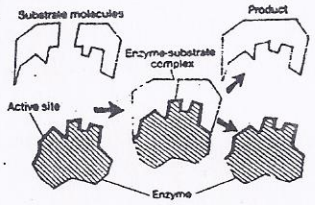
1. MOLECULES OF LIFE: - 4 major elements in living things – carbon, hydrogen, oxygen, nitrogen.
   (a) **Inorganic compounds** – those found in cells include water, salts, inorganic acids, etc. They are composed of atoms of elements that form chemical bonds by ionic and covalent methods. Water shows unique hydrogen "bonding" which is an attraction of water molecules to each other. This gives water some very unique characteristics that makes it vital to life.
   (b) **Organic compounds** – those compounds that contain both carbon and hydrogen. These are large and complex due to the covalent bonding capabilities of carbon. The four major classes of organic compounds are: (1) **Carbohydrates** – formed from monosaccharides (glucose type molecules); **examples are starches, sugars, cellulose, glycogen** (2) **Protein** – formed from amino acids; **examples are enzymes, hemoglobin, insulin, actin, myosin (muscle fibers)** (3) **Lipids** – most are formed from fatty acids and glycerols; **examples are phospholipids (cell membranes); triglycerides;** (4) **Nucleic acids** – formed from nucleotides which consist of a base (A,T,G,C), a sugar (either deoxyribose or ribose), and a phosphate. **Examples of nucleic acids include DNA and RNA.**
   (c) 2 ways organic compounds behave in living organisms:
      (1) **Condensation** – Small molecules join together to form a larger molecule. H_2O is removed during this process.
      (2) **Hydrolysis** – Large molecules are broken apart into smaller ones. H_2O is added during this process.
   (d) **Enzymes** – chemical reactions occur continuously in living things. Each reaction requires the presence of a special protein called an enzyme, which regulates the rate of the reactions. Each enzyme is specific and only acts on particular substances called **substrates.** Factors like temperature and pH can alter the enzyme activity and cause changes in the rate of reactions.



Lock-and-key model of enzyme action.

   (e) **pH Scale** is used to indicate the degree of acidity or the degree of alkalinity of a particular solution. This scale, which ranges from 0 to 14, measures the hydrogen ion concentration in a solution. A pH of 7 indicates a neutral point between acidity and alkalinity.

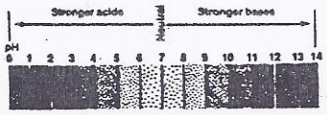


*Figure 1-11. The pH scale.

2. DNA: THE CODE OF LIFE

DNA is an organic molecule composed of nucleotides. Each nucleotide is composed of a phosphate group, sugar (deoxyribose) and a base. There are 4 possible nitrogen bases in DNA. Adenine (A), Thymine (T), Guanine (G), and Cytosine (C).

The molecule is arranged in a double helix (twisted ladder) with the bases forming the "rungs" of the ladder and the phosphate and sugar forming the sides of the ladder. Bases pair in the center of the molecule to form the "rungs". A pairs with T and G pairs with C.

It is this series of bases that make us unique. Strings of these bases code for our genes. It is the sequence of bases that make us all alike but different.

DNA sequences is the code for all protein production in our cells. These molecules do not actually make proteins directly. They send their "helpers" (RNA) into the cytoplasm with the "message" for protein production. Since proteins form all cell structures and enzymes control all chemical reactions, we should see why DNA is called the code of life.

RNA is composed of a single strand with ribose sugar and has the base uracil (U) instead of thymine (T).
3 types of RNA:
(1) **mRNA** – carries message to the ribosome directly from DNA
(2) **tRNA** – picks up amino acids in cytoplasm and brings to ribosome for protein production
(3) **rRNA** – composes the ribosome, the site of protein synthesis

3 processes that involve DNA and RNA.

(1) **Replication** – DNA makes a copy of itself. This is done during interphase before mitosis begins and the cell divides.

(2) **Transcription** – DNA makes single stranded RNA.

(3) **Translation** – RNA molecules make proteins using mRNA as a template (blueprint).

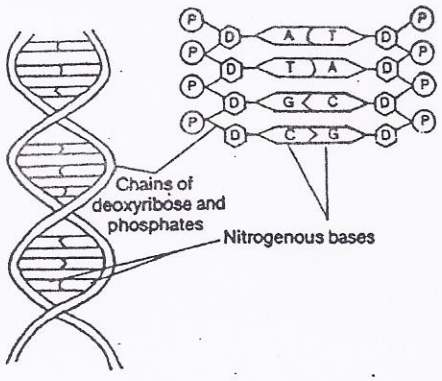
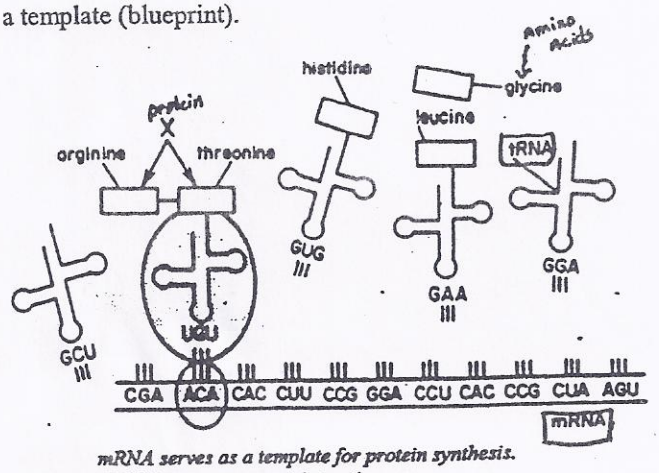


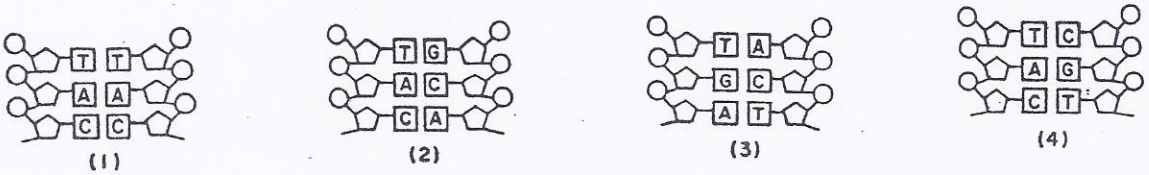
Figure 5-12. Structure of DNA.



mRNA serves as a template for protein synthesis.
tRNA brings amino acids to ribosome.

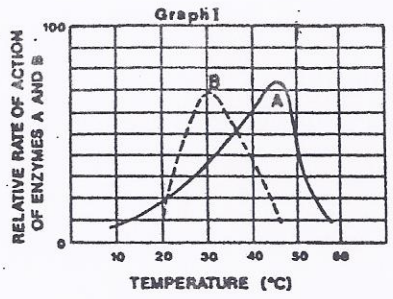
REVIEW QUESTIONS:

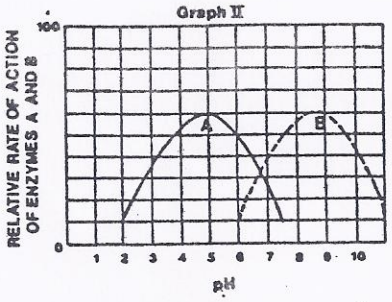
1. Which diagram best illustrates the correct base pairing in a portion of a DNA molecule? (a) 1 (b) 2 (c) 3 (d) 4.



2. DNA and RNA molecules are similar in that they both contain (a) nucleotides (b) a double helix (c) deoxyribose sugars (d) thymine.
3. Which substances are components of a DNA nucleotide? (a) phosphate, deoxyribose and uracil (b) phosphate, ribose, and adenine (c) thymine, deoxyribose, and phosphate (d) ribose, phosphate, and uracil.
4. Genetic material responsible for the individuality of an organisms, that is passed from parent to offspring. (a) DNA (b) Messenger RNA (c) Transfer RNA.
5. This material carries genetic information from the cell nucleus to the ribosomes. (a) DNA (b) Messenger RNA (c) Transfer RNA.
6. This molecule contains thymine instead of uracil. (a) DNA (b) Messenger RNA (c) Transfer RNA.
7. This molecule carries amino acids to the ribosomes. (a) DNA (b) Messenger RNA (c) Transfer RNA.
8. A chemical bond in which two atoms share a pair of electrons is referred to as (a) acidic (b) covalent (a) ionic (d) hydrogen.
9. When two molecules are joined together chemically, a molecule of water is released. This is called (a) hydrolysis (b) absorption (c) condensation (d) transpiration.
10. Fats that are stored in human tissue contain molecules of (a) monosaccharides (b) nucleotides (c) glycerol and fatty acids (d) amino acids.
11. Which of the following variables have the least direct effect on the rate of an enzyme-regulated reaction? (a) temperature (b) pH (c) carbon dioxide concentration (d) enzyme concentration.

*** Base your answers to questions 12 and 13 on the graphs below. Graph I shows the relationship between the relative rates of activity of enzymes A and B and temperature. Graph II shows the relationship between the rates of activity of enzymes A and B and pH.**





*12. Under which conditions is enzyme A most effective? (a) at 45°C and a pH of 9 (b) at 50°C and a pH of 9 (c) at 40°C and a pH of 5 (d) at 45°C and a pH of 5.

*13. The optimum environment for enzyme B is (a) a basic medium (b) an acidic medium (c) either an acid or basic medium (d) a neutral medium.

14. The complete hydrolysis of a protein would result in the formation of (a) fatty acids (b) glycerol (c) amino acids (d) polysaccharides.
15. An enzyme is mainly a (a) lipid material (b) polysaccharide (c) protein (d) vitamin.
16. A neutral solution has a pH of (a) 1 (b) 7 (c) 9 (d) 14.
17. Which pH indicates the strongest basic solution? (a) 3.5 (b) 6.4 (c) 10.0 (d) 13.9.
18. Which organic compound is composed of fatty acids and glycerol and is used for insulation ? (a) carbohydrates (b) proteins (c) lipids (d) nucleic acids.
19. Which group of organic molecules contains molecules such as glucose, starch and cellulose? (a) carbohydrates (b) proteins (c) lipids (d) nucleic acids.
20. The most abundant inorganic substance in a cell is (a) salt (b) sugar (c) amino acid (d) water.

1. CONCEPT OF LIFE

All organisms have the following life functions:

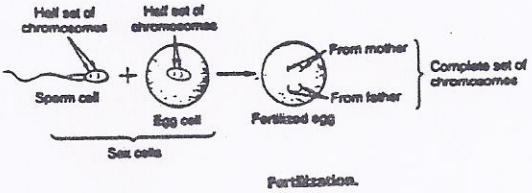
(a) Nutrition – includes activities involved in obtaining food from the environment and breaking the food down into a form that the cell can use.

(b) Respiration – chemical activities that release energy from organic molecules (glucose- food) for use by the cells. Glucose is broken down during cellular respiration and stored in the compound ATP.

(c) Synthesis – involves chemical reactions in which small compounds are joined to form larger ones. An example would be amino acids joining to form proteins during protein synthesis.

(d) Growth – increase in size by an organism. Usually by increasing the number of cells.

(e) Reproduction – producing offspring. This can be sexual or asexual. Sexual reproduction involves joining of male and female DNA material to code for the new organism. Asexual reproduction involves budding or forming a new organism from 1 parent. Organisms produced from sexual reproduction will have variety in their characteristics and will not be identical to either parent. Organisms produced from asexual reproduction will NOT have variety and will be identical to the parent.



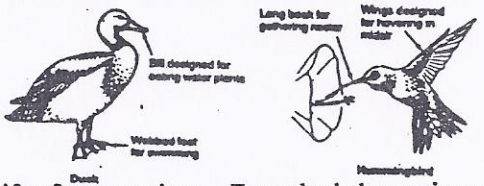
(f) Transport – involves circulation or distribution of materials to all the cells of the organism.

(g) Excretion – involves elimination of cellular waste products – usually water, carbon dioxide, salts and nitrogen compounds in animals; oxygen and glucose in plants.

(h) Metabolism – involves all chemical reactions in an organism.

(i) Homeostasis – maintenance of a stable internal environment in spite of changes in the external environment. Example – breathing rate, heart rate, blood pressure returning to "normal" after exercise. "Normal" is homeostasis for human blood pressure – usually 120/80 mm of mercury.

(j) Adaptation – structure or behavior that enables an organism to better survive their environment. Ex: webbed feet of duck; birds migrating south during winter.



(k) Development – changes that take place during the life of an organism. – Ex: tadpole becoming a frog.

2. CELLS

An organism that lacks a definite membrane enclosing its genetic material is called ***prokaryotic.*** All bacteria are prokaryotic. Bacteria possess a coiled mass of DNA and few organelles. Prokaryotic celled organisms contain no true nucleus and lack membrane bound organelles. They can contain a cell wall, cell membrane, cytoplasm and ribosomes.

An organism that has a definite membrane enclosing its genetic material is called ***eukaryotic.*** Plants and animals are composed of eukaryotic cells. They are much more complex.

Both plant and animal cells contain the following organelles.

(a) Cell membrane or plasma membrane – surrounds and protects the cell and allows only certain substances to pass in and out of the cell.

(b) Cytoplasm – fluid-like material that fills the space between the cell membrane and the nucleus. Contains organelles.

(c) Nucleus – control center of cell – contains DNA. (chromatin/chromosomes)

(d) Nucleolus – dense structures inside nucleus – storage of RNA that forms ribosomes.

