Name:_____Date:_____Period:____

The Big Picture: A Review of Biology

Cells and their Processes

Organic Compounds

- A compound is a combination of 2 or more atoms
- An organic compound is a compound that contains carbon atoms that have combined with each other
- An inorganic compound is a compound with no combination of carbon atoms
- 6 most common elements in organic molecules: SPONCH - sulfur, phosphorus, oxygen, nitrogen, carbon, hydrogen (or CHONPS for remembering them in order of abundance).

The Four Types of Organic Compounds (The Molecules of Life)

- Carbohydrates: Sugars used for short term energy
- Lipids: Fats and oils used for long term energy
- Proteins: Made up of amino acids; used for construction materials and chemical reactions in the body
    - Enzymes: Special types of proteins that speed up chemical reactions in the body but are not changed by the reactions
- Nucleic acids: DNA and RNA; contains genetic information; made up of nucleotides

Cells

- A cell is the smallest unit that is alive and can carry on all the processes of life
- Cells make up organisms (living things)
    - Unicellular organisms are made up of 1 cell
    - Multicellular organisms are made up of many cells
- Cells contain organelles, which are specialized compartments that carry out a specific function
- Types of cells
    - Eukaryotic cells contain a nucleus: animal, plant, fungi, and protist cells
    - Prokaryotic cells contain no nucleus, such as bacteria

Animal Cells

- Organelles include
    - Nucleus: controls cell activities
    - Cell membrane: controls what enters and leaves the cell.
    - Endoplasmic reticulum (ER): tunnels for compounds to move through the cell
    - Golgi body: processes and stores protein
    - Ribosomes: make proteins
    - Mitochondria: makes energy for the cell
    - Lysosome: has enzymes that digest waste and old organelles
    - Cytoplasm: fills the empty space of the cell
    - Vacuole: stores food, water, and waste – provides turgor in a plant cell!
    - Centrioles: help in cell division and are only found in animal, not plant, cells

Plant Cells

- Usually rectangular
- Organelles include
    - Everything that an animal cell has (except lysosomes and centrioles) plus more …
    - Chloroplast: traps sunlight to make food for the plant
    - Cell wall: provides structure and protects the cell

Bacterial cells

- Smaller and simpler than plant or animal cells. They are unicellular and have NO nucleus
- Have a single closed loop of DNA, cell wall, cell membrane, cytoplasm and ribosomes
- Some have a capsule (shell for protection), pili (short hair like structures to hold onto host cells), and flagella (whip like structure for movement)

Viruses

- Noncellular entities with a simple structure and cannot reproduce on their own
- Much smaller than a bacterial, animal, or plant cell
- Parts of a virus
    - Nucleic acid inside the virus – can be either DNA or RNA
    - Capsid: protein coat to protect the nucleic acid inside the virus
    - Spikes: help the virus to attach to host cells
- There is much controversy on whether viruses are alive or not because they cannot reproduce on their own. They do not have the organelles needed to reproduce
    - Viruses must invade a living cell and use the cell's tools to reproduce
    - Host cell: An animal, plant, or bacterial cell that is invaded by a virus
    - Viruses harm and/or kill the host cell that they infect

Cell membrane

- Made up of molecules called phospholipids and special proteins
- Phospholipid bilayer is the 2 layers of phospholipids that make up the cell membrane
- Cell membrane is fluid, which means that it is constantly flowing and moving over the cell
- Cell membrane is selectively permeable, which means that it allows small compounds, but not large ones, to pass right through
- There are different ways that materials are transported across the cell membrane
    - Passive transport: requires no energy
        - Diffusion: compounds move from high to low concentration
        - Osmosis: diffusion of water across a selectively permeable membrane
    - Active transport: requires energy
        - Endocytosis: large compound are brought into the cell
        - Exocytosis: large compounds are exported out of the cell
- Types of solutions
    - Hypotonic solutions cause water to move into the cell so the cell swells up
    - Hypertonic solutions cause water to move out of the cell so the cell shrivels up
    - Isotonic solutions cause no net movement of water into or out of the cell

