases.



### DNA

- Double helix
- Copied by **REPLICATION** (2 identical copies are made)
- Contains the code for amino acids that make up proteins
- Composed of nucleotides
  - Sugar (deoxyribose)
  - Nitrogen base (A, T, C, G)
  - Phosphate group

### RNA

- Single stranded, shorter than DNA (only one gene in length)
- Made by **TRANSCRIPTION**
- Made of ribose
- Contains U instead of T
- Three types:
  - mRNA – messenger (holds the codons to code for sequence of amino acids)
  - tRNA – transfer (brings in the correct amino acids to ribosome- has the anticodon)
  - rRNA – ribosomal (with proteins makes up the ribosomes)

DNA →→→→→ RNA →→→→→ protein (a.k.a. polypeptide)  
**Transcription**      **Translation**

Mutations: any change in the nucleotide sequence

- may be a **point** (substitution) – may or may not code for the wrong amino acid
- may be a **frameshift** (deletion or insertion) will cause all codons to be affected

★ Mutations are passed on to the next generation only if they are found in gametes (egg or sperm cells).

Therefore, mutations occurring in somatic (body) cells do not affect the next generation.

Other mutations include the loss or addition of chromosomes:

This is typically the result of **NONDISJUNCTION** when the chromosomes fail to separate properly during meiosis. Examples of human disorders caused by nondisjunction:

- Trisomy 21 (a.k.a. Down Syndrome)
- Triplo X (XXX)
- Klinefelter's (XXY)
- Turner's (XO) females with only one X chromosome

# EXAMPLES OF MCAS QUESTIONS

## MULTIPLE CHOICE

1. The mold *Aspergillus flavus* grows on grain. *A. flavus* produces a toxin that binds to DNA in the bodies of animals that eat the grain. The binding of the toxin to DNA blocks transcription, so it directly interferes with the ability of an animal cell to do which of the following?

- A. transport glucose across the cell membrane into the cytoplasm
- B. produce ATP using energy released from glucose and other nutrients
- C. transfer proteins from the endoplasmic reticulum to Golgi complexes.
- D. send protein-building instructions from the nucleus to the cytoplasm and ribosomes

2. Hemoglobin is a protein that carries oxygen in red blood cells. The hemoglobin molecules produced by some people have one specific amino acid that is different from the amino acid at that position in normal hemoglobin.

Which of the following is the most likely cause of this amino acid variation?

- A. The hemoglobin gene contains a mutation.
- B. An error occurs during transcription of the hemoglobin gene.
- C. Enzymes replace the amino acid once the hemoglobin is produced.
- D. An additional amino acid is mistakenly inserted into the hemoglobin during translation.

## OPEN RESPONSE

The chart below shows some triplets from a DNA sequence (codons) and their corresponding amino acids.

DNA Codon	Amino Acid
AGA	Arginine
AGG	Arginine
AGC	Serine
AGT	Serine
GGA	Glycine
GGT	Glycine
GGC	Glycine
GGG	Glycine
TTG	Leucine
TGG	Tryptophan
TCG	Serine
TCT	Serine

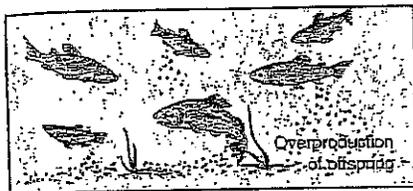
A sequence of DNA in a gene reads GGT TCG AGA.

- a. What is the sequence of amino acids that is produced when this gene is translated?
- b. If the DNA is mutated to read GGT TGG AGC, what will the sequence of amino acids be?
- c. Rewrite the original DNA sequence with a single mutation that would not change the sequence of amino acids.
- d. Explain how a mutation can change the DNA but not change the amino acid sequence.

