Name _____ Date _____ Period _____

Biology EOCT Review Sheet – The biology EOCT will be MAY 18 & 19

BIOLOGY BASICS:

- *Biology is the study of living things. It has many more specific branches such as* botany (study of plants), zoology (study of animals), ecology (study of relationships between living things and the non-living world), genetics (study of heredity), mycology (study of fungi), microbiology (study of microscopic living things), taxonomy (study of classification) and many more.
- *What do these words mean?* Unicellular, multicellular, controlled experiment, autotroph, heterotroph, prokaryote, eukaryote, asexual reproduction, sexual reproduction, homeostasis, hypothesis, theory.
- **Characteristics of Living Things:**
  - All living things are made of cells.
  - All living things are highly organized at the molecular level and also at higher levels.
  - All living things use energy.
  - All living things maintain a stable internal environment even when conditions outside their bodies change (**homeostasis**).
  - All living things grow by cell division or cell enlargement.
  - All living things reproduce organisms like themselves.
  - All living things use DNA as their genetic material

  **Note: response to stimuli, movement, multicellularity, etc are evolutionary innovations not possessed by all organisms.*
- **Cell Theory**
  - All living things are made of cells.
  - Cells are the smallest structural and functional unit of life.
  - Cells only come from other pre-existing cells.

TOPIC 1: CHARACTERISTICS OF SCIENCE

1.1 Steps of the Scientific Method

a. State the problem
b. Gather background information about the problem
c. Form a hypothesis
d. Conduct a controlled experiment
   1. Test only one variable at a time
   2. Use a **control - omit the variable being tested (independent variable)** but keep all other conditions of the experiment the same
   3. Vary the independent variable (tested/manipulated variable)
   4. Measure the affect on the dependent variable (responding variable)
e. Collect data using tables and charts
f. Analyze your data through graphs and draw conclusions

1.2 Lab Safety Protocol – review safety procedures in the Appendix of your textbook

TOPIC 2: CELLULAR BIOLOGY – *How do cells maintain life?*

2.1 Chemistry of Life (biochemistry or organic chemistry)

a. Inorganic review
b. Protons and neutrons make up the nucleus
c. Electrons orbit the nucleus in energy levels
d. Valence electrons are involved in chemical bonds (8 is the magic #)
    1. Covalent bonds form between shared electron pairs
    2. Ionic bonds form between ions (charged atoms that have gained or lost electrons)
e. Hydrogen bonds form between the H^+ of one molecule and the electronegative side of another molecule
f. Acidic solutions have more hydronium (or H^+) ion
    1. pH < 7
    2. Examples – vinegar, citric juice, sodas, stomach acid
g. Alkaline/basic solutions have more hydroxide ions (OH^-)
    1. pH > 7
    2. Examples – detergents, shampoo, drain cleaner
    3. Turns litmus paper blue
h. **All living things need water** because
    1. Its *polarity* allows it to dissolve polar covalent compounds and also ionic compounds
    2. It forms hydrogen bonds that cause *cohesion* (water molecules stick together) and *adhesion* (water molecules stick to other molecules)
    3. Water helps them to *maintain the moderate temperature* range
i. Living things are mainly composed of six elements: **carbon**, hydrogen oxygen, nitrogen, sulfur, and phosphorus.
j. Organic review: living things are composed of four main types of macromolecules

	Carbohydrate	**Lipid**	**Nucleic Acid**	**Protein**
Monomer (made of…)	Sugars like glucose	Fatty acids	Nucleotides	Amino acids
Polymer	Starches or structural carbohydrates	Triglyceride fats, steroids	DNA and RNA	Polypeptide chains, proteins
Examples	Amylase (starch) Cellulose and Chitin (structural)	Testosterone Estrogen Fat & Oils	DNA and RNA	Insulin Hemoglobin Catalase
Function	Energy storage or structural components of cells	Energy storage Chemical messengers	Genetic info that codes for the production of proteins.	Enzymes Structural components of cells

k. Enzymes
    1. Organic catalysts (proteins)
    2. Speed up chemical reactions
    3. DO NOT GET USED UP IN THE REACTION
    4. Only work with one type (shape) of substrate (reactant)
    5. Lower activation energy (energy needed to start reaction)