Photosynthesis

- Process by which organisms use energy from sunlight to make their own food (glucose)
- Glucose is a simple sugar
- Photosynthesis occurs in the chloroplasts of plant cells and in some protists
- Chloroplasts have a green pigment called chlorophyll
- Steps of photosynthesis
    - 1. Light-dependent reaction: chlorophyll in the chloroplasts absorbs sunlight
    - 2. Light-independent reaction (Calvin Cycle): The energy from the sunlight is used to make glucose
- Light energy is completely changed into chemical energy (glucose)
- Chemical equation for photosynthesis: $6CO_2 + 6H_2O$ + light energy $\rightarrow$ $C_6H_{12}O_6 + O_2$

Cellular Respiration

- Process that breaks down glucose in order to make energy for an organism
- ATP: compound that stores energy in an organism – useful energy for the cell!
- Occurs in the mitochondria of a eukaryotic cell
- Two types of cellular respiration
    - Aerobic respiration: requires oxygen to occur
        - Mostly happens in animals and plants
        - There are 3 steps in aerobic respiration
            - Step 1 is glycolysis: glucose is cut in half
            - Step 2 is the Kreb's Cycle (citric acid cycle): glucose halves get electrons chopped off of them

- Step 3 is the electron transport chain: electrons combine with oxygen and are used to make a lot of **ATP**
- Chemical equation for respiration (unbalanced): $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$ + ATP energy
- Aerobic respiration is the opposite of photosynthesis

- Anaerobic respiration: does not require oxygen to occur
  - Mostly happens in bacteria and yeast
  - Also called fermentation
  - Makes less ATP than aerobic respiration

Chromosomes

- DNA strands in the nucleus that contain the directions on how to make and keep an organism alive
- Made up of genes, which are traits of an organism
- Cells will die if their DNA is damaged or removed
- Humans have mostly diploid cells, which means that our cells have 2 of each type of chromosome
  - Homologous chromosomes are 2 of the same type of chromosome
  - We have 23 types of chromosomes – 22 autosomes + sex chromosomes (XY)
  - We have 46 chromosomes in all,
    23 chromosomes from mom + 23 chromosomes from dad
- Human gametes (sperm and egg cells) are haploid cells, which means that they have 1 of each type of chromosome
  - Sperm and egg cells have 23 chromosomes in all
- Autosomes: Chromosomes that do not determine gender
- Sex chromosomes: Chromosomes that determine gender
  - Girls are XX, Boys are XY
- Karyotype: ordered picture of an organism's chromosomes
  - Healthy individuals have 2 of each type of chromosome
  - Individuals with Down Syndrome have 47 chromosomes - three #21 chromosomes
  - Individuals with Turners Syndrome are female with 45 chromosomes –XO
  - Individuals with Klinefelter Syndrome are male with 47 chromosomes – XXY

Cell Cycle

- The cell cycle is the phases in the life of a cell
  - 1. M phase: Mitosis (cell division) occurs
  - 2. G1 phase: Cell grows
  - 3. S phase: DNA synthesis (chromosomes are copied)
  - 4. G2 phase: Cell grows
  - 5. M phase begins again
- Chromosomes must be copied before mitosis so that new cells receive the same chromosomes found in the old cells

Mitosis

- Division of a cell into 2 identical cells
- Before mitosis: Chromosomes have copied themselves (DNA replication)
  - Sister chromatids: original chromosome and its exact copy are attached to each other
- Phases of mitosis (**PMAT**)
  - 1. Prophase: Nuclear membrane falls apart and spindle fibers start to form
  - 2. Metaphase: Sister chromatids line up along the middle of the spindle fibers
  - 3. Anaphase: Sister chromatids separate and move to opposite ends of the cell
  - 4. Telophase: Spindle fibers break down and new nuclear membrane forms around each set of chromosomes
    - Cytokinesis occurs when the cytoplasm actually divides, forming two new cells

