Biology Midterm Review

1. Parts of the Microscope
* 1. Eyepiece – Contains a magnifying lens.
* 2. Arm – Supports the body tube.
* 3. Stage – Supports the slide being observed.
* 4. Opening of the Stage – Permits light to pass up the eyepiece.
* 5. Fine Adjustment Knob – Moves the body tube slightly to sharpen the image.
* 6. Coarse Adjustment Knob – Moves the body tube to focus the image.
* 7. Base – Supports the microscope.
* 8. Illuminator – Produces light or reflects light up toward the eyepiece.
* 9. Diaphragm – Regulates the amount of light passing up toward the eyepiece.
* 10. Diaphragm Lever – Open and closes the diaphragm.
* 11. Stage Clips – Hold the slide in place.
* 12. Low-power Objective – Provides a magnification of 10X and is the shortest objective.
* 13. High-power Objective – Provides a magnification of 40X and is the longest objective.
* 14. Nosepiece – Holds the objectives and can be rotated to change the magnification.
* 15. Body Tube – Maintains the proper distance between the eyepiece and the objectives.



1. Experiment Terms
* There are 7 steps to designing an experiment. They are (in order): Make an observation, ask a question, form a hypothesis, set up a controlled experiment, record observations, analyze the results, and draw a conclusion.
* Hypothesis – A proposed scientific explanation for a set of observations. It must be stated in a way that enables it to be tested.
* Variables – Factors in an experiment that can change. (Equipment, type of material, amount of material, temperature, light).
* Controlled Experiment – Has only one variable that changes. All others are kept unchanged.
* Manipulated Variable – The variable that is deliberately changed.
* Responding Variable – The variable that is observed and that may change in response to the manipulated variable.
* Observation – Information obtained by using the 5 senses.
1. The Cell Theory
* There are three points to the cell theory.
* 1. All living things are composed of cells.
* 2. Cells are the basic units of structure and function in living things.
* 3. New cells are produced from existing cells.
1. Scientists and Their Theories
* Francesco Redi: He attempted to disprove the theory of abiogenesis. He concluded that the spontaneous generation of maggots did not occur.
* Anton Van Leeuwenhoek: Discovered a world of tiny moving objects in rain water, pond water, and dust. He inferred that these objects were alive, and called them animalcules.
* John Needham: Hypothesized that spontaneous generation could occur under certain conditions. His results supported spontaneous generation.
* Lazzaro Spallanzani: His experiment supported the hypothesis that new organisms are produced only by existing organisms. His results rejected spontaneous generation.
* Louis Pasteur: By using a flask with a long curved neck, the showed that boiled broth would remain free of organisms even if air was allowed in, as long as dust and other particles were kept out.
* 1665 – Robert Hooke: Identified empty chambers in cork and names them cells.
* 1674 – Anton Van Leeuwenhoek: Observes tiny living organisms in drops of pond water through his simple microscope (animalcules).
* 1838 – Matthias Scleiden: Concludes that all plants are made up of cells.
* 1839 – Theodore Schwann: Stated that all animals are made up of cells.
* 1885 – Rudolph Virchow: Proposes that all cells come from existing cells.
1. Differences Between Plant and Animal Cells
* Plant cells have a cell wall, vacuole, and chloroplasts, which the animal cells do not.
* Animal cells have centrioles, which plant cells do not.
1. Cell Organelles
* Cell Wall – The main function of the cell wall is to provide support and protection for the cell. The cell wall is outside of the cell membrane. Plant cell walls are composed mostly of cellulose.
* Cell Membrane – The cell membrane regulates what enters and leaves the cell and also provides protection and supports.
* Nucleus – Contains nearly all of the cell’s DNA and with it the coded instructions for making proteins and other important molecules.
* Nucleolus – Where the assembly of ribosomes begins.
* Nuclear Envelope – Dotted with thousands of nuclear pores, which allow material to move into and out of the nucleus.
* Chromatin – Consists of DNA bound to protein. Usually spread throughout the nucleus.
* Chromosomes – These distinct, threadlike structures contain the genetic information that is passed from one generation of cells to the next.
* Ribosomes – Small particles of RNA and protein found throughout the cytoplasm. They produce proteins by following coded instructions that come from the nucleus.
* Smooth Endoplasmic Reticulum – Contains collections of enzymes that perform specialized tasks, such as the synthesis of membrane lipids and the detoxification of drugs.