2.2 Cell Structures and Their Functions (most are found only in eukaryotes)

l. **Cell Membrane** (also called the phospholipid bilayer) **–** *controls what enters and leaves the cell* (selectively permeable); found in prokaryotes and eukaryotes.
m. **Nucleus** – Only found in eukaryotes; contains the DNA (control center) of the cell and is surrounded by a double membrane called the nuclear envelope.
n. **Endoplasmic Reticulum** – is a series of membranes that *transport or distribute materials throughout the cell to maintain homeostasis*.
o. Golgi Apparatus – processes and packages substances made by the cell to get them ready for export out of the cell
p. **Lys**osomes – contain digestive enzymes that **break down** food molecules, old organelles, and foreign substances that the cell has taken in
q. Vacuoles – *store* enzymes, waste products, and water
r. **Mitochondria** – where carbohydrates are broken down into ATP and carbon dioxide in the *Krebs Cycle* (aerobic respiration)
s. **Ribosome** – site where amino acids are assembled into proteins using RNA
t. **Chloroplast** – site where carbon dioxide and sunlight are converted into organic, chemical energy (glucose); found in photosynthetic eukaryotes
u. Cilia and Flagella – move cells through their surroundings or move materials over the cell surface
v. Microtubules and Microfilaments – provide internal support for the cell
w. Cell Wall – found in plant cells, bacterial cells, fungal cells, but not animal cells; this is outside the cell membrane and gives the cell support and protection

2.3 Homeostasis

x. Homeostasis is critical to cell survival because it is the fundamental way a cell responds to its environment
y. Examples of homeostatic mechanisms
    i. Cell membrane of all cells
    ii. Contractile vacuoles in many unicellular protists which pump out water that flows into the cells by osmosis
    iii. Humans have many homeostatic mechanisms, such as those that maintain blood chemistry and body temperature.
z. Water is important to homeostasis
    i. Osmosis is the movement of water across a selectively permeable membrane from a high to a low concentration.
    ii. Osmosis depends on tonicity
        1. Cells will **shrink** when put into a **hyper**tonic solution.
        2. Cells will **swell**, like a hippopotamus, when put into a **hypo**tonic solution**.** An animal cell will take in water until it bursts and dies (plasmolysis) but a plant cell is surrounded by a cell wall, so it will only take in enough water to push the cell against the cell wall.

aa. Water is polar so it can pick up and transport other polar molecules for the cell
bb. Substances enter and leave cells and their organelles by two types of processes: **active (requires energy) transport and passive transport**.

Characteristic	**Active Transport**	**Passive Transport**
Requires the cell to use energy	√	
Happens without energy use		√
Materials move from high to low concentration		√
Materials move from low to high concentration	√	
Osmosis (through the phospholipids bilayer)		√
Diffusion (through the phospholipids bilayer)		√
Facilitated **Diffusion** (through a protein channel)		√
Sodium-Potassium **Pump**	√	
Proton **Pump**	√	
Endocytosis ("eating") also phagocytosis or pinocytosis	√	
Exocytosis ("pooping")	√	

TOPIC 3: PHOTOSYNTHESIS AND RESPIRATION

Photosynthesis and cellular respiration are of critical importance to living things because they form a sequence by which energy enters and moves through the living world.

3.1 Photosynthesis is performed by plants, algae, and cyanobacteria. The chemical equation for photosynthesis is:

$$6CO_2 + 6H_2O + \text{energy from the sun} \rightarrow C_6H_{12}O_6\,(\text{glucose}) + 6O_2$$

Photosynthesis takes place in the ***chloroplasts*** of cells. There are two parts to photosynthesis: (1) the *light reactions*, which use the energy of sunlight to make two energy carriers, ATP and NADPH and (2) the *dark reactions*, which use the ATP and NADPH to fix carbon from atmospheric CO_2 to make carbohydrates. The fixation of carbon during the dark reactions is called the ***Calvin Cycle***. H_2O molecules are split during the light reactions, and O_2 molecules are released to the atmosphere. The light reactions MUST have light to happen, but the dark reactions can happen in either darkness or in the light. Plants are green because the pigment ***chlorophyll*** absorbs other colors of light and reflects green light. The best wavelengths for photosynthesis are in the red and blue range.