(e) Ribosomes – tiny "dot" organelles where proteins are made (protein synthesis).

(f) Endoplasmic reticulum – network of tunnels and channels that transports material throughout the cell.

(g) Mitochondria – site of cellular respiration; produces ATP (energy).

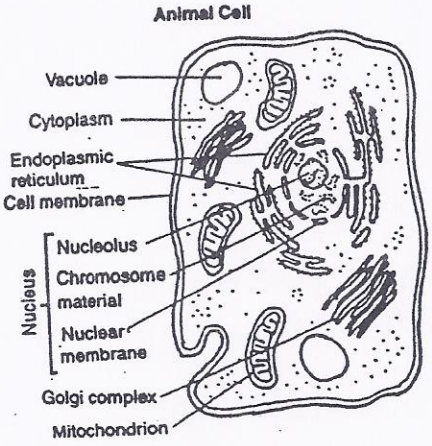
(h) Golgi complex – stacks of flattened membranes with vesicles that packages, assembles many cell products.
(i) Lysosomes – small structure that contain digestive enzymes that take care of foreign particles entering the cell and "digests" worn out cell parts.
(j) Vacuoles – storage of materials. These are very large in plant cells.

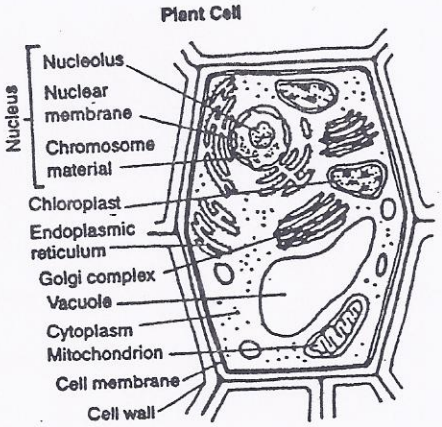
FOUND IN PLANT CELLS ONLY

(k) Chloroplasts – small green pigmented structures that contains chlorophyll. Site of photosynthesis.
(l) Cell wall - nonliving structure found outside of cell membrane in plants that provides strength and rigidity, but does not affect passages of materials in and out of cell.

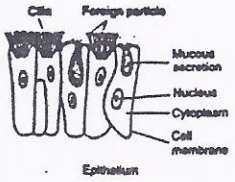
FOUND IN ANIMAL CELLS ONLY

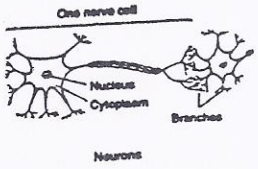
(m) centrioles – tiny cylindrical structures that are found in pairs near the nucleus of animal cells. They are involved in cell division.

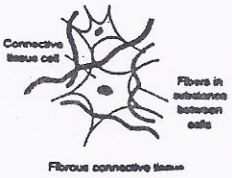




3. **IN MULTCELLULAR ORGANISMS, CELLS ARE ORGANIZED INTO TISSUES.**
   (a) Tissues are groups of similar cells that work together in a common function.
   (b) 4 types of tissues in animals –
      (1) Epithelial tissue– tightly compacted cells that serve as a lining for organs, cavities, blood vessels, etc.
      (2) Connective tissue – contains scattered cells embedded in a matrix (non-living material like tissue fluid, cartilage,) These connect things together in the body – examples – cartilage, bone, blood, fat, tendons, etc.
      (3) muscle tissue – 3 types – skeletal (attaches to bones); smooth – lines blood vessels, digestive organs, etc.; cardiac – heart.
   (c) nervous tissue – special conductive cells that compose brain and body nerves.







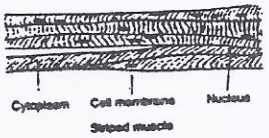


Table 2–4 Summary of Animal Tissues

Tissue	*Location*	*Functions*	*Adaptation*
Epithelial	Covering of body	Protection	Cells fit closely
	Lining internal organs	Secretion	Cells arranged as sacs
Muscle			Long, thin cells that contract
Skeletal	Attached to bones of skeleton	Voluntary movement	
Smooth	Walls of internal organs	Involuntary movement	
Cardiac	Walls of heart	Pumping blood	
Nervous	Brain	Interpretation of impulses, mental activity	Long, thin, sensitive cells
	Spinal cord, nerves, and ganglions	Carrying impulses to and from all organs	

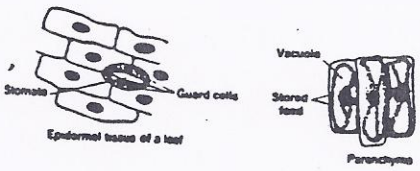
Summary of animal tissues, con't

Tissue	*Location*	*Functions*	*Adaptation*
Connective Binding	Covering organs, and in tendons and ligaments	Holding tissues and organs together	Fibrous intercellular material
Adipose	Beneath skin and around internal organs	Fat storage, cushion, insulation	Cells have fat in their vacuoles
Cartilage	Ends of bones, part of nose and ears	Reduction of friction, support	Flexible intercellular material
Bone	Skeleton	Supporting framework, protection, movement	Hard intercellular substance
Blood	Blood vessels and heart	Carrying materials to and from cells	Intercellular materials in fluid
		Carrying oxygen	Red blood cells have hemoglobin
		Fighting germs	Some white blood cells have pseudopods and lysosomes
		Clotting	Platelets

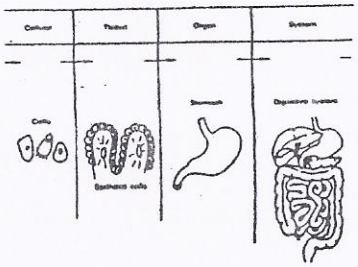
Examples of plant tissues – Epidermal (protection), **Parenchyma** (storage), **Vascular** (movement of water, food), **Sclerenchyma** (support), **Meristematic** (growth), **Chlorenchyma** (photosynthesis).

Table 2–3 Summary of Plant Tissues

Tissue	*Location*	*Functions*	*Adaptations*
Epidermal	Root	Protection	Cells close together
		Increases absorption area	Root hairs
	Stem	Protection	Cells close together
		Reduces loss of water	Waxy covering
	Leaf	Protection	Cells close together
		Reduces loss of water	Waxy covering
		Regulates exchange of gases	Guard cells
Parenchyma	Root, stem, and leaf	Storage of food and water	Boxlike cells; vacuoles
Chlorenchyma	Leaf and young stems	Photosynthesis	Chloroplasts
Vascular	Root, stem, and leaf	Upward conduction of fluids	Xylem tubes
		Downward conduction of fluids	Phloem tubes
Meristematic	Root and stem	Growth; formation of xylem, phloem, and other tissues	Unspecialized, dividing cells
Sclerenchyma	Stem and leaf	Support	Thick, hard cell walls

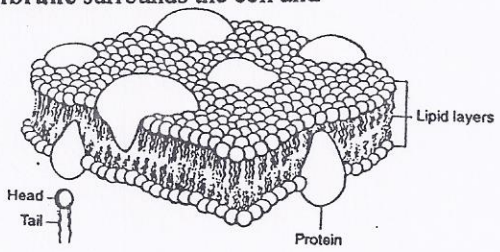


4. TISSUES ARE ORGANIZED INTO ORGANS.
   (a) An organ is a group of similar tissues working together. For example: the stomach is composed of epithelial lining connected to 3 layers of muscle by connective tissue. Nervous tissue controls the secretions and smooth muscle actions of the digestive process.



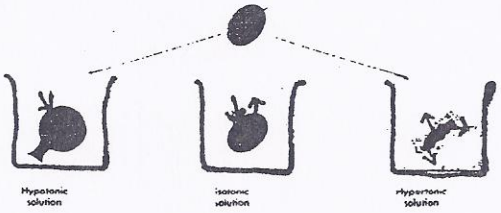
5. ORGANS ARE ORGANIZED INTO SYSTEMS.
   (a) A system is a groups of organs working together to perform a life maintenance function. For example – the mouth, esophagus, stomach, small intestine, large intestine form the major organs of the **digestive system.**

6. **TRANSPORT – Transport** involves the absorption of materials through cell membranes and into the body fluids for circulation throughout the organism. The **cell membrane** surrounds the cell and regulates the passage of materials into and out of the cell.



Cell membrane model

   (a) **Structure of the Cell Membrane -** The currently accepted model is the *fluid mosaic model.* According to this model, the cell membrane consists of a double layer of phospholipids in which large protein molecules float.
   (b) **Function of the Cell Membrane -** The cell membrane selectively regulates the passage of substances into and out of the cell. Smaller molecules, including water, carbon dioxide, oxygen, and the soluble end products of digestion, pass easily through the cell membrane. Most larger molecules, such as glucose, and electrically charged particles (ions) cannot diffuse easily through the cell membrane.
   (c) **Passive Transport** – passage of molecules through the membrane from regions of higher concentration into regions of lower concentration.
   (1) *Diffusion* – examples of molecules that diffuse through the lipid bilayer are oxygen and carbon dioxide.
   (2) *Osmosis* – diffusion of water across a membrane. Three types of solutions describing water balance in regions surrounding a cell are ***isotonic, hypotonic, and hypertonic.***
   (3) *Facilitated diffusion* – uses a carrier protein to passively transport a molecule across the membrane. Example of a substance that uses facilitated diffusion to enter the cell – glucose.



   (d) **Active Transport** – passage of molecule across a membrane using energy (ATP). In most cases, substances are moved from regions of lower concentrations into regions of higher concentrations.
   (1) *Endocytosis (Phagocytosis and Pinocytosis)* – is a process which substances are moved INTO cells. A pinched-in plasma membrane containing solids or fluids travel as vesicles through the cytoplasm.
   (2) *Exocytosis* is a process by which certain substances are moved OUT of cells. Vesicles travel to the cell membrane and substances inside vesicles are ejected from the cell.

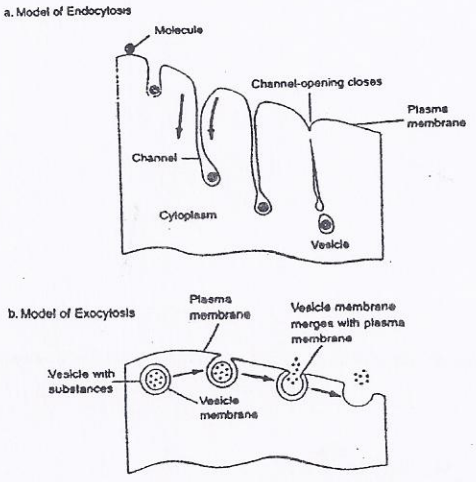
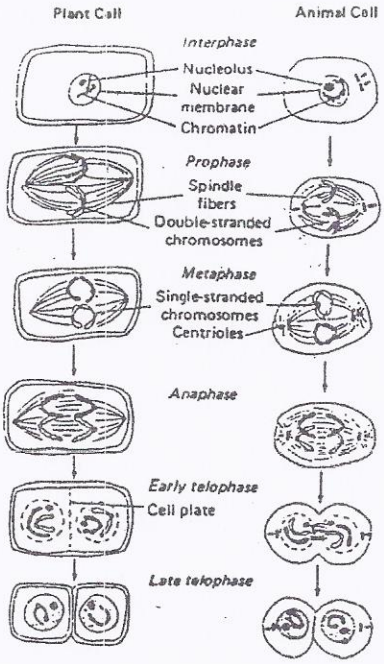


Figure 2-11 Endocytosis and exocytosis

7. CELL DIVISION – MITOSIS

This process occurs in all body cells. A cell can only grow so large, when it reaches a certain point it will divide into two cells. This process is called mitosis. The result is 2 identical cells with the exact same DNA (chromosomes).



Stages of mitosis.

8. MEIOSIS

The formation of gametes is essential to the continuation of a species. This special process of gamete formation from diploid cells is called MEIOSIS. The cells produced in this process have half the number of chromosomes than the original cells. There are 2 divisions in this process. Male and female meiosis processes are different in the number of cells produced. Crossing over and swapping of genetic information can occur during prophase I of this process.

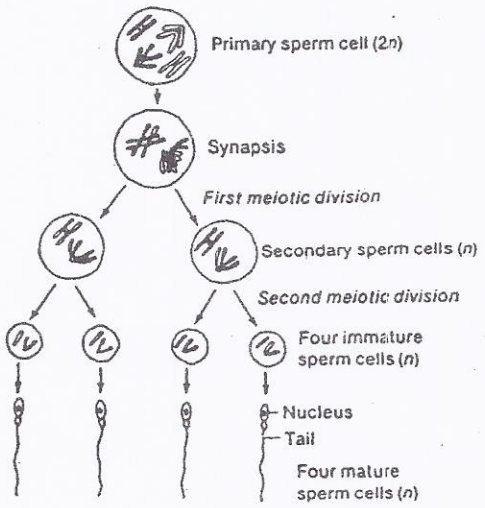


Figure 4-8. Spermatogenesis.

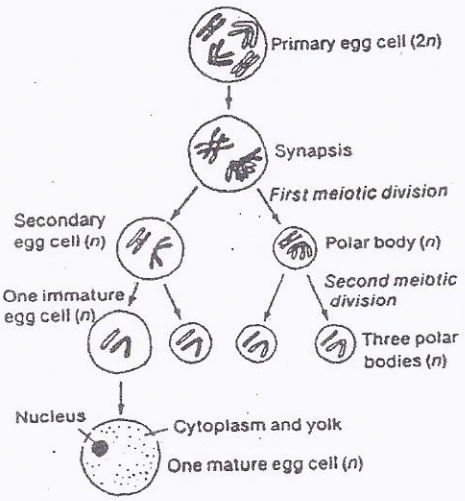


Figure 4-9. Oogenesis.