# 8: EVOLUTION

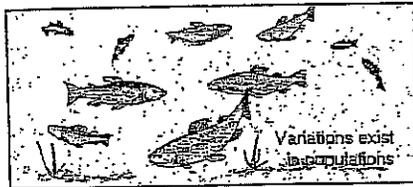
## Evidence for evolution

- Fossil
- Molecular – analyzing amino acids sequences and DNA
- Vestigial structures – any body structure that is reduced in function in a living organism but may have been used in an ancestor ex. Coccyx (Tailbone)
- Homologous structures – a modified structure that is seen among different groups of descendant (Ex. Question #2)
- Comparative anatomy (Figure 19.11 on back)
- Natural Selection
  - Mechanism for change in populations that occurs when organisms with favorable variations for a particular environment survive, reproduce, and pass these variations on to the next generation

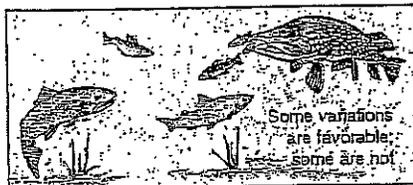


Darwin proposed the idea of natural selection to explain how populations of organisms evolve.

- ◆ In nature, there is a tendency toward overproduction of offspring. Fishes, for example, lay thousands, sometimes millions, of eggs.



- ◆ In any population of organisms, individuals will exhibit slight variations. Fishes may differ slightly in color, fin and tail size, and speed.



- ◆ Individuals with variations favorable for a particular environment are more likely to survive and pass these variations on to the next generation than individuals with less-favorable variations. For example, a fast fish with a skin color that allows it to blend in better with its surroundings is more likely to survive to reproductive age than a slow fish with more obvious coloring.



- ◆ Gradually, offspring of survivors will make up a larger proportion of the population. Depending upon environmental factors, after many generations, a population may come to look entirely different.

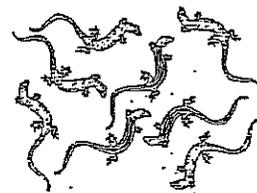
1. The diagrams below show changes in a desert lizard population.



1. Population with variety of inherited traits



2. Predation of individuals with particular traits



3. Reproduction of survivors

Which biological concept is illustrated?

- A. polygenic traits
- B. natural selection
- C. sex-linked inheritance
- D. silent mutations

The pictures below show bone structures in three animals.

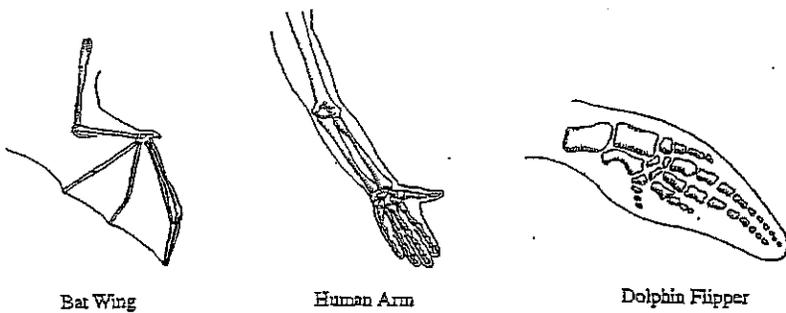
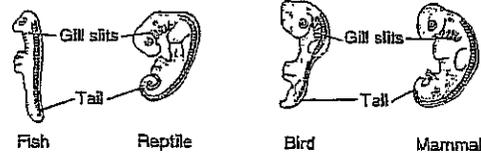


Figure 18.11

Comparative embryological studies of vertebrates are used to indicate their possible common ancestry. The presence of gills and tails in the early stage of all vertebrate embryos supports evidence from the fossil record that aquatic, gill-breathing vertebrates preceded air-breathing, terrestrial species.



The similarity in structure of the bones of these animals suggests that

- A. the size of these bones is the same.
- B. these species share common ancestors.
- C. these species developed at the same time and location.
- D. the chemical make-up of these animals is exactly the same.

3.

The illustration below represents a marine iguana.