Genetics

Meiosis

- Cell division that produces gametes (sex cells), such as sperm and egg cells
- Fertilization: Process of an egg and a sperm cell combining to produce a zygote
  - Zygote: baby that is only 1 cell big
  - Egg cell (23 chromosomes) + Sperm cell (23 chromosomes) = Baby (46 chromosomes)
- Steps in meiosis
  - 1. Before meiosis:
    - Each chromosome doubles (DNA replication)
    - 2 chromosomes of the same type (homologous chromosomes) come together to make a chromosome pair
    - This gives 4 chromosomes stuck together (tetrad)
  - 2. Meiosis I: Chromosome pairs separate into two new cells
  - 3. Meiosis II: Sister chromatids separate into 4 new cells
- In meiosis, one cell becomes four different cells (gametes); but in mitosis one cell becomes two identical cells

DNA

- Deoxyribonucleic acid
- Makes up the chromosomes in the nucleus and never leaves the nucleus
- A chromosome is a chain of different genes
- DNA has a double helix shape
- Has four types of bases: adenine (A), guanine (G), thymine (T), cytosine (C)
- A binds T and G binds C
- DNA is complementary, which means that the bases on one strand match up to the bases on the other strand
  - For example: Strand 1: ATG CCT GAC
    Strand 2: TAC GGA CTG
- Semi-conservative replication is the process by which DNA copies itself and each new piece of DNA is made up of 1 old strand and 1 new strand

RNA

- Ribonucleic acid
- RNA is a copy of DNA that goes out into the cytoplasm to tell the cell what to do in order to stay alive
- RNA is single stranded and has uracil (U) rather than thymine (T)
  - U binds A and G binds C
  - If the DNA is: ATG CCA AAG
    Then the RNA will be: UAC GGU UUC

Using DNA to make protein

- 1. Transcription: DNA in the nucleus is used to make messenger RNA (mRNA)
  - DNA has all the directions the cell needs to live
- 2. mRNA moves out into the cytoplasm
  - mRNA carries the directions to the ribosome
- 3. Translation: mRNA attaches to a ribosome and directs the production of a protein
  - Every 3 bases in mRNA is called a codon and codes for 1 amino acid
  - Amino acids are carried to the ribosome by transfer RNA (tRNA)

Mutations

- A mutation is a change in a gene (DNA)
- If the mutation happens in a body cell, it only affects the organism that carries it
- If the mutation happens in a sex cell, it can be passed on to offspring
- Mutations can be
  - harmful if they reduce an organism's chances for reproduction or survival
  - helpful if they improve an organism's chances for survival
  - neutral if they do not produce an obvious changes in an organism

- lethal if they result in the immediate death of an organism
- Mutations can occur spontaneously or be caused by a mutagen, which is a factor in the environment like UV and chemicals

Mendelian Genetics

- Gregor Mendel is an Austrian monk credited with beginning the study of genetics
- Genetics is the study of heredity
- Humans have 2 genes for every trait
  - Alleles: Different forms of a single gene, like blue and brown are two eye color alleles
- Dominant gene: "Stronger" of 2 genes and shows up in the organism
  - Represented by a capital letter
  - B is the dominant gene for brown eyes
- Recessive gene: "Weaker" of 2 genes and only shows up when there is no dominant gene present
  - Represented by a lowercase letter
  - b is the recessive gene for blue eyes
- Homozygous (purebred): When 2 genes are alike for a trait
  - BB is homozygous for brown eyes, bb is homozygous for blue eyes
- Heterozygous (hybrid): When 2 genes are different for a trait
  - Bb is heterozygous for brown eyes
- Mendel's Law of Segregation states that the 2 genes we have for each trait get separated from one another when we make egg and sperm cells
- Mendel's Law of Independent Assortment states that the gene for one trait is inherited independently of the genes for other traits
  - Only true when the genes are on different chromosomes!