9. ASEXUAL VS. SEXUAL REPRODUCTION

The survival of a species depends on reproduction, the production of new individuals. There are two types of reproduction: **asexual and sexual.**

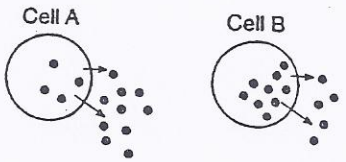
In *asexual reproduction* only one parent is involved and no sex cells are required. Only mitotic cell divisions occur in asexual reproduction. As a result, a parent and its offspring usually have the same genetic (DNA) makeup. Methods of asexual reproduction in Monerans, Protists, Fungi, and Plants include binary fission, budding, spore formation and vegetative propagation. Methods of asexual reproduction in animals include binary fission, budding, and regeneration.

In *sexual reproduction* two parents are involved, each contributing a sex cell, or *gamete.* The two gametes unite and form a single cell called a *zygote.* During meiosis, members of a pair of chromosomes tend to exchange genetic material before they separate. As a result, sex cells contain different sets of chromosomes and genes. The union of a sperm cell and an egg cell will produce gene combinations that differ from those of the parents.

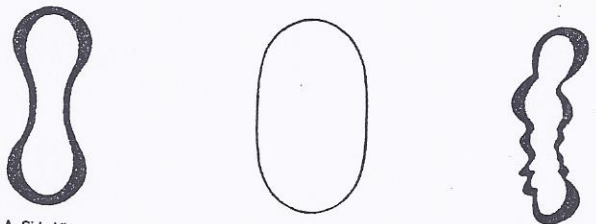
Sexual reproduction, more than asexual reproduction, enables a species to survive under changing conditions because the offspring usually have genetic makeups different from those of their parents and each other.

REVIEW QUESTIONS:

1. Which process would include a movement of a substance through a membrane from a region of lower concentration to a region of higher concentration? (a) osmosis (b) facilitated diffusion (c) active transport (d) passive transport.
2. Chemical analysis indicates that the cell membrane is composed mainly of (a) proteins and starch (b) proteins and cellulose (c) lipids and starch (d) lipids and proteins.
3. When a cell uses energy to move materials across a cell membrane, the process is known as (a) osmosis (b) active transport (c) diffusion (d) passive transport.
4. The diffusion of water molecules into and out of cells is called (a) exocytosis (b) pinocytosis (c) osmosis (d) homeostasis.
5. The arrows in the diagrams at right represent the direction of movement of a certain type of molecule through the cell membrane of two different cells. The dots represent the relative concentrations of this molecule.
   Which processes are illustrated in the diagrams?
   (a) phagocytosis and diffusion
   (b) pinocytosis and osmosis
   (c) active transport and diffusion
   (d) hydrolysis and circulation

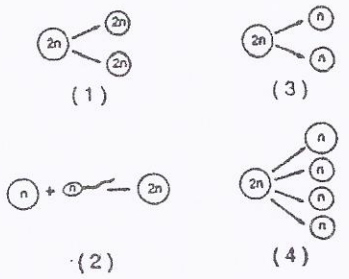


6. The diagrams A,B, C at right show normal red blood cells and their reactions to solution of different salt concentrations.
   Cell A does not swell or shrink when immersed in a solution that is (a) isotonic (b) hypotonic (c) hypertonic (d) only distilled water.
7. The diagrams A,B, C at right show normal red blood cells and their reactions to solution of different salt concentrations.
   Cell C must have been placed in a solution that is (a) isotonic (b) hypotonic (c) hypertonic (d) none of these.

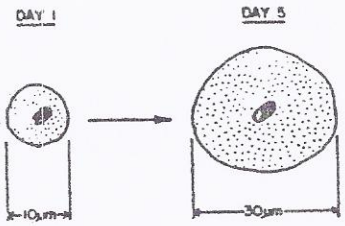


8. A prokaryotic cell is characterized by a (a) lack of cytoplasm (b) lack of ribosomes (c) plasma membrane (d) nuclear membrane.

9. The organelles usually found in the cells of both humans and maple trees are (a) chloroplasts (b) large vacuoles (c) mitochondria (d) cell walls.
10. Which diagram at right represents mitotic cell division? (a) 1 (b) 2 (c) 3 (d) 4.
11. Which diagram at right represents meiotic cell division? (a) 1 (b) 2 (c) 3 (d) 4.
12. The normal diploid chromosome number of the mouse is 40. How many chromosomes would be found in a sperm cell of this mouse? (a) 10 (b) 20 (c) 30 (d) 40.
13. The normal diploid chromosome number of the mouse is 40. How many chromosomes would be found in a skin cell of this mouse? (a) 10 (b) 20 (c) 30 (d) 40.



14. The tendency of an organism to maintain a stable internal environment is called (a) homeostasis (b) cell theory (c) reproduction (d) synthesis.
15. Which term includes all of the chemical activities carried on by an organism? (a) regulation (b) metabolism (c) digestion (d) respiration.
16. The energy available for use by the cell is obtained from the life function of (a) reproduction (b) respiration (c) transport (d) synthesis.
17. The cell organelles that are the sites of aerobic cellular respiration in both plant and animal cells are (a) mitochondria (b) centrioles (c) chloroplasts (d) nuclei.
18. The sites of protein synthesis in the cytoplasm are the (a) lysosomes (b) nuclei (c) centrioles (d) ribosomes.
19. The canals that connect the cell membrane with the nuclear membrane are the (a) ribosomes (b) lysosomes (c) endoplasmic reticulum (d) nuclei.
20. Which life activity is illustrated by the diagrams below of the same cell? (a) reproduction (b) excretion (c) transport (d) growth.



1. GENETICS

The study of heredity (passing traits from parents to offspring) is called genetics. In sexual reproduction each parent donates half the alleles or traits to the offspring. The offspring's characteristics are determined by what genes they possess and what is **DOMINANT OR RECESSIVE**. Dominant genes (alleles) are represented by capital letters and the same letter in small case represents recessive genes. Ex: If brown eyes are dominant over green eyes, Bb, would be used if the person had one gene for brown eyes and one gene for green eyes. We call Bb the **GENOTYPE**. This person will have brown eyes because the brown eyed gene dominates and "masks" the gene for green eyes. We call brown eyes in this case the **PHENOTYPE**. Since the person is Bb, this gene combination is **HETEROZYGOUS** (one dominant and one recessive) If the genotype was BB, they would be **HOMOZYGOUS** dominant.

We solve genetics problems and predict possible offspring by using a Punnett square. The following is an example of a problem showing the possible offspring of a HETEROZYGOUS TALL PLANT WITH A HOMOZYGOUS SHORT PLANT.

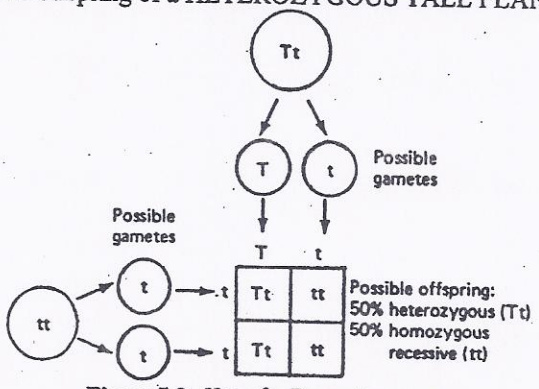


Figure 5-3. Use of a Punnett square.

2. INCOMPLETE DOMINANCE: Sometimes genetics does not follow the dominant/recessive rule. This happens when no trait truly dominates the other one. This occurs in many flowers, such as snapdragons. When a pure red snapdragon is crossed with a pure white snapdragon the heterozygous offspring are pink. We use all capital letters on these problems to show that it is different from the traditional genetic cross.

2 examples of incomplete dominance:

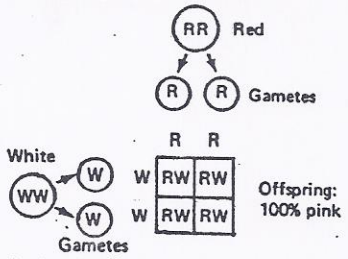


Figure 5-4. A cross between contrasting homozygous organisms for a trait that shows incomplete dominance.

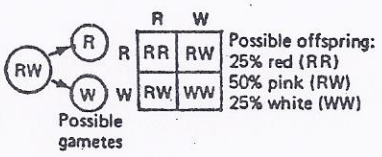


Figure 5-5. A cross between organisms heterozygous for a trait that shows incomplete dominance.

3. MULTIPLE ALLELES: When there is more than 2 different alleles for a trait, we see multiple alleles. Blood type problems show this inheritance pattern. For some reason, we use the capital I in this problems to signal that they are multiple allele problems. Study the chart below and answer the sample question.

Table 5-1. Blood Types and Genotypes in the ABO Blood Group System

Blood Type	Genotype
A	I^AI^A or I^Ai
B	I^BI^B or I^Bi
AB	I^AI^B
O	ii

4. SEX DETERMINATION: Many organisms are either male or female. This is determined by a pair of chromosomes known as sex chromosomes. XX represents female sex chromosomes. XY represents male sex chromosomes. The X chromosomes can "carry" genes for other traits, such as hemophilia, color blindness, etc. These traits are called X-linked traits and also sex-linked because they are only expressed in males. Males express the gene for X-linked traits because they have only one X chromosome. Unlike the females with two X chromosomes, one of the X chromosomes can "mask" the expression of the trait. The Y-chromosomes carry traits, called holandric traits, that are passed on only in the males.

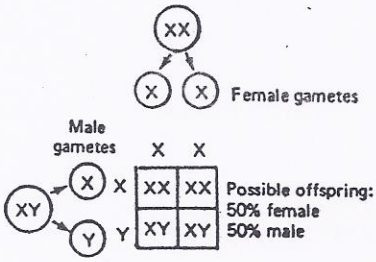


Figure 5-8. Sex determination.

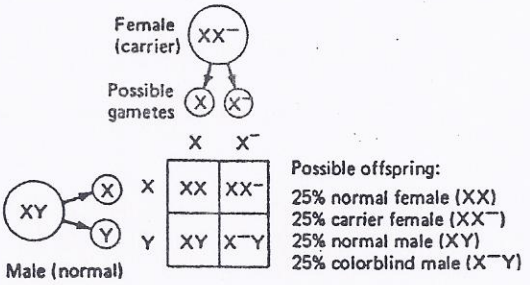


Figure 5-9. Inheritance of color blindness.

5. MUTATIONS - Changes in the genetic material are called mutations. Mutations in sex cells may be transmitted to the next generation. Mutations in body cells may be passed on to new cells of the individual as a result of mitosis, but will not be transmitted to the offspring by sexual reproduction.

(a) **Chromosome mutations** – involve a change in the structure or number of chromosomes. One example is *nondisjunction (when one or more pairs of homologous chromosomes fail to separate during meiosis).* ***See right.*** **Down's syndrome** in humans is caused by the presence of an extra 21st chromosome. Other chromosome mutations may be caused by deletion, translocation, inversion and duplication of parts of the whole chromosome.

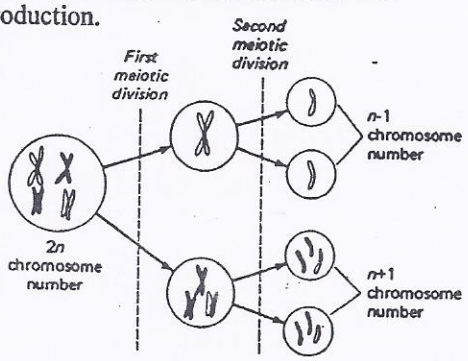


Figure 5-10. Nondisjunction.

(b) **Gene mutations** - involve a change in the chemical makeup of the DNA. This is where one or more DNA nucleotides are deleted or substituted with others. These are called *point mutations* and *frameshift mutations.* Diseases such as sickle cell anemia and cystic fibrosis are caused gene mutations. Occasionally random gene mutations produce changes that make the individual better adapted to the environment. Such mutant genes tend to increase in frequency within a population.

(c) **Mutagenic Agents** – increase the incidence ofmutation. Examples of these are X rays, ultraviolet rays, radioactive substances, nicotine, and alcohol.

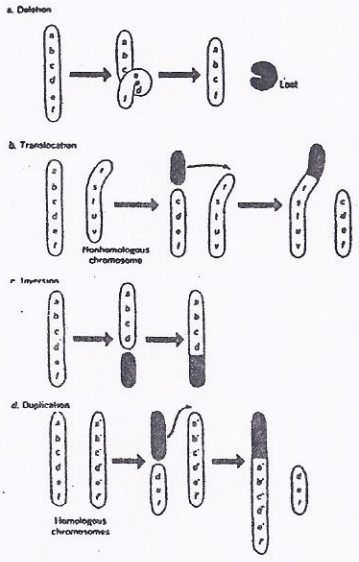


Figure 15–12 Chromosome mutations

6. TOOLS USED TO STUDY GENETICS

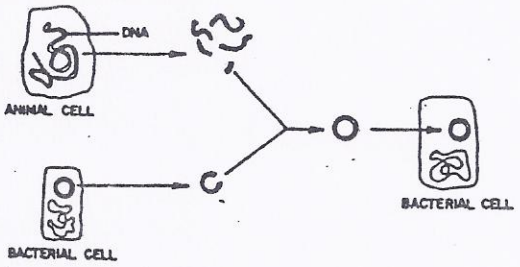
(a) Pedigrees – a drawing used to show transmission of traits though a family. Several generations may be illustrated. The use of a pedigree chart may also make it possible to identify carriers of recessive genes.