* Rough Endoplasmic Reticulum – Involved in the synthesis of proteins. Abundant in cells that produce large amounts of protein for export.
* Golgi Apparatus – The function is to modify, sort, and package proteins and other materials from the endoplasmic reticulum for storage in the cell or secretion outside of the cell.
* Lysosomes – Cellular organelles that break down waste materials and cellular debris.
* Vacuoles – Membrane-bound organelle which is in all plant and fungal cells, and some protest, animal and bacterial cells.
* Mitochondria – Found in eukaryotic cells. Generates most supplies for the cell.
* Chloroplasts – Found in plant cells. Creates food for the plant and keeps cell healthy.
* Cytoskeleton – Series of intercellular proteins that help a cell wall with shape, support, and movement.
* Microtubules – Component of the cytoskeleton. Maintains cell structure, providing platforms for intracellular transport forming the mitotic spindle, as well as other cellular processes.
* Microfilament – Thinnest filaments of the cytoskeleton. Helps in cell movement.
* Centrioles – Organelles that are in the animal and plant cells near the nucleus that creates the spindle fibers used in cell division.
1. Types of Solutions
* Isotonic Solutions are solutions in which the concentration of solutes outside of the cell is equal to the concentration of solute molecules inside of the cell. There is no net change in water movement.



* Hypotonic Solutions are solutions in which the concentration of solutes outside of the cell is lower than found inside the cell. Water diffuses into the cell.
* Hypertonic Solutions are solutions in which the concentration of solutes outside of the cell is higher than that found inside of the cell. Water diffuses out of the cell.



1. Fluid Mosaic Model
* Scientists describe their understanding of the cell membrane as the fluid mosaic model.
* Nearly all cell membranes are made up of a lipid bilayer.
* The hydrophilic head is water loving and soluble in water.
* The hydrophobic tail is water hating and not soluble in water.



1. Cell Membrane Diagram
* 1. Glycoprotein
* 2. Channel Protein
* 3. Pore Protein
* 4. Cholesterol
* 5. Fibrous Protein



1. Passive Transport
* Passive Transport – the movement of materials across a cell membrane without the use of cellular energy.
* Examples: Diffusion, Osmosis, and Facilitated Diffusion.
* Diffusion – can be explained by the movement of molecules from an area of high concentration to an area of low concentration. Diffusion rates increase with increasing temperature, pressure, and concentration. When molecules are finally distributed equally, then equilibrium is reached.
* Osmosis – the diffusion of water through a selectively permeable membrane. Water will tend to move across the membrane until equilibrium is reached. The concentration of water will be the same on both sides of the membrane.
* Facilitated Diffusion – occurs when protein carrier molecules located in the cell membrane can aid in passive transport. Sometimes cells must move materials against the concentration gradient. This requires the use of cellular energy.
1. Active Transport
* Molecular Transport – Small molecules and ions (calcium, sodium, and potassium ions) are carried across membranes by proteins in the membrane that act like energy-requiring pumps. Changes in protein shape seem to play an important role in the pumping process. A considerable portion of the energy used by cells in their daily activities is devoted to providing the energy to keep this form of active transport.
* Endocytosis – the process of taking material into the cell by means of infoldings, or pockets, of the cell membrane. The pocket that results breaks loose from the outer portion of the cell membrane and forms a vacuole within the cytoplasm.
* In phagocytosis (cell eating) extensions of cytoplasm surround a particle and package it within a food vacuole. The cell then engulfs it.
* In pinocytosis liquids are taken up from the surrounding environment. Tiny pockets form along the cell membrane, fill with liquid, and then pinch off to form vacuoles within the cell.
* Exocytosis – In the process of exocytosis, cells release large amounts of material from the cell. The membrane of the vacuole surrounding the material fuses with the cell membrane, forcing the contents out of the cell.
1. ATP & ADP
* One of the principal chemical compounds that cells use to store and release energy is adenosine triphosphate (ATP).
* ATP consists of adenine (a nitrogeneous base), a 5-carbon sugar called ribose, and three phosphate groups. The phosphate groups are the key to the ATP’s ability to store and release energy.
* When a cell has energy available, it can store small amounts of it by adding a phosphate group to ADP molecules, producing ATP.
* The addition of a phosphate group is called phosphorylation.
* ATP has enough energy to power a variety of cellular activities including active transport across cell membranes, protein synthesis, and muscle contraction.