3.2 Respiration takes place in all living cells—not just animal cells. In respiration, the energy in the bonds of the ***glucose molecule is transformed into ATP***, which is easily used by cells to supply energy for their needed chemical reactions. Although all cells carry out respiration, not all cells can perform ***aerobic respiration***, which is the most efficient type of respiration. The chemical equation that describes cellular respiration is the opposite of the one for photosynthesis.

$$C_6H_{12}O_6\,(\text{glucose}) + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{chemical energy (ATP)}$$

Subprocess of Cellular Respiration	In what part of the cell?	Starting products?	End Products?	How many ATP produced?
Glycolysis (anaerobic)	Cytoplasm	Glucose + 2 ATP	Pyruvate (also called ***pyruvic acid*** *If converted to ***acetic acid*** and then ***Acetyl CoA*** for entry into Krebs Cycle	Net gain of **2 ATP**
Lactic Acid ***Fermentation*** (anaerobic) ---------- Alcoholic ***Fermentation*** (anaerobic)	Cytoplasm	***Pyruvic acid***	***Lactic acid*** + NAD^+ ---------- ***Ethanol*** + CO_2	***No net ATP*** are produced, but NAD^+ is regenerated
Krebs Cycle (aerobic)	Mitochondrial matrix	***Acetyl CoA***	$4CO_2$	***Net gain of 2 ATP***
Electron Transport Chain (aerobic)	Mitochondrial inner membrane	NADH + $FADH_2$	**H_2O + lots of ATP**	***Net gain of 34 ATP***

TOPIC 4: PROTEIN SYNTHESIS

4.1 Structure of DNA—In the 1950's James Watson and Francis Crick discovered how the unique structure of DNA is able to allow it to replicate itself and also to encode the instructions for making the polypeptide chains that form proteins.

a. DNA's structure is often referred to as a ***double helix*** or a twisted step ladder.
b. DNA is a polymer built of monomer subunits called ***nucleotides.*** A nucleotide consists of a *sugar, a phosphate group,* and one of four *nitrogen bases*: adenine or guanine (larger purines) thymine and cytosine (smaller pyrimidines). The sides of the DNA chain are formed from alternating molecules of the sugar deoxyribose and phosphate groups. The nitrogen bases form the rungs of the DNA ladder.
c. ***Adenine*** *can only pair with* ***thymine*** and ***guanine*** *can only pair with* ***cytosine*** *(in DNA)*—this is referred to as Chargaff's Rules (also called base-pairing rules)
d. When DNA *replicates*, each original side chain is used as a template to make the other half of the DNA molecule. This is called ***semiconservative*** replication.
e. The structure of RNA molecules differs from DNA in several important ways:

	DNA	RNA
Name of 5-carbon sugar in nucleotide units	***Deoxyribose***	***Ribose***
How many chains in molecule?	2	1
Names of Nitrogen Bases in nucleotides	Adenine, ***thymine***, guanine, cytosine	Adenine, ***uracil***, guanine, and cytosine

4.2 Protein synthesis involves DNA molecules and also three types of RNA molecules: messenger RNA (m-RNA), ribosomal RNA (r-RNA), and transfer RNA (t-RNA) Protein synthesis takes place in two stages: *transcription* and *translation*.

	Transcription	**Translation**
Location in cell?	In the *nucleus*	In the *cytoplasm* on *ribosomes*
Process?	One DNA chain is used as a template to make a m-RNA chain	An m-RNA chain attaches to a ribosome. As the ribosome moves along the m-RNA chain, t-RNA molecules bring amino acids to build a polypeptide chain
Beginning materials	*DNA nucleotides*	*m-RNA chain*, ribosome, t-RNA molecules attached to amino acids
End products	*m-RNA* strand	Polypeptide chain or *protein*

Enzymes will not work properly if they do not have the correct three dimensional shapes—they would be unable to bind to their substrate molecules. The shape of enzymes is determined by the sequence of their amino acids, which is encoded in the DNA of the cell.