(b) Karyotypes – a picture of chromosomes arranged in homologous pairs. Chromosome numbers and abnormalities can be observed and studied.

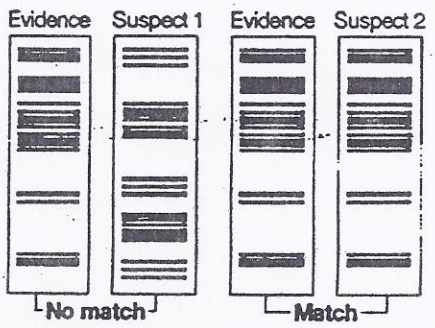
7. DNA MANIPULATIONS:

Biotechnology uses living organisms and new techniques to produce things people need. Genetic engineering gives scientists the ability to alter the genetic material in an organism by rearranging its genes or by combining its genes with those from another unrelated organism. The altered DNA is called recombinant DNA.

Recent experiments include splicing a human gene, such as the gene for insulin, into the DNA of bacteria. Since bacteria reproduce so rapidly, it is possible to mass produce large quantities of bacteria that can produce human insulin. The diagram to the right shows a simplified version of this process.



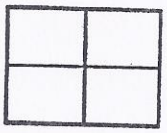
It is also possible to manipulate DNA by cutting it into pieces with enzymes and running it through a gel substance using an electric current. This process is called gel electrophoresis. It has been used to sequence and identify genes of organisms. This process is often used to compare a sample of DNA found in tissues collected at a crime scene with the DNA of the suspect. The diagram at right shows what a sample gel with DNA bands would look like.



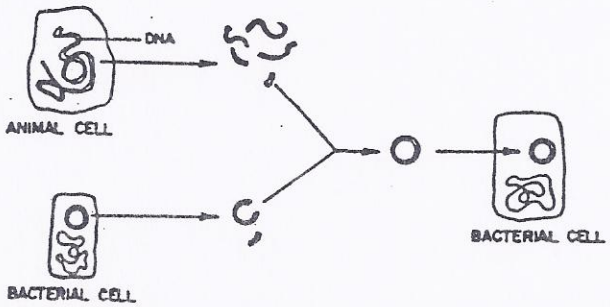
REVIEW QUESTIONS:

1. A child with blood type O has a mother with blood type A and a father with blood type B. The parental genotypes for blood types must be (a) I^AI^A and I^BI^B (b) I^Ai and I^BI^B (c) I^AI^B and I^Bi (d) I^Ai and I^Bi.

2. A person with type O blood marries a person with type AB blood. Possible blood genotypes of their children are (a) I^Ai and I^BI^B (b) I^BI^B and I^AI^A (c) I^Ai and I^Bi (d) I^AI^B and ii.



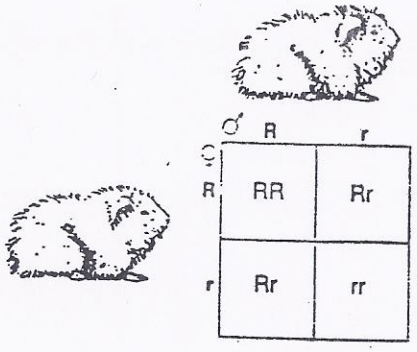
3. The diagram of a technique at right represents (a) amniocentesis (b) the formation of a karyotype (c) animal cloning (d) the formation of recombinant DNA.



4. This process is useful in producing (a) identical frogs (b) organ transplants (c) insulin and human growth hormone (d) artificial hearts and kidneys.

5. Which scientist is credited with stating the principle that traits among offspring result from combinations of dominant and recessive unit characters? (a) Darwin (b) Watson (c) Lamarck (d) Mendel.

6. In pea plants, tallness is dominant over shortness. If 50% (1/2) of one generation of pea plants are short, what were the probable genotypes of the parents? (a) TT x tt (b) Tt x tt (c) Tt x Tt (d) tt x tt.

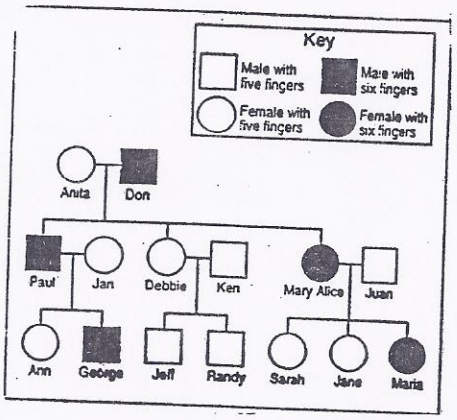


7. The Punnett square at right shows a cross between two heterozygous long-haired guinea pigs. What is the chance of any of the offspring having short hair? (a) 0% (b) 25% (c) 50% (d) 75%.

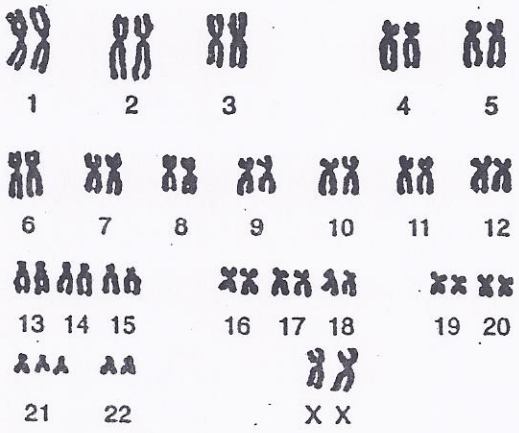
8. In humans, right handedness is dominant over left-handedness. What are the most probable gneotypes of two right-handed parents who have a left-handed child? (a) RR x RR (b) RR x rr (c) Rr x RR (d) Rr x Rr.

9. In the pedigree at right, the parents of Sarah and Jane are (a) Anita and Don (b) Mary Alice and Juan (c) Debbie and Ken (d) Paul and Jan.

10. In the pedigree at right, Maria inherited six fingers from (a) Sarah (b) Juan (c) Jane (d) Mary Alice.



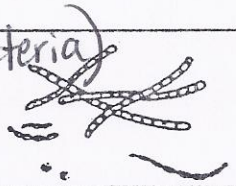
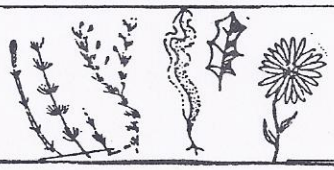
11. A karyotype is shown at right. Information in this karyotype indicates that the individual is a
(a) female with sickle-cell anemia
(b) male with Tay-Sachs disease
(c) female with Down syndrome
(d) male with phenylketonuria



12. Sometimes a section of a chromosome is lost during meiosis. This loss results in a change in genetic material known as
(a) a deletion (b) replication (c) crossing over (d) polyploidy.

1. CLASSIFICATION SYSTEMS

We currently have a five kingdom classification system. Each kingdom can be further sub-divided into Kingdom, Phylum, Class, Order, Family, Genus, Species.

Kingdom Monera (Archaebacteria / Eubacteria) *Prokaryote cells (no nucleus)* *Simple organisms – most are unicellular* *Autotrophic and heterotrophic* *Examples: bacteria, blue green algae*	
Kingdom Protista *Eukaryotic cells (have nucleus & Organelles)* *Most are unicellular* *Autotrophic and heterotrophic* *Examples: Amoeba, Paramecium, Euglena*	
Kingdom Fungi *Eukaryotic cells* *Multicellular* *Heterotrophs but cannot Digest inside bodies* *Examples: Mushrooms, yeast, mold, mildew*	
Kingdom Plantae *Eukaryote cells* *Multicellular* *Autotrophic* *Examples: all trees, grasses, flowering plants*	
Kingdom Animalia *Eukaryote cells* *Multicellular* *Heterotrophic* *Examples: humans, fish, insects*	

2. ADAPTATIONS AND NATURAL SELECTION

We study the history of organisms by using fossils. Fossils have been found preserved in ice, tar, amber and frequently in sedimentary rock. This type of rock is found in layers. Scientists assume when studying undisturbed rock layers that each layer is older than all the layers, or *strata,* above it.

Some fossils in older strata are unlike any modern, living things. This suggests that some organisms have died out, or become extinct. On the other hand, some fossils are very similar to modern life forms.

Theories of **evolution** (process of change through time) attempt to explain the similarities and differences among species.

Lamarck based his theory on the principle of use and disuse; and the inheritance of acquired characteristics. According to Lamarck, organisms developed new structures because they were needed and these new structures were passed on to offspring. As these traits were strengthened and passed on to each new generation, the species became better adapted to its environment.

Darwin's theory was based on the presence of variation among members of a species and the process that he called "natural selection." Populations continually changed due to (1) overpopulation (2) competition (3) survival of the fittest (4) natural selection (5) reproduction (d) speciation. In Darwin's theory, environmental pressures act as a force for the natural selection of the best adapted individuals – those with helpful adaptations that enable them to survive and reproduce successfully.

Today we use Darwin's ideas along with genetic discoveries to understand the genetic basis of variations in populations. Organisms that survive will have favorable characteristics and pass these on to the next generation. This is how insects develop resistance to insecticides and bacteria develop resistance to antibiotics. Other organisms

develop traits to enable them to survive over time, such as **camouflage** (protective coloration) and **mimicry** (look like a harmful organism).

A new species, **speciation**, will also occur over time due to **geographic isolation.** This occurs when small groups of organisms become separated from the main population by a geographic barrier, such as a body of water or a mountain range. New species will eventually develop due to the isolation.

Geographic isolation may lead to **reproductive isolation.** This is when the two identical species that have been separated for a time cannot interbreed even if the geographic barriers are removed. When two populations can no longer interbreed and produce fertile offspring, they have become two distinct species.

We use comparative anatomy (homologous structures), comparative embryology(development before birth), comparative cytology(cells) and comparative biochemistry to find similarities in organisms. This is our basis for modern classification.

3. VIRUSES

Most scientist do not consider viruses to be living organisms for several reasons:

(1) All viruses are composed of either DNA or RNA (never both) enclosed in a protein coat.

(2) Viruses can reproduce only within a host cells. They use the cell's living machinery for their own metabolism. They cannot grow, obtain nourishment or reproduce outside a host cell.

(3) Viruses, like the Tobacco-mosaic virus (TMV), can be crystallized like a mineral. In a crystalline state, a virus can exist for years unchanged, until it invades a host.

Viruses are more closely related to their hosts than they are to each other. Thus, the common flu virus is more closely related to humans, and the TMV more closely related to tobacco, than the two to each other. For these reasons, taxonomists do not classify viruses in their own separate kingdom.

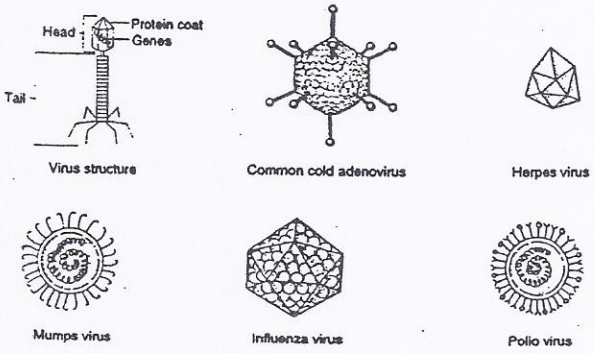


Figure 18–3 Some representative viruses

4. KINGDOM MONERA – OVERVIEW (Archaebacteria / Eubacteria)

(a) All monerans are prokaryotes.

(b) Monerans are shaped like rods, spheres, and helical spirals.

(c) Some generate energy by carrying out aerobic respiration; other by anaerobic respiration.

(d) They obtain food by photosynthesis or chemosynthesis.

(e) They are microscopic.

(d) They live in all types of habitats and can obtain nourishment from all organic substances, including plastics and petroleum.

(e) *Cyanobacteria* were classed as blue-green bacteria. They can carry out photosynthesis and are commonly found in lakes or ponds.

(f) Fermenting bacteria are anaerobic and are used to produce cheese, yogurt and other food products.

(g) Some species of bacteria can survive under the most extreme environmental conditions, including boiling, freezing, and even being submerged in hot acids. Bacteria also are found at great ocean depths and great atmospheric heights.

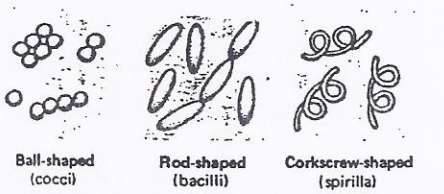
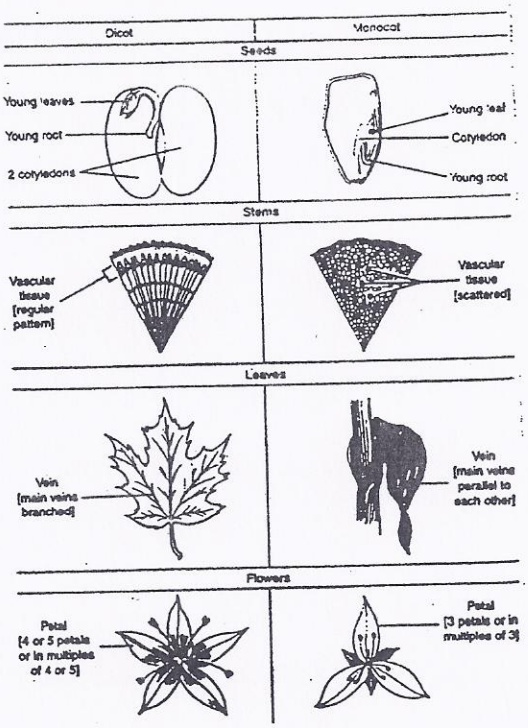


Figure 18–4 The three main shapes of monerans

5. KINGDOM PLANTAE – OVERVIEW

Bryophytes – examples are mosses, liverworts, hornworts. These lack vascular tissue and have no true roots, stems or leaves. They have rhizoids instead of roots that anchor the plant. They must live where it is moist for reproduction. Consequently, mosses and other bryophytes are small and usually live near water.