* Most cells only have a small amount of ATP – enough to last a few minutes of activity.
* A single molecule of glucose stores more than 90 times the chemical energy of a molecule of ATP. It is more efficient for cells to keep only a small supply of ATP on hand.
1. Photosynthesis
* The key cellular process identified with energy production is photosynthesis – a process in which plants use the energy of sunlight to convert water and carbon dioxide into high-energy carbohydrates (sugars and starches) and oxygen, a waste product.
* Carbon Dioxide + Water (with light) 🡪 Sugars + Oxygen
* 6CO2 + 6H2O (with light) 🡪 C6H12O6 + 6O2
* A carrier molecule is a compound that can accept a pair of high energy electrons and transfer them along with most of their energy to another molecule. This process is called electron transport and the electron carriers themselves are known as the electron transport chain.
* One of these carrier molecules is the compound nicotinamide adenine dinucleotide phosphate or NADP+.
* NADP+ accepts and holds two high-energy electrons along with a hydrogen ion (H+). This converts NADP+ into NADPH. This is one way the energy can be trapped in chemical form.
1. More Scientists
* 1643 – Jan Van Helmont – after careful measurements of a plant’s water intake and mass increase, he concludes that trees gain most of their mass from water.
* 1771 – Joseph Priestly – using a bell jar, a candle, and a plant, he finds that the plant releases oxygen.
* 1774 – Jan Ingenhousz – he finds that aquatic plants produce oxygen bubbles in the light but not in the dark. He concludes that plants need sunlight to produce oxygen.
* 1845 – Julius Robert Mayer – Mayer proposes that plants convert light energy into chemical energy.
* 1948 – Melvin Calvin – he traces the chemical path that carbon follows to form glucose. These reactions are also known as the Calvin Cycle.
* 1992 – Rudolph Marcus – he wins the Nobel prize in chemistry for describing the process by which electrons are transferred from one molecule to another in the electron transport chain.
1. Light Dependant Reaction
* A) Photosystem 2
* Photosystem 2’s pigments absorb light.
* Electrons in chlorophyll become energized and are passed onto the electron transport chain.
* Enzymes on the inner surface of the thylakoid membrane break up water molecules.
* One water molecule breaks into: 2 energized electrons that replace the high energy electrons that chlorophyll lost to the electron transport chain; 4 hydrogen ions that are released into the thylakoid membrane; and oxygen which is released into the air.
* B) Electron Transport Chain
* High-energy electrons move through the electron transport chain from photosystem 2 to photosystem 1.
* Energy from the electrons is used by the molecules in the electron transport chain to transport H+ ions from the stroma to the inner thylakoid space.
* C) Photosystem 1
* Pigments in photosystem 1 use light energy to reenergize the electrons from photosystem 2.
* NADP+ picks up high-energy electrons along with a H+ ion at the outer surface of the thylakoid membrane to become NADPH.
* D) Hydrogen Ion Movement
* More hydrogen ions are pumped across the membrane as electrons are passed to NADP+.
* Inside of the thylakoid membrane fills up with H+ ions.
* The outside of the membrane becomes negatively charged.
* E) ATP Formation
* ATP synthase (protein) allows H+ ions to pass through the thylakoid membrane.
* ATP synthase rotates as H+ ions pass through it.
* As it rotates, ATP synthase binds ADP and a phosphate group to produce ATP.
* The NADPH and ATP formed by the light-dependant reactions contain a lot of energy but they are not stable enough to store that energy for more than a few minutes.
* ATP – Energy stored in bonds between phosphate groups.
1. Light-Independent Reactions (Calvin Cycle)
* The Calvin Cycle is named after American scientist Melvin Calvin who worked out the details of the light-independent reactions.
* The Calvin Cycle uses ATP and NADPH from the light-dependent reactions to produce high energy sugars.
* Remember: The Calvin Cycle takes place in the stroma of the chloroplast and doesn’t require light.
* A) Six carbon dioxide molecules enter the cycle from the atmosphere. The carbon dioxide molecules combine with six 5-carbon. The result is twelve 3-carbon molecules.
* B) The twelve 3-carbon molecules are converted into higher energy forms using energy from ATP and high-energy electrons from NADPH.
* C) Two of the twelve 3-carbon molecules are removed from the cycle. The plant cell uses these molecules to produce sugars, lipids, amino acids, and other compounds needed for cell growth and development.