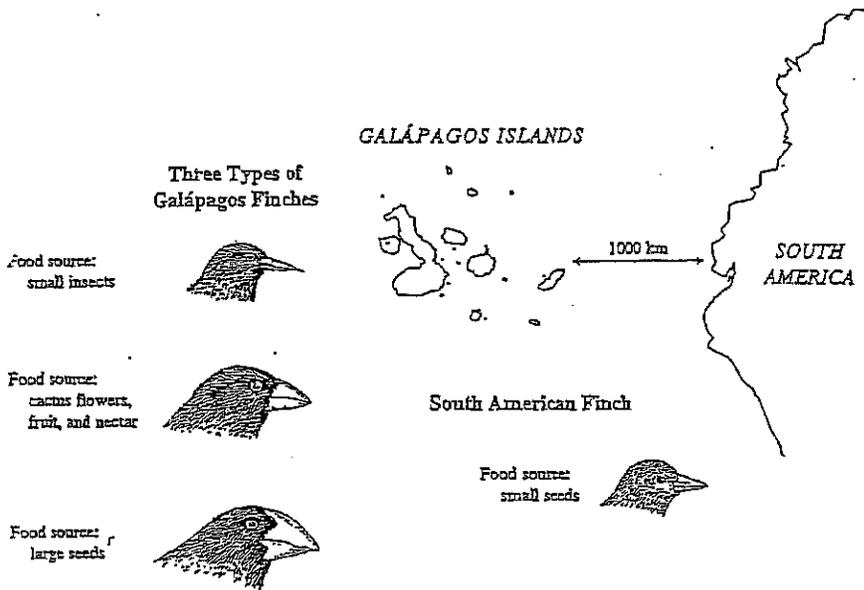
The marine iguanas of the Galápagos Islands feed on seaweed and algae. Marine iguanas have flattened tails while other species of iguanas that live inland on the Galápagos and on the South American mainland have rounded tails.

Which of the following best explains this difference in tail shape?

- A. Flattened tails are better for swimming than rounded tails.
- B. Flattened tails move more easily on land than in the ocean.
- C. Flattened tails are harder for predators to grasp than rounded tails.
- D. Flattened tails release heat more rapidly in the ocean than on land.

4.

The illustrations below show a South American finch and some of the species of finches found on the Galápagos Islands. The map shows the relationship of the Galápagos Islands to the west coast of South America.



There are 13 species of finches found on the Galápagos Islands. These finches have a wide variety of food sources and beak shapes. There is one genetically similar species of finch found on the South American mainland. This finch eats small seeds.

Use the map and the bird illustrations to identify and explain two ways that these finches provide evidence that supports the theory of evolution.

- 1. B.
- 2. B.
- 3. A.
- 4. The three types of Galápagos finches share a common ancestor to the South American mainland finch. Geographic isolation leads to genetic variation.

## Topic Nine: Human Anatomy and Physiology

**Homeostasis** – the process of maintaining constant internal conditions

Examples of Homeostasis:

- Concentration of O<sub>2</sub> and CO<sub>2</sub> levels
- pH of blood and other fluids
- concentration of nutrients and waste products
- concentration of salts and other electrolytes
- volume and pressure of cellular fluid + blood

The ultimate control of homeostasis is done by the **nervous system**.

- Most physiological systems use feedback to maintain the body's internal environment.
- Often this control is in the form of negative feedback loops. Heat control is maintained by the integration of the skin (Integumentary), muscular, nervous and circulatory system.
- **Negative Feedback Control Mechanisms** (most common) are called negative because the information caused by the feedback causes the reverse response. Example: As blood glucose levels rise above a specific level the pancreas releases insulin to lower the levels (cells pick up glucose or it is stored in the liver as glycogen). If glucose levels in the blood fall below a specific level the pancreas releases the hormone glucagon to cause the liver to break down glycogen and release glucose.
- **Positive Feedback Control** is sometime used. The input of stimulus increases or accelerates the response. Example: The hormone oxytocin is released during labor when the walls of the uterus contract. Oxytocin causes an increase in frequency and strength of the uterine contractions. This in turn causes further production of oxytocin.
- Multicellular organisms have a series of organs and organ systems that function in homeostasis. Changes in the external environment can trigger changes in the internal environment as a response.