Tracheophytes – examples are ferns, conifers (pines), oak trees and flowering plants. These plants have vascular tissue (xylem and pholem) and have roots, stems, and leaves (ferns have fronds). Some plants produce seeds, others do not. If they produce naked seeds they are called **gymnosperms.** Examples are pines, cedars, etc. If they produce covered seeds, nutshell or fruit, they are called **angiosperms.** Examples are oak trees, herbs, apple trees, lily, etc. Angiosperms are the most numerous of plants. They can be further divided into monocots and dicots. Differences are found in the chart at right.



KINGDOM ANIMALIA – AN OVERVIEW

More than 90% of animals on earth do not have a backbone. These are called **invertebrates.** Those that do have a backbone are called **vertebrates.**

Invertebrates

Porifera – sponges – live in ocean and are sessile (attached) to rocks. Asymmetry.

Cnidarians –jellyfish and hydra can float and have long tentacles used for protection and food getting. Radial symmetry.

Worms – 3 different phyla – flatworms, nematods, annelida (earthworms) Earthworms are the first animals to have a true coelom (fluid-filled body cavity). Bilateral symmetry.

Mollusks – snails and slugs. They have shells for protection.

Echinoderms – spiny skin. Starfish and sea urchins. Radial symmetry

Arthropods – largest phylum of animals. Name means "jointed legs". Exoskeleton made of chitin (polysaccharide). Includes spiders, ticks, scorpion, crab, lobster, insects.

Vertebrates

Fish – bony fish (trout) whose skeleton is bone or cartilage fish (shark) whose skeleton is made of cartilage. Bony fish breathe through gills and have an operculum covering the gills. Sharks do not have an operculum, but have gill slits.

Amphibians – live part in water and part on land. Examples are frogs, toads, salamanders. Because their eggs lack a shell, they must go into the water to lay eggs.

Reptiles – adapted to life on land. Examples: snakes, lizards, turtles, alligators, and crocodiles. They have a dry skin covered with scales.

Birds – they can regulate their internal body temperature. They have feathers, wings, hollow bones, beaks, shelled eggs, and a four chambered heart. They are classed by their beaks or if they can fly.

Mammals – mammals are able to maintain their body temperature, have a four chambered heart, have body hair, and mammary glands to nourish their young. Humans are part of this

group. Some mammals lay eggs (duck billed platpus), some are pouched (kangaroos), but most are placental mammals. Humans are placental mammals. They have a special structure called a placenta, which allows for young to develop within the mother's body for a period of time. An umbilical cord connects the unborn animal to the placenta. This cord allows for the transfer of nourishment from the mother to the fetus.

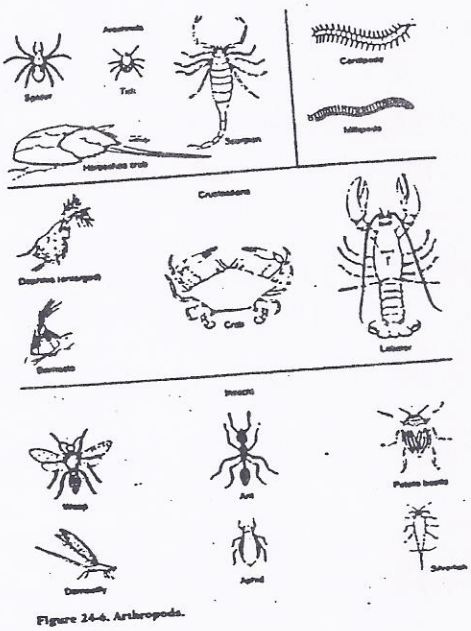


Figure 24-6. Arthropods.

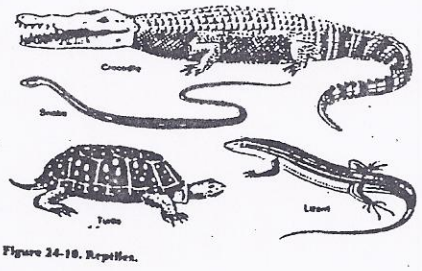


Figure 24-10. Reptiles.

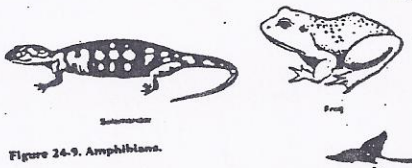


Figure 24-9. Amphibians.

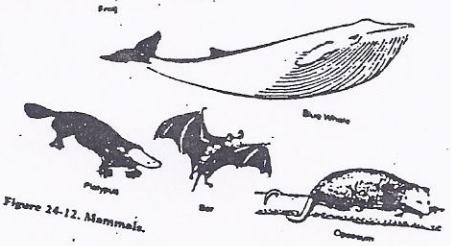


Figure 24-12. Mammals.

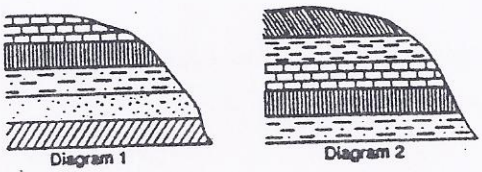
REVIEW QUESTIONS:

1. A possible conclusion based on the modern theory of evolution is that (a) most species have changed (b) all living things developed from fish (c) most plants and animals can interbreed (d) all dogs are more closely related to fish than to whales.

2. Which is a major concept included in Lamarck's theory of evolution? (a) change is the result of mutations (b) new organs arise according to the needs of the organism (c) dominant genes increase the rate of evolution (d) sexual reproduction is the genetic basis for variations.

3. In most populations, the individuals that produce the greatest number of offspring are (a) always the strongest (b) usually the best adapted (c) those that have only recessive traits (d) those that are the most intelligent.

4. The diagrams at right show two cliffs that are located several kilometers apart. Both cliffs are made of undisturbed sedimentary strata with distinct layers. Which layer would contain the oldest fossils?



(a) 

(b) 

(c) 

(d) 

5. *Acer saccharum* is the scientific name for the sugar maple tree. *Acer* is the name of the tree's (a) genus (b) phylum (c) species (d) kingdom.

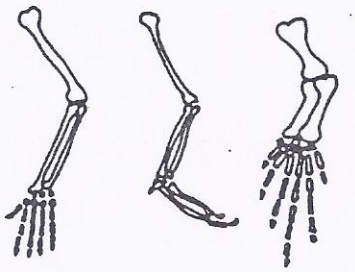
6. In a modern system of classification, two organisms would be most closely related if they were classified in the same (a) kingdom (b) phylum (c) genus (d) species.

7. Which kingdom contains heterotrophic organisms that absorb digested food? (cannot digest inside their own bodies) (a) Plantae (b) Animalia (c) Fungi (d) Protista.

8. Which kingdom contains totally autotrophic organisms that are not mobile? (a) Plantae (b) Animalia (c) Fungi (d) Protista.

9. Which kingdom contains organisms such as bacteria with prokaryotic cells? (a) Plantae (b) Animalia (c) Fungi (d) Monera.

10. The diagram at right represents the forelimbs of three different organisms. These structures are classified as homologous because they
(a) demonstrate the law of use and disuse
(b) are identical in function
(c) represent acquired characteristics
(d) are similar in structure and origin



11. The scientific name for a dog is *Canis familiaris,* and the scientific name of a wolf is *Canis lupus.* This indicates that the dog and the wolf are in the same (a) species (b) genus (c) family (d) Kingdom.

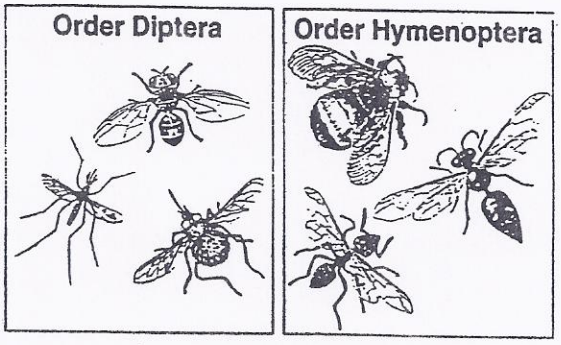
12. Viruses consist of an outer coat composed of protein and an inner material composed of (a) DNA or RNA (b) glucose (c) starch (d) urea.

13. Needlelike or scale-like leaves are characteristic of (a) gymnosperms (b) angiosperms (c) ferns (d) liverworts.

14. Which is correct about viruses? (a) They possess both DNA and RNA. (b) They are usually observed with a light microscope. (c) They can replicate on their own. (d) They can only replicated inside a host cell.

15. A plant group that requires a watery environment to complete its life cycle is (a) Sphenophyta (b) Coniferophyta (c) Bryophyta (d) Angiospermophyta.

16. Insects in the order Hymenoptera differ from those in the order Diptera by the presence of
(a) two pairs of wings
(b) antennae
(c) transparent wings
(d) three pairs of legs.



ATP – STORED ENERGY

When energy is stored, it is usually stored in the energy carrier **ATP**. ATP is found in all living things and is able to absorb energy and release it when needed by a cell. ATP is made up of one adenosine molecule and three phosphate groups. The bond holding together the last two phosphates is a high-energy bond. When the bond is broken, a tremendous amount of energy is released for use by the cell. After the bond is broken, the remaining molecule holds only two phosphate groups. It is now called **ADP**. ADP can absorb energy, use this energy to add another phosphate, and become ATP again. ATP allows the cell to use its energy a little at a time.

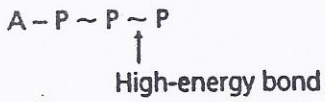


Figure 10-1. Energy is stored in high-energy bonds.

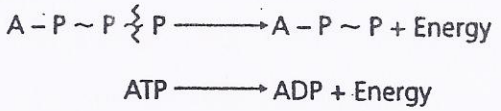


Figure 10-2. When a bond is broken, energy is released.

RESPIRATION: The process of taking oxygen gas from the atmosphere and glucose from food molecules to produce carbon dioxide, water and energy in the form of **ATP**. This process occurs in all plant, animal and other organisms cells in the mitochondria. This process does not occur in prokaryotes since they do not have mitochondria. They produce energy using a different format.

OVERALL EQUATION FOR REACTION: $C_6H_{12}O_6 + 6\,O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

glucose *oxygen* *carbon dioxide* *water* *energy*

Aerobic respiration: 2 stages

(1) Glycolysis: occurs in cytoplasm;
*Splits glucose into 2 pyruvic acid molecules;
*Oxygen is not involved directly in this step

(2) Citric Acid Cycle or Kreb's Cycle:
*Occurs in mitochondria
*Requires oxygen
*Pyruvic acid is changed into CO_2, H_2O, potential ATP's and actual ATP's
*Potential ATP's are converted into actual ATP's by a series of electron carriers called the **electron transport chain**. It is a complex process needing the inner folded membrane of the mitochondria.

Eventually a net gain of 36 ATP molecules are formed from 1 molecule of glucose. These ATP molecules provide energy to run the cell.

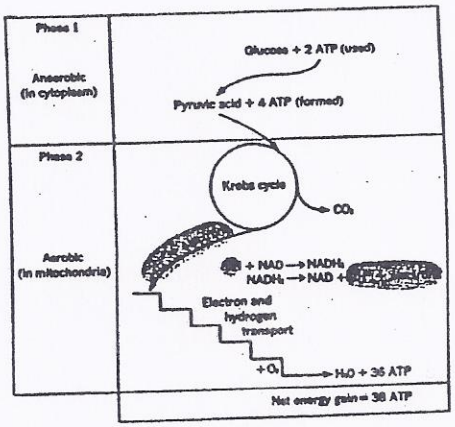


Figure 10-3. Energy release in cells.

Anaerobic respiration (without oxygen) occurs when oxygen is not present. This process is called fermentation.

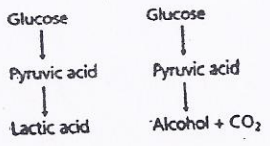


Figure 10-4. Fermentation.

Yeast cells undergoes alcoholic fermentation when oxygen is not present. Alcohol and CO_2 are produced. Animals produce lactic acid when oxygen is not available. This is called lactic acid fermentation. This process occurs in our muscle cells during strenuous activity. The body cannot supply enough oxygen to the muscle cells to keep up with ATP production. When lactic acid forms and builds up, fatigue sets in.

oxygen debt

PHOTOSYNTHESIS: Process of plants taking carbon dioxide from the atmosphere along with water from the soil to produce oxygen gas and glucose. The equation below represents the process.