* D) The remaining ten 3-carbon molecules are converted back into six 5-carbon molecules. They combine with six new CO2 molecules to begin the next cycle.
* The Calvin cycle uses six molecules of carbon dioxide to produce a 6-carbon sugar molecule.
1. Chloroplasts
* Plants gather the sun’s energy with light-absorbing molecules called pigments. The plant’s principal pigment is called chlorophyll which is found in the chloroplasts.
* There are two types of chlorophyll, chlorophyll a and chlorophyll b.
* When chlorophyll absorbs light, much of the energy is transferred directly to electrons in the chlorophyll molecule raising the energy levels of these electrons. The high-energy electrons make photosynthesis work.
* Thylakoid – saclike photosynthetic membrane.
* Granum – stack of thylakoids.
* Photosystems – clusters of chlorophyll and other pigments found in the membranes of the thylakoids that absorb light energy.
* Stroma – semi-fluid material that contains enzymes that makes up most of the chloroplasts volume.
* Stroma Lamallae – act like the skeleton of the chloroplast.



1. Cellular Respiration and the Release of Energy
* Cellular respiration is the process that releases energy by breaking down glucose and other food molecules in the presence of oxygen.
* Oxygen + Glucose 🡪 Carbon Dioxide + Water + Energy
* 6O2 + C6H12O6 🡪 6CO2 + 6H2O +Energy
* Respiration does not take place in one step. The energy in food must be released a little bit at a time.
1. Glycolysis
* Glycolysis is the first set of reactions in cellular respiration and is an energy-releasing process. Glycolysis takes place in the cytoplasm of the cell.
* When glycolysis is complete, 4 ATP molecules have been produced. Net gain of 2 ATP.
* The process of glycolysis is so fast that cells can produce thousands of ATP molecules in a few milliseconds.
* Glycolysis doesn’t require oxygen.
1. Krebs Cycle
* In the presence of oxygen, pyruvic acid produced in glycolysis passes to the second stage of cellular respiration, the Krebs cycle. (Named for British biochemist Hans Krebs).
* The Krebs cycle begins when pyruvic acid enters the mitochondria.
* There are two membranes: the smooth outer membrane and the folding inner membrane.
* Cristae – finger-like projections of the inner membrane. They increase surface area and there are enzymes on the cristae that assist in the breakdown of sugar molecules in the mitochondrion.
* Matrix – the fluid inside the mitochondrion. It contains enzymes responsible for Krebs cycle reactions.
* During the Krebs cycle, pyruvic acid is broken down into carbon dioxide in a series of energy-extracting reactions that occur in the matrix of a mitochondrion.
* Because the first compound formed in this series of reactions is citric acid, the Krebs cycle is also known as the citric acid cycle.
* The energy tally from one molecule of pyruvic acid is 4 NADH, 1 FADH2, and 1 ATP.
* The ATP directly produced from the Krebs cycle can be used for cellular activities.
1. Electron Transport
* The third stage of cellular respiration takes place within the inner mitochondrial membrane.
* The electron transport chain uses the high-energy electrons from the Krebs cycle to convert ADP to ATP.
* A) High-energy electrons from NADH and FADH2 are passed along the electron transport chain. At the end of the chain is an enzyme that combines these electrons with hydrogen ions and oxygen to form water.
* B) Every time 2 high-energy electrons transport down the electron transport chain, their energy is used to transport hydrogen ions across the membrane into the inter-membrane space, making it positively charged. The other side of the membrane becomes negatively charged.
* C) H+ ions escape from the inter-membrane through channels I ATP synthase. ATP synthase spins. Each time it does, it grabs a low-energy ADP and attaches a phosphate, forming high-energy ATP.
1. Fermentation
* When oxygen is not present, glycolysis is followed by a particular chemical pathway. The combination of glycolysis and this pathway is called fermentation.
* Fermentation doesn’t require oxygen so it is said to be anaerobic, which means “not in air”
* There are two main types of fermentation; alcoholic fermentation and lactic acid fermentation.
* Yeasts and a few other microorganisms use alcoholic fermentation.
* Pyruvic acid + NADH 🡪 alcohol + CO2 + NAD+
* The production of NAD+ allows glycolysis to continue.
* This type of fermentation causes bread to rise. When yeast in dough runs out of oxygen, it begins to ferment, giving off bubbles of carbon dioxide that form the air spaces you see in bread. The small amount of alcohol produced in the dough evaporates when the bread is baked.