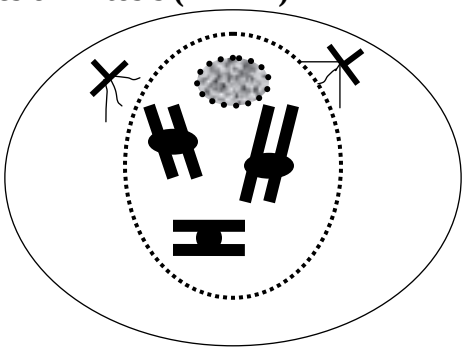
TOPIC 5: GENETICS (CELL DIVISION)

5.1 Phases of the cell cycle

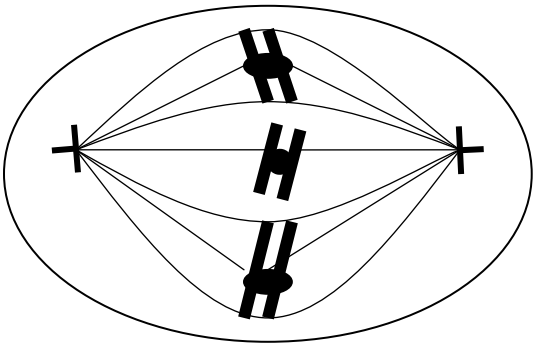
G_1 = Growth 1 – cells spend most of their lives in this stage (growth & function)
S = Synthesis – replication occurs (DNA is copied)
G_2 = Growth 2 – cells continue to grow and other cell organelles are copied
M = ***Mitosis*** – division of the nucleus (prophase, metaphase, anaphase, telophase)
C = ***Cytokinesis*** – division of the cytoplasm (different in plant v. animal cells)

**Phases G_1, S, and G_2 together make up the phase called Interphase, where the cell is not dividing. It is carrying out its normal cellular activities and preparing for division during Interphase.*

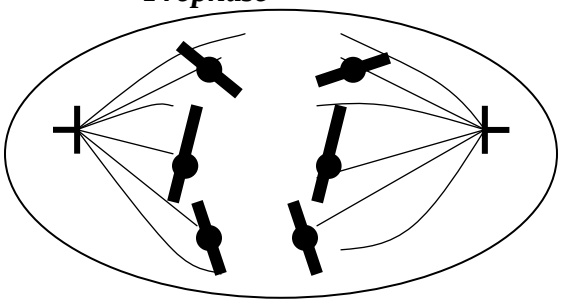
5.2 **Phases of Mitosis (PMAT)**



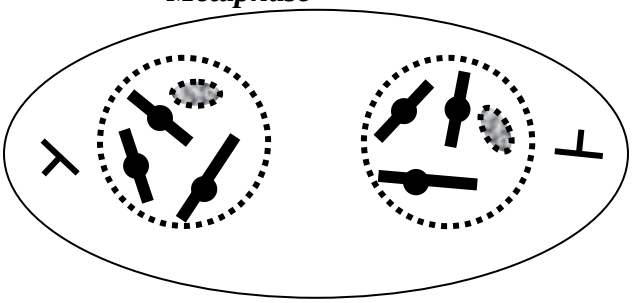
Prophase



Metaphase



Anaphase



Telophase

5.3 Comparison of Mitosis and Meiosis

	Mitosis	**Meiosis**
Purpose of This Type of Cell Division	**Growth, tissue repair, *asexual* reproduction**	**Production of *gametes* for *sexual* reproduction**
Parent Cell Chromosome Number	Diploid (pairs)	Diploid (pairs)
Daughter Cell Chromosome Number	***Diploid (pairs)***	***Haploid (half of pair)***
Number of Daughter Cells Produced	**2**	**4**
Number of Times DNA is Copied	1	1
Number of Cell Division	1	2
Comparison of Mother Cell and Daughter Cells	***Genetically Identical***	***Genetically Different***
Does shuffling of DNA occur?	NO	YES
Does crossing-over happen?	NO	YES

TOPIC 6: MENDELIAN GENETICS

6.1 Vocabulary terms:

a. **Heredity is the passing on of traits from parents to offspring.**
b. Genetics is the branch of biology that studies heredity.
c. Gene is a piece of DNA that codes for the production of a protein.
d. Trait is a *characteristic* that is inherited, like eye color or skin color.
e. **Dominant** traits are *expressed* if only one allele is present and can mask the presence of recessive alleles.

f. **Recessive** traits are *masked* by the presence of a dominant allele (only expressed when homozygous recessive).
g. Alleles are *alternative forms* of a gene that produce different choices for a trait, such as brown eyes or blue eyes.
h. **Genotype** is the *combination of alleles* present in an organism.
i. **Phenotype** is *outward appearance* of an organism: the allele that is expressed.
j. **Homozygous** means that both alleles for a trait are the *same*—either both dominant or both recessive
k. **Heterozygous** means that the two alleles for a trait are *different*
l. Incomplete dominance is an inheritance pattern where the phenotype of a heterozygous organism is an intermediate between the dominant and the recessive traits—*neither allele is dominant and capable of masking* the presence of the other.
m. Sex-linked traits are *controlled by genes located on the X chromosome*. They are *passed from mother to son*. Hemophilia and red-green colorblindness are examples in humans.
n. Multiple alleles refer to traits that *have more than one possible allele*. In humans, *blood type* is such a trait: A, B, and O alleles can combine to produce four possible phenotypes: Type A, type B, Type O and Type AB.