OVERALL EQUATION FOR REACTION: $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6\,O_2$

carbon dioxide *water* *glucose* *oxygen*

Photosynthesis occurs in 2 phases:

(1) Light reactions:
- *Take place in grana of chloroplast;
- *Light energy is absorbed by chlorophyll;
- *Absorbed energy splits H_2O into H and O; (often called photolysis)
- *Oxygen is released;
- *Hydrogen is picked up by NADP for use in dark reaction (Calvin Cycle);
- *ATP is produced when H atoms are picked up by NADP for use in dark reactions. (often called electron transport chain reactions)

(2) Dark reactions or Calvin Cycle:
- *Take place in stroma of chloroplast;
- *CO_2 from air combines with H atoms ($NADPH_2$) to produce PGAL. (often called carbon fixation)
- *ATP from light reaction provides energy;
- *Glucose is made from PGAL

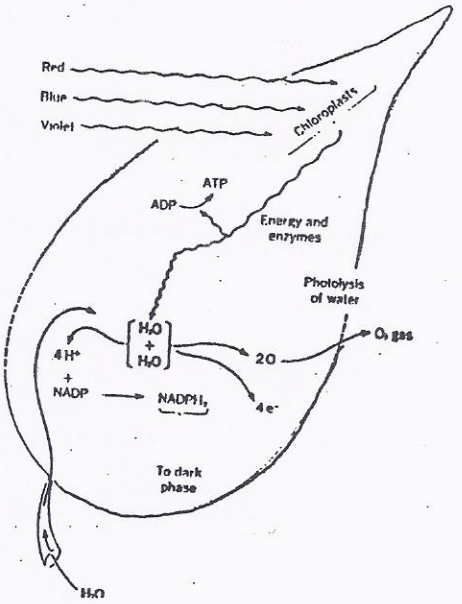


Figure 11–16 Outline of the light phase of photosynthesis

Both **respiration** and **photosynthesis** are called ***biochemical pathways.*** Both processes involve the use of CO_2 and H_2O. In photosynthesis, CO_2 and H_2O are materials used. In respiration, CO_2 and H_2O are the waste products. Respiration takes place in all living cells, but photosynthesis occurs only in cells that contains chlorophyll. Respiration breaks down sugars. Photosynthesis builds sugars. Glucose and oxygen are products of photosynthesis and the raw materials needed for respiration.

Table 11–3 Comparison of Photosynthesis and Aerobic Cellular Respiration

Photosynthesis (Chloroplast)	*Aerobic Cellular Respiration (Mitochondrion)*
ADP → ATP (energy storage)	ADP → ATP (energy storage)
O_2 released	O_2 used (combined)
$CO_2 \rightarrow C_6H_{12}O_6$ (CO_2 fixed)	$C_6H_{12}O_6 \rightarrow CO_2$ (CO_2 released)
$NADPH_2$ → NADP (coenzyme reduced)	NAD → $NADH_2$ (coenzyme oxidized)

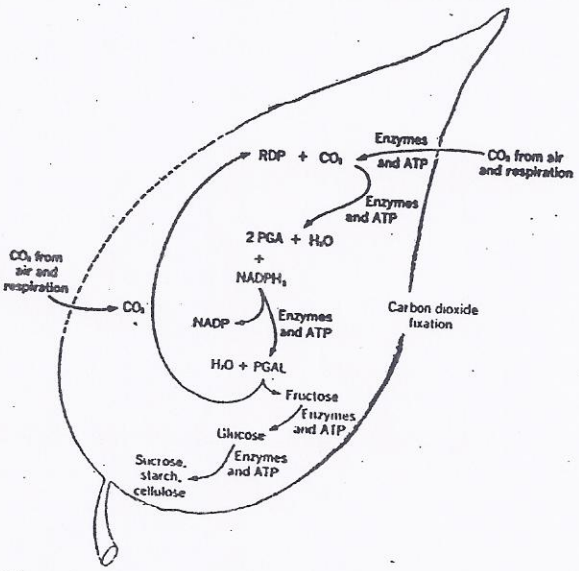


Figure 11–17 Outline of the dark phase of photosynthesis

ECOSYSTEMS

Ecology is the study of relationships between organisms and between organisms and their environment.
Ecosystem is an area where all living and non-living things interact.
Populations are all members of a SINGLE species living in an ecosystem.
Community is all the living species interacting in an ecosystem.

Each organism lives in a habitat. The role they play in this habitat is called their niche. For example a grasshopper's habitat is grass and its niche is to eat grass and provide food for worms and frogs.

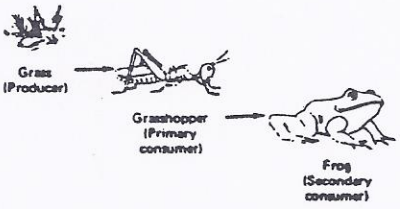
Predators eat other organisms and prey is what is eaten. Lions are predators that kill and eat zebras, which is prey.

Symbiosis is a close association between two different types of organisms.
3 Major types of Symbiosis:
(1) Mutualism – relationship where both organisms benefit. Ex: lichen (algae and fungus) algae provides food for fungus which provides support and water for the algae.
(2) Commensalism – relationship where one organism benefits while the other does not benefit, but is not harmed. Ex: barnacles living on whales; orchids living on large tropical trees.
(3) Parasitism – relationship where one organism benefits and the other is harmed. Ex: fleas on dog;

Autotrophic organisms that make food are called producers. They have the ability to photosynthesize the sun's energy into sugar for their own cells and provide food for others. Heterotrophic organisms that eat food are called consumers.

Types of consumers:
(1) Primary consumer (1st order consumer) – eats plant and is called an herbivore.
(2) Secondary consumer (2nd order consumer) – eats primary consumer and is called a carnivore (eats only meat) or an omnivore (eats both plants and meat).
(3) Decomposers – organisms that break down dead organisms and return nutrients to the environment. Example: bacteria, fungi
(4) Scavengers – feed on dead organism's but does not give back to the environment. Ex: buzzards, insects.

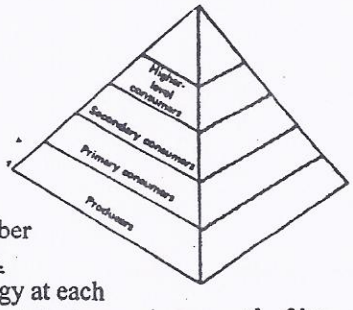
Food chains show the organisms that are involved in the flow of energy, starting with producers and ending with the consumers.



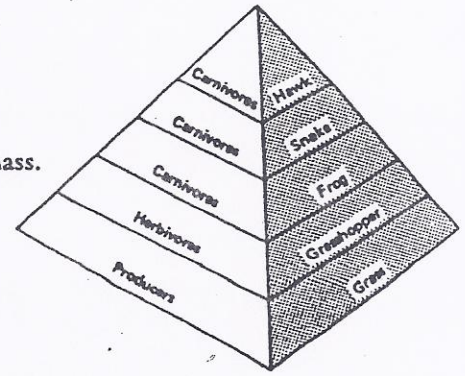
A food chain.

Food webs show all feeding relationships within the community. It is an overlap of all the food chains.

Pyramid of biomass compares the total mass of the different types of organisms found in an ecosystem. Producers make up the base of the pyramid. They are the most numerous and have the greatest total mass. Primary consumers form the next level, and secondary and higher consumers form the next levels of the pyramid. A pyramid of numbers shows the number of organisms at each feeding level called trophic levels. A pyramid of energy can also show the amount of energy at each level. The producer level is always the highest. Energy is lost as heat as each organism feeds on the other.



A pyramid of biomass.



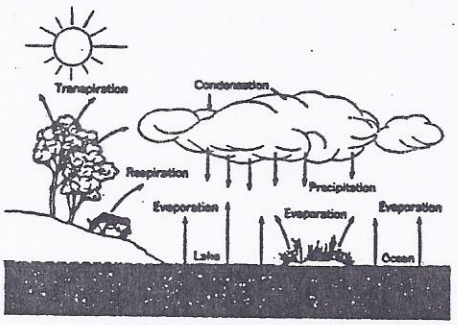
A pyramid of energy.

NUTRIENT CYCLES

In ecosystems, the recycling of inorganic, or nonliving, materials enables substances that are in limited supply on Earth to be reused. Materials are reused in a series of nutrient cycles.

Water cycle - *This involves movement of water from air to ground and back to air.*
Precipitation – movement of water from air to earth *(These are processes involving nonliving*
Evaporation – movement of water from earth to air *materials only.)*

Transpiration – movement of water from plants to air *(These are processes involving living organisms)*
Respiration – movement of water from animals to air



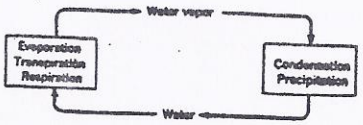


Figure 40-3. The water cycle.

Carbon-Oxygen cycle – *Carbon and oxygen is passed between the CO_2 of air and the organic molecules in living things.*
Photosynthesis – plants use carbon from CO_2 to form carbohydrates (glucose) and release O_2.
Respiration – plants and animals use oxygen (from air) + glucose to make energy and release CO_2.

Decomposition - CO_2 is released into air as formerly living matter breaks down.
Burning of Fossil Fuels - CO_2 is released into air as fossil fuels burn. They need O_2 to burn.

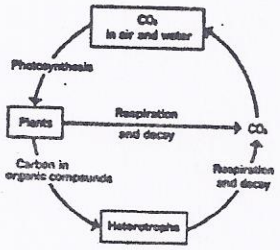


Figure 40-4. The carbon cycle.

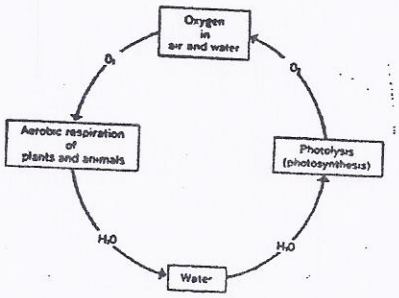


Figure 40-6. The oxygen cycle.

Nitrogen cycle - *Nitrogen gas is converted into forms plants can use. Animals obtain nitrogen in the form of proteins, where they build body structures and cell membranes with this.*

Bacteria – "fix" nitrogen into forms that plants can use.
Lightning – can also "fix" nitrogen in air so it can be used in the soil by plants.

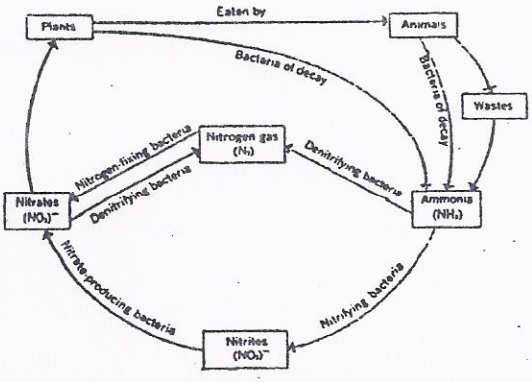


Figure 40-5. The nitrogen cycle.

SUCCESSION

Many ecosystems undergo an orderly series of changes that are called succession. The first living things to inhabit an area is called **pioneer species.** Lichens, mosses, and algae may be pioneer organisms on bare rock. Succession ends over a period of time with the development of a stable community. We call this **climax community.** This community prevails until it is disrupted by a catastrophic change, such as a tornado, flood, or forest fire.

BIOSPHERE AND BIOMES

The biosphere is the portion of the earth in which living things exist. It includes complex ecosystems, water, soil and air. The biosphere contains abiotic and biotic factors. **Abiotic** factors are nonliving. They include things like soil, rain, sunlight, and temperature. The living organisms make up the **biotic** factors. Biotic factors interact among themselves and with abiotic factors to create a stable, functioning biosphere.

A **biome** is a geographical area characterized by a particular climate. There are aquatic biomes (oceans, lakes, streams, rivers) and terrestrial biomes (land). Terrestrial biomes are determined by the land's latitude, altitude and precipitation. Different plants and animals inhabit each biome and are adapted for that particular biome. Table 7-1 below shows the different terrestrial biomes of the earth.

***Table 7-1. The Biomes of the Earth**

Biome	Characteristics	Plants	Animals
Tundra	Permanently frozen subsoil	lichens, mosses, grasses	caribou, snowy owl
Taiga	Long, severe winters; summers with thawing subsoil	conifers	moose, black bear
Temperate-deciduous forest	Moderate precipitation; cold winters, warm summers	deciduous trees (maple, oak, beech)	gray squirrel, fox, deer
Tropical forest	Heavy rainfall; constant warmth	many species of broad-leaved plants	snake, monkey, leopard
Grassland	Considerable variability in rainfall and temperature; strong prevailing winds	grasses	pronghorn antelope, prairie dog, bison
Desert	Sparse rainfall; extreme daily temperature fluctuations	drought-resistant shrubs and succulent plants	kangaroo rat, lizard

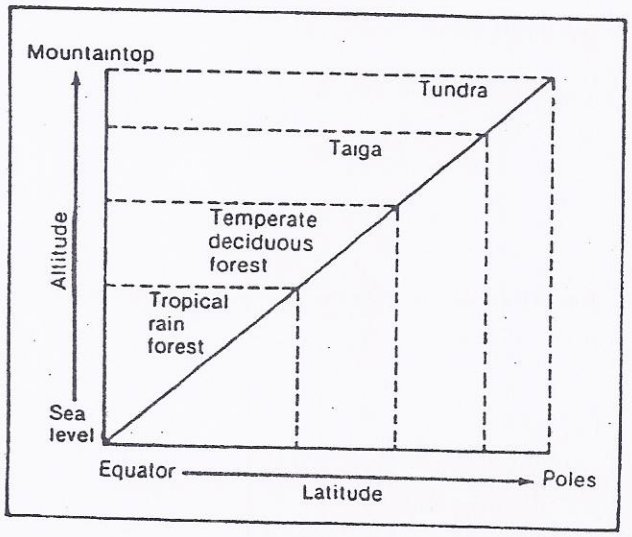


***Figure 7-8.** Relationship between latitude and altitude.

POPULATION GROWTH AND HUMAN IMPACT

All organisms, including humans, depend on Earth for survival. Earth has a limited supply of materials needed to support life. Humans have created many ecological problems. These problems include population explosion, a decrease in food-producing land, poor nutrition, and a wasting of natural resources.