Punnett Squares

- Punnett squares are charts that are used to show the possible gene combinations in a cross between 2 organisms
  * Let's say that B is the dominant gene for brown eyes and b is the recessive gene for blue eyes*
- Genotype: The genes of an organism (Bb)
- Phenotype: The physical appearance of an organism (brown eyes)

Parents
Bb x bb

	B	b
b	Bb	bb
b	Bb	bb

Offspring genotype
50% Bb
50% bb

Offspring phenotype
50% Brown eyes
50% blue eyes

Parents
Bb x Bb

	B	b
B	BB	Bb
b	Bb	bb

Offspring genotype
25% BB
50% Bb
25% bb

Offspring phenotype
75% brown eyes
25% blue eyes

Human Genetics

- Multiple alleles are three or more alleles that exist for a single gene
  - For example, A, B, and O are the multiple alleles for blood type
  - The possible blood types are A, B, AB, and O
    - You can be A+ or A-, B+ or B-, AB+ or AB-, O+ or O- depending on whether your blood cells have a special Rh protein
- Codominance occurs when 2 dominant genes are expressed and both genes are seen in the organism
  - AB blood is codominant, a cat with black and white spots is codominant, a roan horse is codominant
- Incomplete dominance occurs when both genes are expressed and blended together in the organism

- If the red flower color gene (R) is mixed with the white flower color gene (r) then the offspring will be pink (Rr)

- A polygenic trait is a trait that is controlled by more than one pair of genes, like skin color and height
- A sex-linked trait is a trait that is found on the X chromosome, such as colorblindness
  - Females are XX so have 2 copies of sex-linked traits
  - Males are XY so have 1 copy of sex-linked traits
  - More common in males

Anatomy and Physiology

Levels of Organization

- Cells → Tissues → Organs → Organ systems → Organism
- 4 tissue types: Epithelium, Connective, Muscle, and Nerve
- Relationship of structure to function is key!
- Homeostasis allows the body to perform its normal functions. The body's systems interact to maintain homeostasis.
- Physiological feedback loop: Sensor → Integrator → Effector
  Thermoregulation: Sensor (skin) → Integrator (brain) → Effector (muscles or sweat glands in skin)
- Communication between cells is required for coordination of body functions. For example, nerves communicate with electrochemical signals; hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells (ex) gap junctions in animal cells and plasmodesmata in plant cells.

Skeletal/Muscular System

- Bones provide support and protection
- Bones produce both red and white blood cells.
- Cartilage is a tough, elastic, connective tissue found in different parts of the body, such as joints, outer ear, and larynx. Cartilage is a major part of the embryonic and young vertebrate skeleton; it is changed into bone as you grow.
- Ligaments link bones
- Tendons attach muscle to bone
- 3 types of muscle: Skeletal, Smooth, and Cardiac
- Skeletal muscles are voluntary and pull on bones to produce movement. Skeletal muscles are always found in antagonistic pairs.
- Smooth muscle is involuntary. It lines the GI tract.
- Cardiac muscle is involuntary and makes up the heart. It is highly specialized for communication.

Nervous System

- The nervous system controls communication between different parts of the body and the body's interactions with the environment.
- The basic unit of the nervous system is the neuron.
- 3 main parts of the neuron: dendrites, cell body, axon.
  1. Dendrites receive impulse
  2. Cell body contains the nucleus
  3. Axons carry impulse away
- Central nervous system: brain and spinal cord
  Peripheral nervous system: cranial nerves + spinal nerves
- Sensory neurons carry information from the environment to the spinal cord/brain (CNS)
- Motor neurons carry information from the spinal cord/brain (CNS) to the effectors: muscles or glands

Circulatory System

- The circulatory system contains: the heart, blood vessels, and blood
- The heart has 4 chambers: 2 upper atria and 2 lower ventricles. The atria are the receiving chambers. The ventricles are the pumping chambers. The aorta sends blood to the body.
- 3 main blood vessel types: Arteries, capillaries, and veins
    1. Arteries carry blood away from heart
    2. Veins return blood to the heart
    3. Capillaries are the site of gas and nutrient/waste exchange between the blood and cells
- Kidneys remove nitrogenous wastes from blood.
- Liver removes many toxic compounds from blood.