6.2 Mendel described 3 laws of inheritance:

a. Law of Dominance – The presence of a *dominant allele can mask* the presence of a recessive allele.
b. **Law of Segregation** –Because each diploid organism has two alleles for each trait, it *can produce two types of gametes*, one with each allele.
c. **Law of Independent Assortment**—genes for different traits are inherited independently of each other.

Use a Punnett Square to predict the offspring of a ***heterozygous*** tall pea plant with a ***homozygous*** short plant. Tall is dominant over short in peas.

Parent genotypes _____
Offspring genotypes _____
Offspring phenotypes _____

TOPIC 7: PATTERNS OF INHERITANCE

7.1 Vocabulary Terms:

a. mutation – a *change in the DNA* of an organism that can be passed on to offspring
b. nondisjunction – when *chromosomes don't separate* from each other correctly
c. monosomy – in diploid organisms, when *one chromosome of a pair is missing*
d. **trisomy – in diploid organisms, when there is *an extra chromosome* of a pair**
e. autosome – any chromosome that is *not a sex chromosome*

7.2 Tell how each of the following conditions is inherited.

a. hemophilia – sex-linked recessive trait passed from a mother who is a carrier to sons because allele is on the X-chromosome
b. Huntington's disease – an autosomal dominant gene
c. **Down Syndrome – Trisomy 21 in humans causes Down Syndrome**
d. Duchenne muscular dystrophy – sex-linked recessive gene
e. colorblindness –sex-linked recessive traits

**** Sex-linked recessive traits are passed from a mother to her sons because the defective allele is on the X-chromosome and sons get their only X chromosome from their mother*

TOPIC 8: GENETIC ENGINEERING

8.1 Genetic engineering is a new field of biology in which *genes can be transferred from one organism to another*.

8.2 This field has led to the development of oil spill eating bacteria, bacteria that make human insulin for diabetics, and many disease-resistant crops.

8.3 Vocabulary Terms:

a. Gene splicing – inserting source DNA into another organism's DNA
b. Plasmid – circular bacterial DNA
c. Recombinant DNA – DNA formed by combining 2 different DNA sources
d. Cloning vector – an organism or virus that makes multiple copies of recombinant DNA
e. Restriction enzyme & sticky ends – cuts DNA and leaves open DNA nucleotides
f. Gel electrophoresis – technique to separate different lengths of DNA segments
g. Polymerase chain reaction (PCR) – technique for making lots of copies of DNA
h. DNA fingerprinting – a unique picture of one's DNA made by gel electrophoresis

TOPIC 9: THE THEORY OF EVOLUTION

9.1 Origin of the Universe – Big Bang theory

9.2 Origin of Life on Earth

a. Theory of spontaneous generation of macromolecules from inorganic molecules because conditions on the early Earth was very different from present conditions
b. Reducing atmosphere instead of an oxidizing one (no free atmospheric oxygen)
c. Many small molecules dissolved in "organic soup"
d. Lots of volcanic activity and electrical storms to provide energy
e. Miller-Urey experiment modeled early Earth conditions and produced macromolecules
f. Production of coacervates and microspheres with cell-like structures

9.3 Non-working Theory of Evolution through *inheritance of acquired traits – Lamarck*

g. Giraffes have long necks because their ancestors *had to stretch* to reach high leaves
h. Ducks have webbed feet because their ancestors *stretched* their toes
i. Traits *acquired during an organism's lifetime were passed to their offspring*
j. <u>This theory has been proven wrong!</u>