Populations:

Carrying capacity – The number of organisms that the resources in an area can support for an indefinite period of time.

Limiting factors – Factors that limit population size.

2 types:

Density Dependent Factors – competition, predation, parasitism, crowding. (These factors affect large crowded populations.)

Density Independent Factors – temperature, floods, droughts, etc. (These factors can affect any population regardless of size.)

Renewable resources – these include those that are replaced constantly by new production or cycling. Examples are sunlight, crops, animals, oxygen, carbon dioxide, water.

Nonrenewable resources – these include those that are NOT replaced or recycled naturally. Examples are metals, topsoil, and fossil fuels.

Extinct Species – disappearance of an entire species. This is usually caused by habitat destruction. Examples: dinosaurs, dodo bird, woodland caribou

Endangered Species – numbers of the members of a species is so low that there is a possibility of extinction. Examples: African elephant, Florida panther

Predator-Prey Relationships – As predators become numerous, they eat more prey than are born. Prey numbers drop. Since there are less prey, predators began to starve and their numbers drop also. Then as predators are reduced, prey numbers begin to rise and the cycle begins again. It is important to have predator-prey relationship in balance.

HUMAN EFFECTS

Pollution-

(1) Air pollution – greenhouse effect, smog, acid precipitation (rain and snow), ozone layer, chlorofluorocarbons (CFC's)
(2) Fresh water pollution – sewage, animal wastes, toxic chemicals, farmland runoff (pesticides, phosphorus), heated water from industries, radioactive waste
(3) Soil pollution – erosion, chemicals, pesticides, loss of topsoil, overuse of farmland, garbage dumps
(4) Ocean pollution – wastes, oil spills

Other problems:

(1) Deforestation without replanting
(2) Extinct, endangered species

Solutions?

(1) Conservation of all resources
(2) Clean up environment
(3) Recycle when possible
(4) Biological control of pests instead of chemical
(5) Rotating crops

REVIEW QUESTIONS:

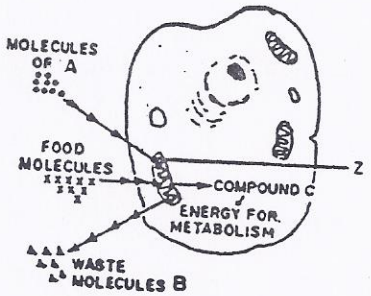
1. The raw materials used by green plants for photosynthesis are (a) oxygen and water (b) oxygen and glucose (c) carbon dioxide and water (d) carbon dioxide and glucose.

For each statement in questions 2-9, select the phrase chosen from the list below that is most closely associated with the statement.

(a) light reactions only (b) Calvin (dark) cycle only (c) neither light nor Calvin cycle

2. Light energy is absorbed by chlorophyll in (a) (b) (c).
3. Oxygen gas is used in (a) (b) (c).
4. Carbon dioxide is used in (a) (b) (c).
5. Water is split in (a) (b) (c).
6. Glucose is formed in (a) (b) (c).
7. ATP is formed in (a) (b) (c).
8. ATP is used in (a) (b) (c).
9. Oxygen is released in (a) (b) (c).

Base your answers to questions 10-15 on the diagram at right, which represents a cellular process in animals.



10. Compound C, the energy for metabolism is (a) oxygen (b) glucose (c) ATP (d) DNA.
11. If this cell is carrying on aerobic respiration, B represents molecules of a waste product known as (a) carbon dioxide (b) ATP (c) ethyl alcohol (d) pyruvic acid.
12. Molecules of A entering the cell to react with food are (a) carbon dioxide (b) enzymes (c) lipids (d) oxygen.
13. The cell organelle labeled Z is known as a (a) chloroplast (b) mitochondria (c) nucleolus (d) vacuole.
14. The food molecules entering this cell would be (a) urea (b) fatty acids (c) amino acids (d) glucose
15. Which of the following is the correct equation for cellular respiration?
    (a) oxygen + glucose → ATP + carbon dioxide + water
    (b) oxygen + sucrose → carbon dioxide + water
    (c) carbon dioxide + water → oxygen + glucose
    (d) carbon dioxide + water → sucrose + glucose

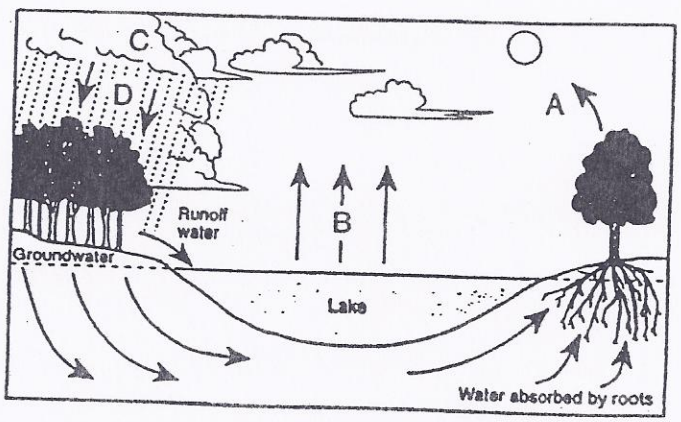
16. How do cells release energy for cellular function? (a) when cells break down sucrose to glucose and fructose (b) when a phosphate attaches (bonds to ADP (c) when a phosphate breaks off from ATP (d) when the cell releases waste.

17. How many phosphate groups would a molecule of ADP have? (a) 0 (b) 1 (c) 2 (d) 3.

18. The source of the organism's cellular energy (ATP) comes from (a) carbon dioxide (b) enzymes (c) food (d) water.

19. In an abandoned field, the gradual replacement of grasses by shrubs and then by trees is known as (a) predation (b) transfer of energy (c) ecological succession (d) food chain.

Use the diagram at right to answer 20-22.



20. What letter represents the process of transpiration? (a) A (b) B (c) C (d) D.

21. What letter represents the process of precipitation? (a) A (b) B (c) C (d) D.

22. This cycle is the (a) carbon (b) nitrogen (c) oxygen (d) water.

Use the following chart to answer questions 23-27.

A	Characteristics	Climax Flora	Climax Fauna
B	Long, severe winters	*D*	Moose, Black Bear
Tropical Rain Forest	Heavy Rainfall	Many species of broadleaf plants	*E*
Desert	*C*	Succulent plants	Lizards

23. Which heading belongs in box A? (a) Land Biome (b) Aquatic Ecosystem (c) The Biosphere (d) Succession Stage.

24. What name belongs in box B? (a) Tundra (b) Taiga (c) Grassland (d) Temperate Forest

25. Which characteristic belongs in box C? (a) extreme daily temperature fluctuations (b) constant rainfall (c) seasonal animal migrations (d) strong prevailing winds.

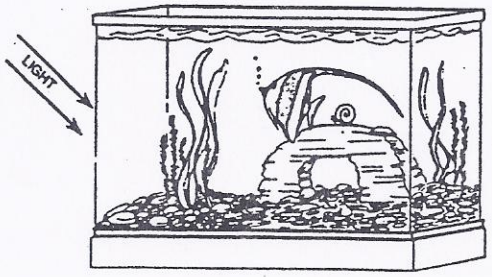
26. Which organisms belong in box D? (a) maple trees (b) cactus plants (c) lichens (d) conifers.

27. The climax fauna in box E would probably include (a) lizards and caribou (b) red fox and whitetail deer (c) bison and antelope (d) monkeys and snakes.

28. An abiotic factor affecting the behavior and survival of such organisms as robins and violets is the (a) population of rabbits (b) length of daylight (c) presence of harmful bacteria (d) number of herbivores.

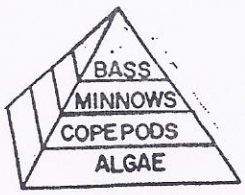
29. Which organisms could function as pioneer organisms on bare rock? (a) scavengers (b) parasites (c) lichens (d) shrubs.

30. What are the abiotic factors represented in this illustration of an aquarium? (at right)
(a) snail, gravel, and water
(b) snail, fish, and plants
(c) water, light, and gravel
(d) plants, light, and water

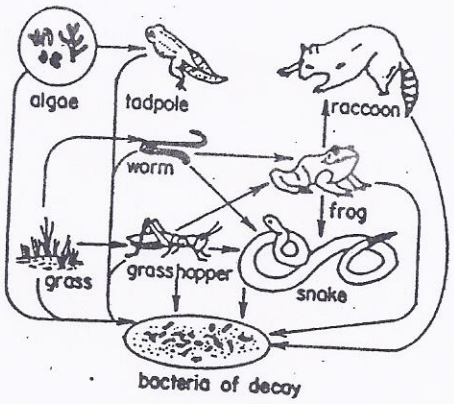


31. Which food chain relationship illustrates the nutritional pattern of a primary consumer? (a) seeds and fruits eaten by a mouse (b) an earthworm eaten by a mole (c) a mosquito eaten by a bat (d) a mold growing on a dead frog.

32. Which level of this food pyramid represents the largest biomass? (a) bass (b) minnows (c) copepods (d) algae.



Base your answers to questions 33-37 on the diagram at right. The diagram represents different species of organisms interacting with each other in and around a pond environment.



33. The adult frog represents which type of consumer? (a) producer (b) carnivore (c) saprophyte (d) parasite.
34. Which organisms are classified as herbivores?
    (a) algae, tadpole, raccoon
    (b) worm, snake, bacteria
    (c) tadpole, worm, grasshopper
    (d) grasshopper, bacteria, frog
35. Which statement about the algae and grass is true?
    (a) They are omnivores.
    (b) They are parasites.
    (c) They contain the greatest amount of stored energy.
    (d) They are decomposers.
36. Which statement about the bacteria of decay is true?
    (a) They are omnivores.
    (b) They are parasites.
    (c) They contain the greatest amount of stored energy.
    (d) They are decomposers.
37. The interactions among organisms shown in this diagram illustrate (a) geographic isolation (b) abiotic factors (c) organic evolution (d) a food web.

38. The organisms that prevent the earth from becoming covered with the bodies of dead organisms are known as (a) herbivores (b) parasites (c) saprophytes (d) producers.

39. The presence of nitrogen fixing bacteria in nodules on the roots of legumes such as the peanut plant provides the bacteria with nutrients and a habitat and the legumes with nitrogen compounds that the plant can use. This relationship is called (a) commensalism (b) mutualism (c) parasitism (d) saprophytism.

40. Which term describes the bird and the cat in the pattern of energy flow?
    (a) herbivores (b) saprophytes
    (c) producers (d) consumers.

    Sun → grass → grasshopper → bird → cat

41. The number of African elephants has been drastically reduced by poachers who kill the animals for the ivory in their tusks. African elephants have become (a) extinct (b) polluted (c) deforestated (d) endangered.

42. Gypsy moth infestations of rural area of New York State may pose a potentially serious threat to many forested areas. Which would probably be the most ecologically sound method of gypsy moth control? (a) widespread application of DDT (b) introduction of biological control (c) removal of forest habitat (d) contamination of food supply.

43. A poor land use practice that usually leads to the loss of soil nutrients is (a) reforestation (b) recycling (c) overcropping (d) sewage control.

44. The major cause of species extinction is (a) hunting (b) pesticide use (c) habitat destruction (d) water and air pollution.

45. Which is NOT generally a cause of water pollution? (a) increased growth of human population (b) increased use of pesticides (c) increased industrialization (d) increased use of biological controls.

46. The peregrine falcon has been bred in captivity and then released into areas where there is an ample food supply. This procedure best illustrates (a) species preservation (b) biological control (c) pesticide use (d) species exploitation.

47. If a dam is built across a river, the dam creates an artificial lake or reservoir. Dams are useful because they hold river water and collect and store runoff. Dams can cause problems, however, to a shore-bird habitat located where the reservoir would be located. It would also cause problems for the farmland located just downstream from the dam. Pick one situation (farmland or shore-birds) and discuss the problems the dam would create and possible solutions.

SCIENTIFIC METHODS

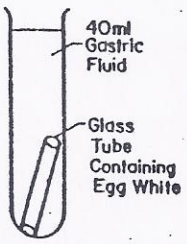
Define the problem to be solved – this is based on research, not a thought out of "thin air."
Hypothesis – testable statement based on previous research. Experiment is designed to test the hypothesis.

Experiment – controlled testing. It should have a group getting the experimental treatment and one group getting all factors except the experimental treatment.
Independent variable – variable being manipulated or tested in the experiment.
Dependent variable – variable being measured at the end of the experiment.
Controls – factors kept the same between the experimental group and control group.

Collect, organize data during the experiment. Take accurate measurements. The data may be recorded in a log in the form of a chart, or data table. Often the results are plotted on a graph. Scientists also use computers to record and organize experimental results.

Make predictions, generalizations and draw conclusions. The results of an experiment are collected and analyzed. For a conclusion to be meaningful, the experiment must be repeated many times, and all the results obtained must be included in the analysis.

Example:
A student is studying the effect of temperature on the hydrolysis (breaking down)action of the enzyme protease which is contained in gastric fluid. An investigation is set up using 5 identical test tubes, each containing 40 mL of gastric fluid and 20 mL of glass tubing containing cooked egg white, as shown in the diagram. The data collected are shown in the data table at right.