Respiratory System

- The respiratory system provides exchange of oxygen and carbon dioxide.
- Nose → pharynx → larynx → trachea → bronchi → bronchioles → alveoli
- Nose: mucus and cilia to cleanse, filter, and warm air.
- The pharynx is your throat. It is a part of the respiratory & digestive system.
- The larynx is your voice box and is at the top of the trachea.
- The trachea is your windpipe. It branches into your lungs via left and right bronchi. Bronchi further branch into bronchioles which keep branching and eventually end at very tiny alveoli.
- The alveoli are the most important part of the bronchial tree: Lots of surface area for gas exchange!
- Alveoli are surrounded by capillaries.

Digestive System

- The digestive system consists of the mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum, and anus.
- The digestive system converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.
- Mouth begins both mechanical (chewing) and chemical (saliva has enzymes to break down starch) digestion
- Stomach continues mechanical and chemical digestion. It also begins absorption (alcohol).
- Most absorption of nutrients happens in the small intestine (jejunum and ileum). It is very long and has villi/microvilli for lots of surface area.
- Liver secretes bile (emulsify fats) into the small intestine (duodenum). Pancreas secretes pancreatic juices (lots of enzymes) into the duodenum.
- Reabsorption of water happens in the large intestine.
- Feces are expelled through the rectum out the anus.

The Theory of Evolution

Evolution

- Evolution is a change in a species over time
- The theory of evolution was stated by Charles Darwin and is based on natural selection
- Natural selection states that organisms with traits well suited to an environment are more likely to survive and produce more offspring than organisms without these favorable traits
- Biodiversity: Organisms become very different from each other as they evolve and become better suited to their environments
- The theory of evolution is supported by evidence that includes
    - Adaptations: structures and behaviors that organisms have evolved in order to survive better in their environments
    - The fossil record which is information about all known fossils
    - Comparative anatomy which is when the bodies of different organisms are compared to see if they are related

- Homologous structures are body structures on different organisms that are similar. Evidence of a recent common ancestor/divergent evolution. Example: human arm and whale fin.
- Analogous structures are different body structures that serve a common purpose. Evidence of convergent evolution. Example: butterfly wing and bird wing.
- Vestigial structures are body structures that may have served a purpose in ancient ancestors but no longer are functional in current organisms. Example: human appendix

- The fact that all vertebrate embryos look very similar as they develop before birth
- The fact that the DNA/proteins (macromolecules) of closely related organisms looks very similar

Taxonomy

- Taxonomy is the science of classifying living things
- Organisms are organized into 7 different levels of taxonomy (King Philip came over for good spaghetti)
  - 1. Kingdom – most broad
  - 2. Phylum
  - 3. Class
  - 4. Order
  - 5. Family
  - 6. Genus
  - 7. Species – most specific
- Closely related organisms have more levels of taxonomy in common than unrelated organisms
- There are six kingdoms of living things (Archie eats pretty fantastic apple pies)
  1. Archaebacteria: bacteria that live in extreme environments
  2. Eubacteria: common bacteria
  3. Protista: single-celled organisms
  4. Fungi: mushrooms, yeasts, molds
  5. Animalia: animals
  6. Plantae: plants
- Every organism has a unique two-word scientific name that is written in Latin
  - The first word is the genus, the second word is the species (Humans are *Homo sapiens)*
- Some scientists prefer to organize organisms into domains rather than kingdoms
  - There are three domains (Archie eats eels)
    1. Archaea: Bacteria that live in extreme environments (prokaryotes)
    2. Eubacteria: Common bacteria (prokaryotes)
    3. Eukarya: Organisms whose DNA is in a nucleus (eukaryotes)