9.3 Current Working Theory of Evolution through *Natural Selection - Darwin*

a. Evidence that *species change over time*
   i. Fossil evidence
   ii. Genetic evidence in DNA, amino acid sequence comparisons
b. Details of Darwin's theory of natural selection
   i. **More offspring are produced than can survive—**there is a struggle for survival
   ii. Offspring are genetically different
   iii. Those offspring with traits that give them an advantage for survival are **more likely to survive** long enough to reproduce and pass on their traits
   iv. Over time, the <u>"advantageous" genes will become more common in the gene pool</u>
   v. Changes in the environment cause changes in which genes are selected for or against
c. <u>Macro</u>-evolution is evolution on a <u>large scale</u> over long time periods and involves the appearance of a new species
d. <u>Micro</u>-evolution is evolution on a <u>small scale</u> over a short time period and shows a change on the frequency of a gene within a population
e. <u>Divergent evolution</u> is the most common evolutionary pattern. It is when <u>two related species become less alike</u> over time.
f. <u>Convergent evolution</u> is when <u>two unrelated species independently develop a characteristic that appears to be the same</u>, such as the eye of a human and the eye of an octopus.

TOPIC 10: CLASSIFICATION

10.1 The current system of two-word names was developed by Linnaeus and is called *binomial nomenclature*.
   a. Every species has a two word *scientific name* in latin.
   b. The scientific name is composed of the organism's genus first and then the species.
   c. The scientific name of an organism is either underlined or written in Italics. The genus is always capitalized and the species is never capitalized.

10.2 There are **6 kingdoms: *Archaebacteria, Eubacteria, Protista, Fungi, Plantae, and Animalia***

10.3 Organisms are further grouped from kingdom into phylum, class, order, family, genus, and species, *getting more and more similar*.

10.4 Organisms in the same species are so closely related that they can produce fertile offspring.

*10.5 **Be able to use a dichotomous key to classify organisms.*

10.6 Kingdom characteristics

	Archaebacteria	**Eubacteria**	**Protista**	**Fungi**	**Plantae**	**Animalia**
Prokaryote or Eukaryote?	Prokaryote	Prokaryote	Eukaryote	Eukaryote	Eukaryote	Eukaryote
Unicellular or Multicellular?	Unicellular	Unicellular	Either	Either	Multicellular	Multicellular
Metabolism	Chemoautotrophs, Methanogens, Thermoacidophiles, Heterotrophs	Heterotrophs, Photosynthetic autotrophs,	Heterotrophs, Photosynthetic autotrophs	Heterotrophs	Photosynthetic autotrophs	Heterotrophs
Cell Wall?	Yes; peptidoglycan not present	Yes; peptidoglycan present	sometimes	Yes; made of chitin	Yes; made of cellulose	no
Reproduction	Binary fission (asexual)	Binary fission	Binary fission Conjugation Mitosis	Sexual and asexual reproduction	Sexual and asexual reproduction	Sexual and asexual reproduction
Representative organism	Methane-producing bacteria in the guts of cows	Cyanobacteria Streptococcus Bacillus	Amoeba, Paramecium, Euglena	Yeast, Mushrooms	Pine tree Daisy	Human Crayfish Sponge

TOPIC 11: VIRUSUS

11.1 Characteristics
   a. are not alive.
   b. are not made of cells
   c. cannot carry out metabolic activities unless they are in a host cell.

11.2 Viruses consist of a piece of genetic material (either DNA or RNA) and a protein coat.

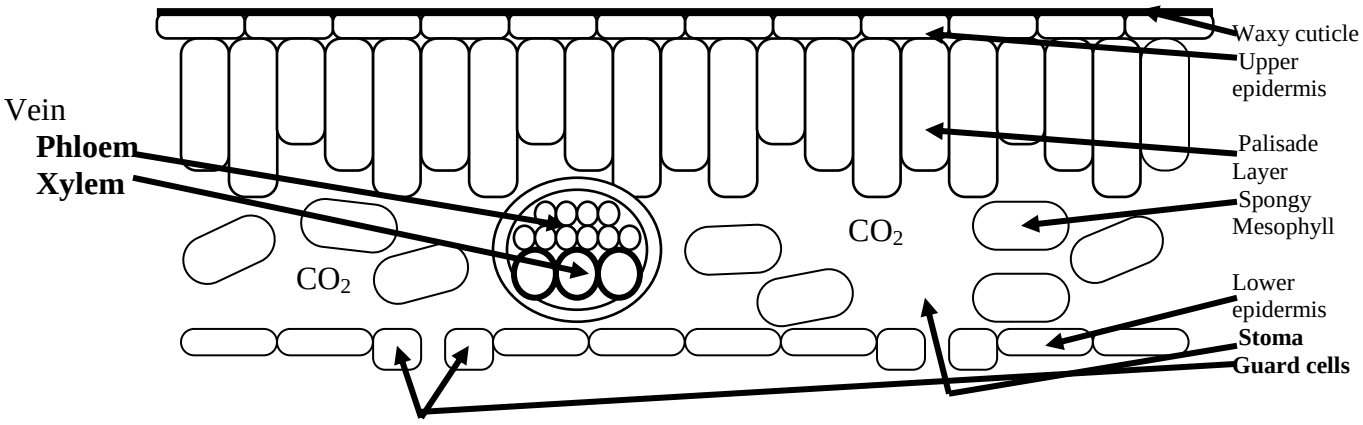
11.3 Viruses cannot be treated with antibiotics because they are not alive.