* Lactic acid fermentation.
* Pyruvic acid + NADH 🡪 lactic acid + NAD+
* The production of NAD+ allows glycolysis to continue.
* Lactic acid is produced in your muscles during rapid exercise when the body cannot supply enough oxygen to the tissue.
* Your muscle cells rapidly begin to produce ATP by lactic acid fermentation. The build-up of lactic acid causes a painful burning sensation. This is why muscles may feel sore after only a few seconds of intense activity.
* Some unicellular organisms produce lactic acid as a waste product. Prokaryotes are used in the production of cheese, yogurt, butter, milk, sour cream, pickles, and sauerkraut.
* At the end of glycolysis, 90% of the chemical energy stored in glucose is sill unused, locked in the high-energy electrons of pyruvic acid.
1. Taxonomy
* Taxonomy is the science of classifying organisms. Scientists who carry out this work are called taxonomists.
* Biological classification systems have two main purposes: identifying organisms, and providing a basis for recognizing natural groupings of living things.
* Common names can cause confusion, which is why they use scientific names.
* First attempts at standard scientific names often described the physical characteristics of a species in great detail.
* Carolus Linnaeus was a Swedish botanist who was credited with devising the biological classification system based on an organism’s physical and structural features. The system recognized that the more features organisms have in common, the closer their relationship. He also created rules for assigning names to plants and animals.
* Each organism is assigned a two-part Latin name, which is known as its scientific name.
* Latin (and sometimes Greek) is still used today for naming species. It provides a common language for all scientists, regardless of their national origin.
* Many scientific names describe some characteristic of the organism. Many are derived from the name of the discoverer or the geographic location of the organism.
1. Levels of Classification
* Linnaeus’ hierarchical system of classification includes seven levels, or taxa.
* They are (in order): Kingdom, Phylum, Class, Order, Genus, and Species.
* An easy way to remember this is King Phillip Came Over For Guppy Soup.
1. Classification of Living Things



1. Characteristics of Viruses
* Viruses are particles of nucleic acid (DNA or RNA), protein, and in some cases, lipids.
* They differ widely in terms of size and structure. Most are so small they can only be seen using a powerful electron microscope.
* All viruses have one thing in common: they enter the cell, and once inside, use the machinery of the infected cell to produce more viruses.
* A typical virus is composed of a core of DNA or RNA surrounded by a protein coat called a capsid.
* The capsid includes proteins that enter enable a virus to enter a host cell. The capsid proteins bond to receptors on the surface of a cell and “trick” the cell into allowing it inside. Most viruses are highly specific to the cells they infect.
* Plant viruses infect plant cells, most animal viruses infect any related species of animals, and bacterial viruses infect only certain types of bacteria. Viruses that infect bacteria are called bacteriophages.
* Some viruses replicate or copy themselves immediately, killing the host cell. Others replicate themselves in a way that doesn’t kill the host immediately.
* In a lytic infection, a virus enters the cell, makes copies of itself, and causes the cell to burst or lyse.
* In a lysogenic infection, a virus integrates its DNA into the DNA of the host cell, and the viral genetic information replicates along with the host cell’s DNA. The viral DNA that is embedded in the host’s cell is called a prophage. Lysogenic viruses do not lyse the host right away. They remain inactive for a period of time.
* Some viruses contain RNA as their genetic information and are called retroviruses. They get their name from the fact their genetic information is copied backward. RNA 🡪 DNA instead of DNA 🡪 RNA.
* The DNA copy of a retrovirus’ RNA is inserted into the DNA of the host cell much like a prophage. Retroviruses may remain dormant for varying lengths of time before becoming active.
* The virus that causes AIDS is a retrovirus.
1. Shapes and Characteristics of Bacteria
* Monerans are the oldest and most abundant living organisms known to date. They include all bacterial types and some photosynthetic and chemosynthetic organisms.
* Most bacteria have one of three basic shapes: Cocci (Coccus) which is spherical, Bacilli (Bacillus) which is rod-shaped, and Spirilla (Spirillus) which is spiral.
* Arrangement of cocci: coccus – single, diplococcic – pair, streptococci – chain, staphylococci – clusters.
* Obligate Aerobes – bacteria that require oxygen for respiration
* Obligate Anaerobes – bacteria that conduct respiration processes in the absence of oxygen
* Facultative Anaerobes – bacteria that can survive with or without oxygen. A majority of bacteria fit into this group.