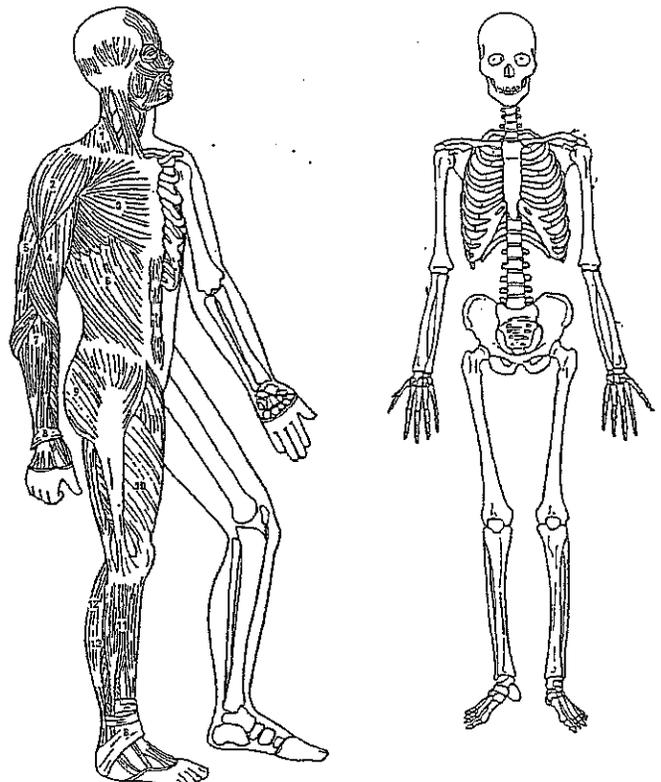
### Organ Systems

#### Muscular System

- Allows movement and locomotion
- Three kinds of muscle cells
  - Skeletal
  - Cardiac
  - smooth

#### Skeletal System

- Provides support and protection
- A place for muscles to attach
- Tendons
- Ligaments
- Red + white blood cells made in marrow of long bones
- Stores minerals (calcium)



## The Digestive System

→ Digests and absorbs food into nutrient molecules by chemical and mechanical breakdown; eliminates solid wastes into the environment. Digestion breaks food particles into small enough molecules (monomers) that can pass into the blood stream (capillaries). Absorption of food occurs in the small intestines.

Know where what gets digested and by what enzymes:

Mouth → carbohydrates → salivary amylase

Stomach → proteins → pepsin

Small Intestines → lipids → lipase

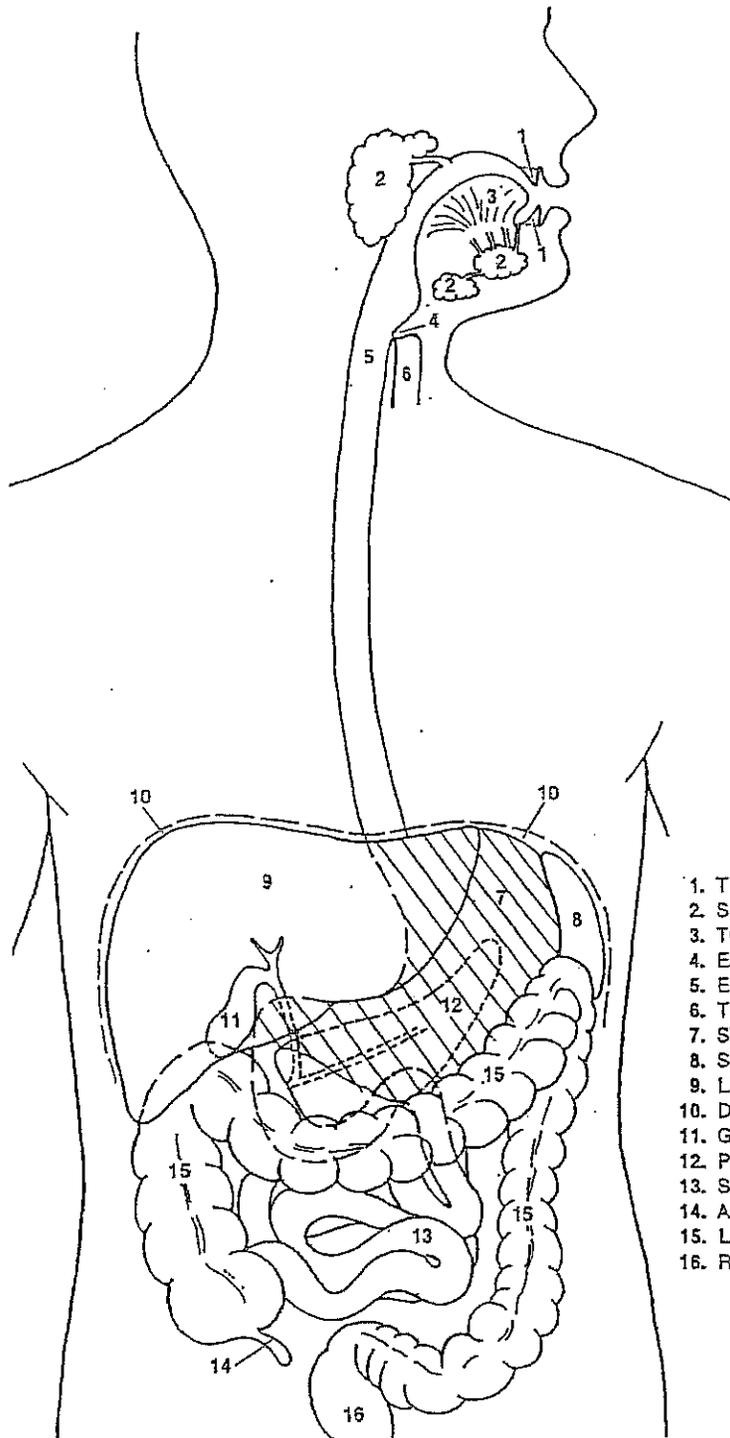
→ polypeptides → trypsin and chymotrypsin (pancreas)