TOPIC 12: PLANT ADAPTATIONS

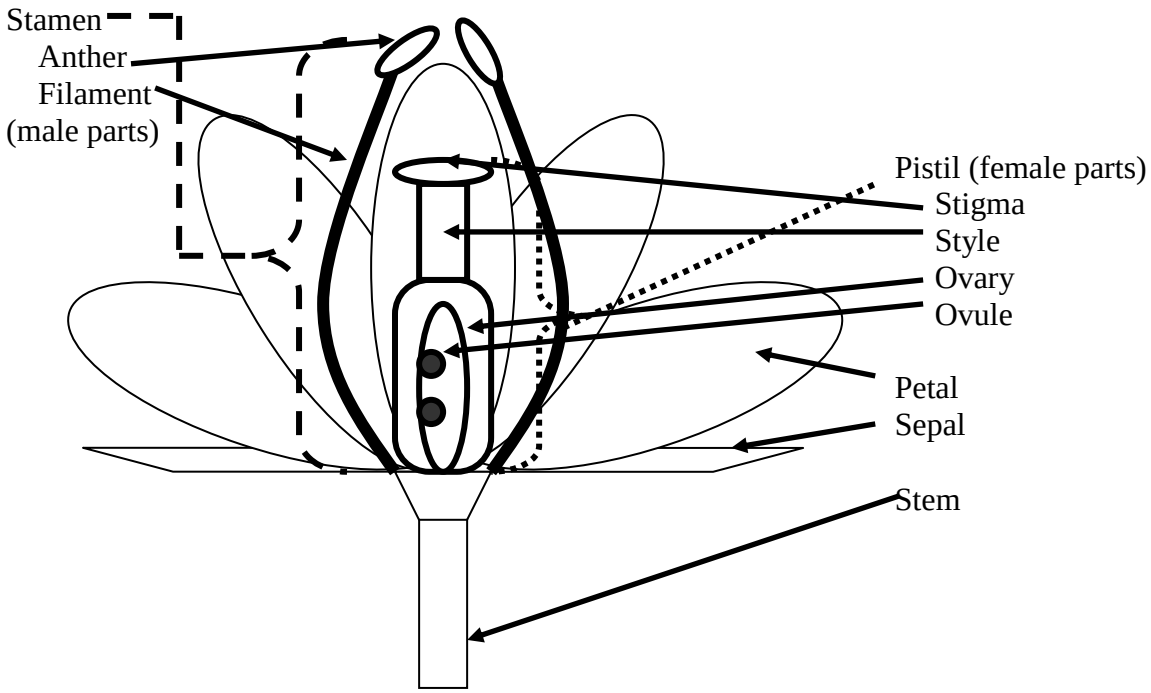
12.1 Plants can be *classified according to their reproductive and vascular structures*.