Ecology

Ecology

- Ecology is the study of how organisms fit into their environment
- A community is the organisms that live in a particular environment
- A habitat is the physical location of a community
- An ecosystem is a collection of organisms and their physical environment
- The diversity of an ecosystem is a measure of the number of species living there
- There are different feeding groups of organisms
  - Autotrophs: Organisms that make their own food, like plants and some bacteria
  - Heterotrophs: Organisms that cannot make their own food, like
    - Herbivores: Eat plants
    - Carnivores: Eat meat
    - Omnivores: Eat plants and meat
- There are different factors is an ecosystem
  - Abiotic factors are nonliving things
  - Biotic factors are living things, such as
    - Producers: Organisms that take in energy from their surroundings to make their own food
    - Consumers: Organisms that eat other organisms for energy
    - Decomposers: Special type of consumer that eats waste products and dead organisms for energy
- There are different trophic levels in a food chain
  - A trophic level is a feeding level in an ecosystem
  - A food chain is a lineup of organisms that shows who eats who
  - 1st trophic level is usually a producer
  - 2nd trophic level is a primary consumer
  - 3rd trophic level is a secondary consumer
  - 4th trophic level is a tertiary consumer
  - Last trophic level is a decomposer
- Every time an organism eats, it obtains energy from its food
  - Energy is transferred from the 1st to the 2nd to the 3rd trophic level and so on (but some of this energy does get lost along the way)
  - Energy pyramid: Picture showing how much energy is transferred to the different trophic levels in a food chain
- A food web is a network of connected food chains

Cycles of Matter

- Water, nitrogen, carbon, and oxygen are recycled in the environment through cycles
- The Nitrogen Cycle
  - Nitrogen in the atmosphere is taken in by bacteria that live in plant roots
  - The nitrogen is passed onto the plants and any animals that eat the plants
  - Once the plant or animal has died, decomposers (bacteria) again take up the nitrogen in the dead material and send it back to the atmosphere
- The Water cycle
  - Precipitation, such as rain and snow, fall to the earth
  - The water either
    - seeps into the ground for plants to use and the plants give off excess water back to the atmosphere through transpiration
    - or runs off the land to lower-lying bodies of water where it evaporates back into the atmosphere
- The Oxygen-Carbon cycle
  - Carbon dioxide from the atmosphere is taken in by plants who use it during photosynthesis and release oxygen back into the atmosphere
  - Oxygen in the atmosphere is taken in by animals and plants who use it during respiration and release carbon dioxide back into the atmosphere

Interaction in an environment

- Each organism has a niche, or role, to play in its environment
- Competition is a struggle between organisms for resources, such as food, water, shelter
- Predators are organisms that catch, kill, and eat other organisms called prey
- Symbiosis is a close relationship between 2 organisms in which one organism lives near, on, or even inside another organisms and in which at least one organism benefits
  - There are three types of symbiosis
  - 1. Commensalism is when one of the 2 organisms benefits from the symbiosis
  - 2. Mutualism is when both organisms benefit from the symbiosis
  - 3. Parasitism is when one organism benefits (parasite) and the other organism is harmed (host) from the symbiosis
    - The parasite feeds on the host while it is still alive, weakening but not killing it
- An adaptation is a change in the behavior or physical characteristics of a species that make it better suited to its environment
- Populations of organisms increase and decrease due to overpopulation of a competitor or predator, disease, lack of food or water or shelter, and extreme weather
- Ecosystems are constantly changing due to changing populations of organisms, changing weather, natural disasters, and human activity
- Every time a change occurs, the balance of the ecosystem has to be readjusted

Use these websites to take practice tests!

http://www.quia.com/quiz/730669.html

http://www.quia.com/quiz/729689.html