→ carbohydrates → pancreatic amylase

Large Intestine → no digestion only absorbs water! Bacteria make vitamins (D) solid wastes like cellulose pass through undigested.

Mouth → esophagus → stomach → small intestine → large intestine → rectum → anus

**Peristalsis** = rhythmic contractions of smooth muscle that moves food through digestive system



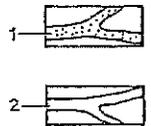
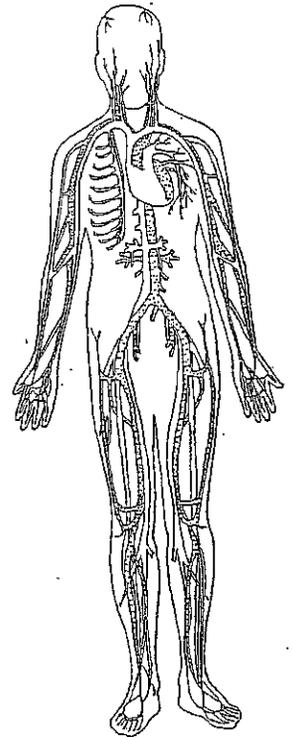
The body cannot use food in the form it ordinarily comes in because the pieces are too large and some foods, such as fats, are not water soluble and therefore cannot be absorbed into the bloodstream or pass into the tissue cells. The chemical complexity of most foods is also more than the body can handle. The role of the digestive system is to reduce large and complex foods to the water-soluble substances the cells can use. The process is both physical – as when the teeth chew meat into tiny bits – and chemical – as when the enzyme ptyalin helps to change starches into smaller compounds. The timing of the digestive system is very important: food must move slowly enough so that all the necessary changes can occur and absorption can take place, but fast enough to prevent harmful decomposition.

There are two parts to the digestive system. The *alimentary canal* is a tube about nine meters long running from the *mouth* to the *anus* and includes the *throat*, *esophagus*, *stomach*, and the *small and large intestines*.

1. TEETH \_\_\_\_\_
2. SALIVARY GLANDS \_\_\_\_\_
3. TONGUE \_\_\_\_\_
4. EPIGLOTTIS \_\_\_\_\_
5. ESOPHAGUS \_\_\_\_\_
6. TRACHEA \_\_\_\_\_
7. STOMACH \_\_\_\_\_
8. SPLEEN \_\_\_\_\_
9. LIVER \_\_\_\_\_
10. DIAPHRAGM \_\_\_\_\_
11. GALLBLADDER \_\_\_\_\_
12. PANCREAS \_\_\_\_\_
13. SMALL INTESTINE \_\_\_\_\_
14. APPENDIX \_\_\_\_\_
15. LARGE INTESTINE \_\_\_\_\_
16. RECTUM \_\_\_\_\_