	Non-vascular plants	**Vascular plants – spores**	**Vascular plants - seeds**
Presence of vascular tissue	***No***	***Yes***	***Yes***
Reproductive strategy	Sporophytes or gametophytes	Sporophytes or gametophytes	Cones (gymnosperms) Flowers (angiosperms)
Example	***Moss, liverworts***	***Ferns***	***Pine trees, roses***

12.2 Leaf structure



12.3 Flower structure



TOPIC 13: ANIMAL ADAPTATIONS

13.1 Major evolutionary adaptations

a. symmetry (asymmetry, radial, bilateral)
b. segmentation (anterior – head/ceph "brain", mid – abdomen, posterior – tail and anus)
c. jointed appendages (specialized limbs)
d. jaws
e. specialized organs and systems

	Jawless Fish	Cartilaginous Fish	Bony Fish	Amphibian	Reptiles	Mammals	Birds
Major evolutionary advance	First vertebrates, cranium, closed circulatory system, with ventral heart	Paired fins Scales Jaws streamlined bodies	Swim bladder Operculum Bony skeleton	Lungs Double loop circulatory system	Amniotic egg	Mammary glands, larger brain size, specialized teeth	Flight Hollow bones, air sacs as extensions of lungs, crop, gizzard instead of teeth
Body covering	Thin mucous-covered skin	Tooth-like scales	Flat overlapping scales	Thin moist skin	Thick skin with Scales	Thick skin with Hair	Thick skin with Feathers
# chambers in heart	2	2	2	3	3 ½	4	4
Endotherm or ectotherm	Ectotherm	Ectotherm	Ectotherm	Ectotherm	Ectotherm	Endotherm	Endotherm
Respiration	Gills	Gills	Gills	Lungs, skin	Lungs	Lungs	Lungs, air sacs
Representative animal	Lamprey, hagfish	Shark, skate, ray	Trout	Frog, salamander	Lizard, snake, tortoise	Kangaroo, rat, lion, human	Parrot, robin

TOPIC 14: ECOLOGY

14.1 Levels of organization in the environment from most specific to most general:

a. A group of organisms of the same species in the same place at the same time is called a ***population***.
b. A group of different populations in the same place at the same time is a ***community***.
c. A group of interacting communities and the nonliving parts of their environment is called an ***ecosystem***.
d. A group of ecosystems compose the largest ecological unit, the ***biosphere***.
e. ***Biotic*** factors in an ecosystem are the living things within that ecosystem.
f. ***Abiotic*** factors in an ecosystem are the nonliving parts of the ecosystem: water, land, atmosphere, for example.

14.2 Relationships between organisms within ecosystems

a. Organisms can be related in ***food chains*** and food webs depending on what eats what.
b. Food chains and ***food webs*** trace the flow of energy through the ecosystem.
c. An organism's ***habitat*** is where it lives.
d. An organism's ***niche*** is what its particular role is within its ecosystem.
e. Organisms may be related in a variety of ways: ***Predator-prey, Commensalism, Parasitism, Mutualism***

14.3 **Energy flow** through ecosystems

a. Energy for the living things on Earth comes from the Sun.
b. Energy pyramids are quantitative representations of available energy at each level of the pyramid.

c. Energy pyramids consist of ***producers***, ***primary consumers, secondary consumers, and tertiary consumers.***
d. Energy pyramids rarely have more than 4 levels because at each level only 10% of the previous level's energy is available to the next level (that's less energy to support organisms in the next trophic level).

14.4 **Major biomes** of the world

Biome	Average yearly temperature range	Average yearly precipitation	Soil	Vegetation
Tundra	-26°C to 12 ^{o}C	Less than 25 cm	Moist thin topsoil over permafrost; **nutrient-poor**	Mosses, lichens, dwarf woody plants
Tiaga	-10°C to 14 ^{o}C	35-75 cm	**Low in nutrients**, very acidic	Needle-leaved **evergreen** plants
Temperate deciduous	6°C to 28°C	75-125 cm	Moist, **moderate nutrient levels**	Broad-leaf trees and shrubs
Temperate grassland	0°C to 25^{o+}C	25-75 cm	Deep layer of topsoil, **very rich in nutrients**	Dense, tall grasses in moist areas, short clumped grasses in drier areas
Desert	7°C to 38°C	Less than 25 cm	Dry, often sandy, **nutrient-poor**	Succulent plants and scattered grasses
Savanna	16°C to 34 ^{o}C	75-150 cm	Dry, thin topsoil, porous, **nutrient-poor**	Tall grasses, scattered trees
Tropical rain forest	20° C to 34^{o-}C	200-400 cm	Moist, thin topsoil, **nutrient-poor**	Broad-leaf evergreen trees and shrubs

14.5 **Man's effect on the ecosystem** and possible solutions to the following problems
a. global warming
b. acid rain
c. Air pollution
d. water pollution
e. depletion of non-renewable resources