Tube	Temperature (°C)	Amount of Enzymatic Hydrolysis in 48 hours
1	4	0.0 mm
2	8	2.5 mm
3	21	4.0 mm
4	37	7.5 mm
5	100	0.0 mm

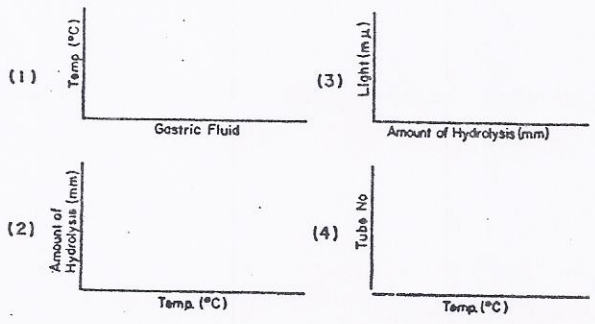
a. What is the independent variable in this investigation?

b. What is the dependent variable?

c. What were the controls in the experiment?

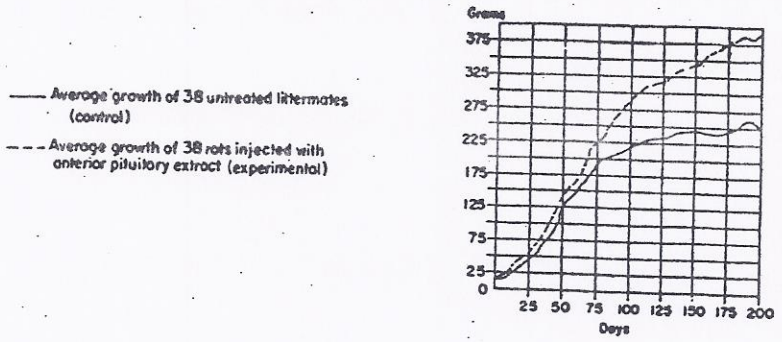
d. If an additional test tube were set up identical to the other test tubes and placed at a temperature of 15°C for 48 hours, what amount of hydrolysis might be expected? (a) less than 2.5 mm (b) between 2.5 mm and 4.0 mm (c) between 4.0 mm and 7.5 mm (d) more than 7.5 mm.

e. The best graph of the results of this investigation would be made by plotting the data on which set of axes? (a) 1 (b) 2 (c) 3 (d) 4.

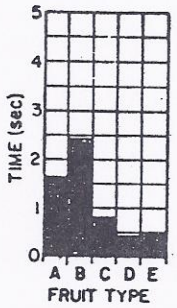


GRAPHS

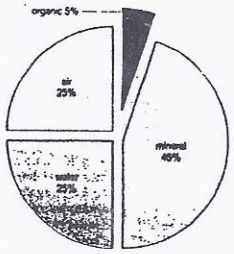
Line graphs are more common. Independent variables are plotted on x axis and dependent variables are plotted on y axis. Both axes must be clearly labeled with proper units. A title is strongly suggested. More than one set of information can be plotted on a graph, but a legend must be included. See samples below.



Bar graphs are another graph used in biology. Data is used in these graphs when plotting data such as rainfall per months, brands of items, and color. These are used when plotting data that cannot be measured using units. See samples below of bar graphs.



Pie graphs are also used in biology. They will usually be used to demonstrate data that totals 100%. A pie graph is shown below.



USING TOOLS IN THE BIOLOGY LAB

Safety First! Follow your teacher's safety rules when working on labs and activities. Here are some samples below!

1. Do not handle chemicals or equipment unless you are told to do so by your teacher.
2. Do not use broken glassware. Report it to your teacher.
3. Report any personal injury or damage to clothing to your teacher.
4. Follow all instructions, both written and oral, carefully.
5. Wear safety glasses, tie back long hair, and protect clothing when working with chemicals.
6. Never touch or taste any substance unless specifically told to do so by your teacher.
7. When heating a liquid in a test tube, make sure that the opening of the test tube is pointed away from you and away from anyone nearby.
8. Dispose of waste materials as instructed by your teacher.
9. Clean and wipe dry all work surfaces at the end of class.
10. Wash hands before leaving the laboratory.

Microscope use

In using the compound microscope, begin by viewing the specimen with the low power objective, focusing first with the coarse adjustment, then with the fine adjustment. The objectives can then be switched from low power to high power.

The image of an object seen under the microscope Is enlarged, reversed (backward), and inverted (upside down). When viewed through the microscope, an organism that appears to be moving to the right is actually moving to the left. An organisms that appears to be moving toward the observer is actually moving away from the observer.

Total magnification is found by multiplying the eyepiece lens times the objective lens. For example, if you are viewing the slide using the 40X objective lens and your eyepiece is 10X, the total magnification is 400 times. 10X x 40X = 400X total magnification.

Making a wet mount slide:

1. Use a dropper to put water in center of slide.
2. Place tissue or organism on the water drop.
3. Cover the specimen with a cover slip.
4. To stain the section, add a drop of iodine solution Or methylene blue at one edge of the cover slip. Touch a small piece of paper towel to the opposite side of the cover slip to draw the stain across the slide and through the specimen.

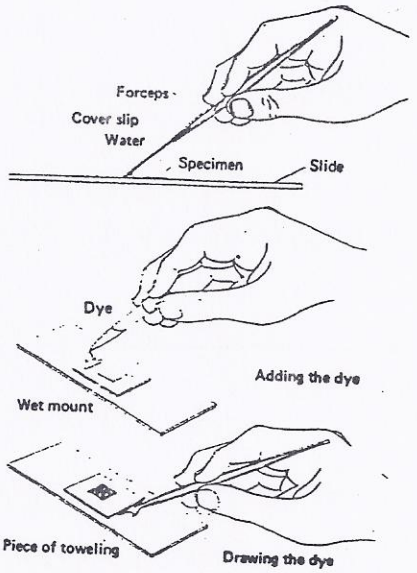


Figure 5. Making a wet mount and staining a specimen.

MAKING MEASUREMENTS

METRIC RULERS: Basic unit of length is meter, m. We use the centimeter, cm, and millimeter, mm, in biology. 1 m = 100 cm. 1 m = 1000 mm. 1 cm = 10 mm.

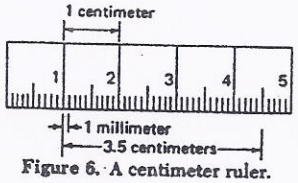


Figure 6. A centimeter ruler.

CELSIUS THERMOMETERS: We use the Celsius thermometer in the laboratory. On the Celsius scale, 0 is the freezing point of water and 100 is the boiling point of water. On a thermometer, each degree is marked by a short line, and every tenth degree is labeled.

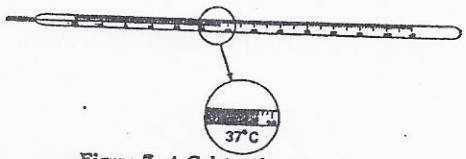


Figure 7. A Celsius thermometer.

GRADUATED CYLINDERS: The basic unit for measuring the volume of a liquid is the liter, L. 1 liter contains 1000 mL, milliliters. We use a graduated cylinder to measure the volume of liquids in the lab.

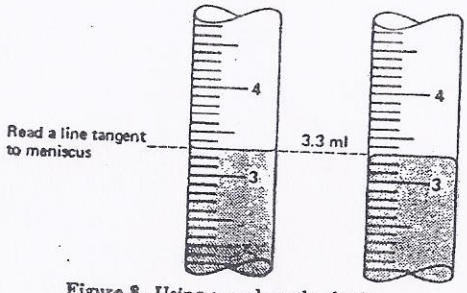
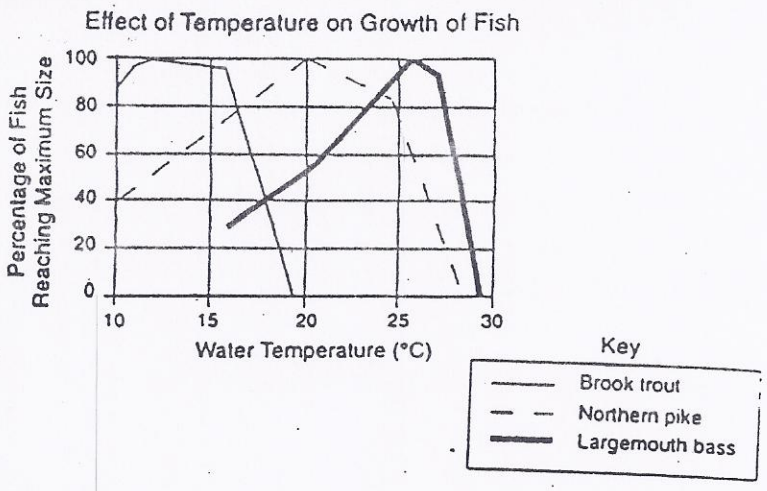


Figure 8. Using a graduated cylinder.

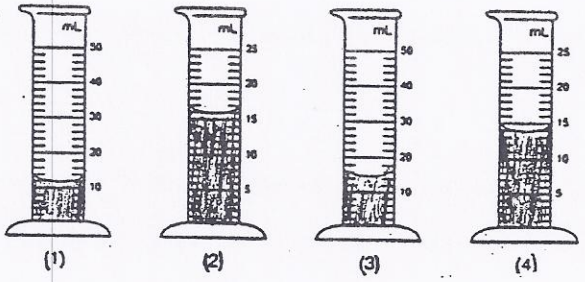
Practice questions:

1. The graph at right shows the results of an experiment. At 16°C, what Percentage of the brook trout reached maximum size? (a) 30% (b) 55% (c) 75% (d) 95%.



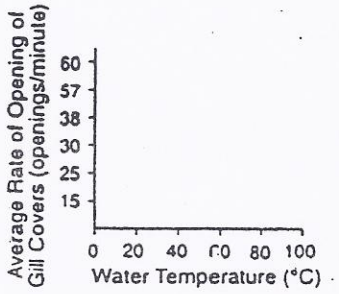
2. When a test tube of water containing E*lodea* (an aquatic plant) is placed near a bright light, the plant gives off gas bubbles. When the light is placed at different distances from the plant, the rate of bubbling is affected. The independent variable in this experiment is (a) concentration of gas in the water (b) type of aquatic plant in the tube (c) distance of the plant from the light (d) amount of water in the test tube.

3. Which graduated cylinder at right contains a volume of liquid closest to 15 mL? (1) (2) (3) (4)

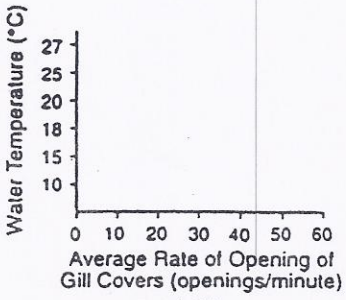


4. The data at right were obtained during an investigation involving freshwater sunfish. Which set of labeled axes should be used to present the data most clearly?

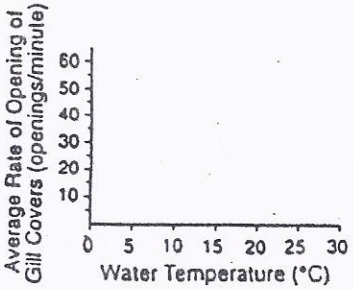
Water Temperature (°C)	Average Rate of Opening of Gill Covers (openings/minute)
10	15
15	25
18	30
20	38
23	60
25	57
27	25



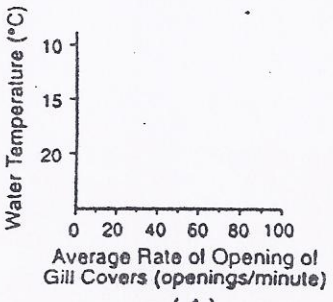
(1)



(3)



(2)



(4)

OTHER SKILLS AND BIOLOGICAL INFORMATION

Use your textbook and other references to find the answers to the following questions.

1. What is the difference between comparing and contrasting?

2. What is an inference? Give an example.

3. Distinguish between longitudinal and cross section. Use a drawing with your explanation if you wish.

4. What is symmetry?

5. What is bilateral symmetry? Give an example of an organism that has this.

6. What is radial symmetry? Give an example of an organism that has this.

7. What is asymmetry? Give an example of an organism that has this.

8. What type of symmetry does the following organisms have?
   (a) earthworm

   (b) hydra

   (c) spider

   (d) sponge (ocean)

   (e) humans

9. If the eyepiece on your microscope is a 10X lens, what objective lens are you looking through if total magnification is 440 times?

10. On a microscope, what controls the amount of light that comes through the slide?

11. What do you use to measure volume of water in the lab?

Additional Review Information

Biology	Study of living things
Chemistry	Study of matter and the changes that occur in matter
Physics	Study of how energy and matter are related
Astronomy	Study of star, planets, and galaxies
Geology	Study of rocks, minerals and the various processes that occur within Earth.
Oceanography	Application of several sciences to the study of the world's oceans.

Anatomy	Study of the structure of the body.
Botany	Study of plants
Cytology	Study of cells
Ecology	Study of the interaction of organisms with their environment.
Embryology	Study of the early developmental stages of an organism's life
Genetics	Study of how characteristics are passed from parents to offspring.
Physiology	Study of the internal functions of organisms
Marine biology	Study of living things in the oceans.
Microbiology	Study of microscopic life
Taxonomy	Classification of living things.
Zoology	Study of animals.