## Circulatory System

- Supplies O<sub>2</sub> and nutrients to every cell in the body and removes wastes and CO<sub>2</sub>
- Blood contains:
  - plasma (liquid)
  - red (RBCs – hemoglobin (contains iron) carry O<sub>2</sub> + CO<sub>2</sub>)
  - white – fight disease, engulf bacteria
  - Platelets – help clot blood and form scabs
  - Antibodies from the immune system
  - Hormones from the endocrine system
  - Wastes products – to be filtered by liver and kidneys
- Arteries carry blood away from the heart
- Veins carry blood to the heart
- Capillaries connect arteries and veins + are the site of exchange of nutrients and wastes
- Two circuits
  - Systemic – to body + back to heart
  - Pulmonary – to lungs + back to heart
- Pathway of blood throughout body
  - O<sub>2</sub> poor enters right side of heart (atrium + ventricle)
  - Pumped to lungs
  - Diffusion of CO<sub>2</sub> for O<sub>2</sub> occurs at junction of alveoli and capillaries
  - O<sub>2</sub> rich blood returns to left side of heart (atrium + ventricle)
  - Blood pumped to body (aorta → arteries → arterioles → capillaries)
  - O<sub>2</sub> and nutrients exchanged at cells
  - Wastes and CO<sub>2</sub> picked up by capillaries
  - Capillaries → venules → veins → vena cava → heart
- wastes are removed as blood circulation passes the kidneys (nitrogenous wastes) and liver (toxins)



1. ARTERIAL CIRCULATION  
2. VENOUS CIRCULATION

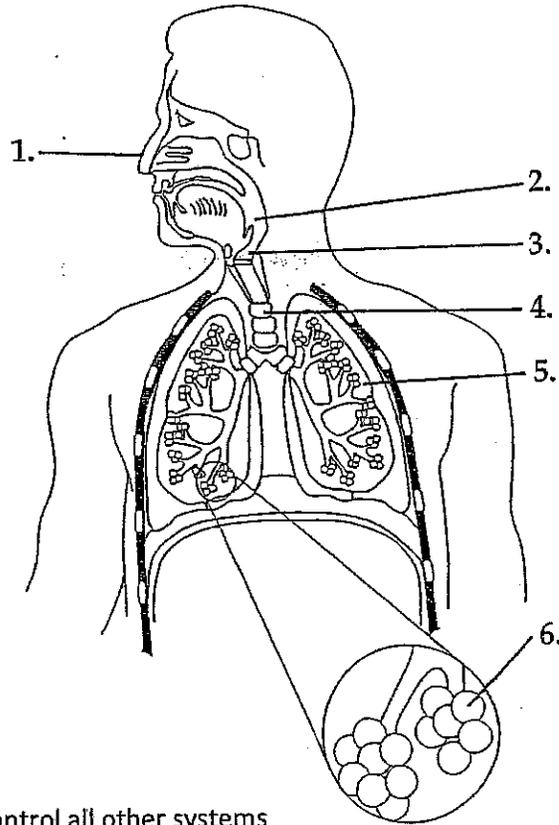
## Excretory System

(The kidneys → ureter → bladder → urethra)

- regulates the volume of body fluids (removes excess water)
- regulates blood pressure
- regulates the concentrations of ions (Cl<sup>-</sup>, K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>+</sup>) and electrolytes
- maintains calcium levels
- maintains blood pH level (~7.2)
- Stimulate red bone marrow to make blood cells
- eliminates nitrogenous wastes (products of metabolism of proteins)
  - urea, ammonia, drugs and toxic substances
- wastes are removed as urine
- Nephron = functioning unit of the kidney

## Respiratory System

- moves O<sub>2</sub> from external environment to internal (lungs) for CO<sub>2</sub>
- maintains blood pH level
- Nose + mouth → pharynx → larynx → trachea → bronchi → bronchioles → alveoli → capillaries



- |    |                |
|----|----------------|
| 1. | <u>nose</u>    |
| 2. | <u>pharynx</u> |
| 3. | <u>larynx</u>  |
| 4. | <u>trachea</u> |
| 5. | <u>lung</u>    |
| 6. | <u>alveoli</u> |

## Nervous System – control all other systems

→ coordinates and controls all actions of all internal organs and body systems. Memory, learning, and conscious thought are a few functions of the nervous system. Maintaining autonomic functions like heartbeat, breathing, control of involuntary muscles are also carried out by the nervous system.

- Central Nervous System
  - Brain
  - Spinal Cord
- Peripheral Nervous System
  - Sensory neurons – send signal to brain
  - Motor neurons – send signal to muscles or organs
- Main component = **neuron** = nerve cell
- Electrical signal pathway (dendrite → cell body → axon → terminal buds → neurotransmitters → synapse → another neuron, muscle cell or gland)

