



ACT

SCIENCE

A

Abdomen- The abdomen refers to the region between the pelvis (pelvic brim) and the thorax (thoracic diaphragm) in vertebrates, including humans. The space constituting the abdomen is termed the abdominal cavity. The borders of the abdominal cavity are comprised of the posterior peritoneal surface, the anterior abdominal wall, the inferior pelvic inlet, and the superior thoracic diaphragm. The abdomen functions to house the digestive system and provides muscles essential for posture, balance, and breathing.

Abdominal Cavity- The abdominal cavity is a large cavity found in the torso of mammals between the thoracic cavity, which it is separated from by the thoracic diaphragm, and the pelvic cavity. A protective layer that is called the peritoneum, which plays a role in immunity, supporting organs, and fat storage, lines the abdominal cavity. As shown in the below diagram on the left, the abdominal cavity has been divided into nine different areas, where every organ doesn't necessarily only occupy one. This division helps with the diagnosis of diseases based on the place where a person is experiencing abdominal pain.

Abiogenesis- Abiogenesis is the creation of organic molecules by forces other than living organisms. While organisms can create carbon-carbon bonds relatively easily thanks to enzymes, to do so otherwise requires large inputs of energy. Early in the history of science, this fact was used to dispute evolution, as it could not be conceived how organic molecules could be produced from non-organic sources. The theory of abiogenesis as an evolutionary theory was given much credit when Stanley Miller conducted his famous experiment trying to prove the inorganic beginning of life.

Abiotic- Abiotic factors, also called abiotic components are non-living factors that impact an ecosystem. Abiotic factors are part of the ecosystem and can impact the associated living things, but they are not living. The term "abiotic" comes from the root parts "a-" meaning "without," and "bio," meaning "life." The living parts of an ecosystem are called "biotic factors."

Acetic acid- Acetic acid is a mildly corrosive monocarboxylic acid. Otherwise known as ethanoic acid, methanecarboxylic acid, hydrogen acetate or ethylic acid, this organic compound is used in chemical manufacturing, as a food additive, and in petroleum production. The molecular formula of acetic acid is $C_2H_4O_2$ or CH_3COOH , where $-COOH$ defines the presence of the single carboxyl group.

Active Immunity- Active immunity is a resistance to disease through the creation of antibodies by the immune system. As opposed to passive immunity, where antibodies are injected into an organism during pregnancy or they are artificially acquired, active immunity requires a process of training immune cells to recognize and counteract foreign bodies.

Active Site- The active site of an enzyme is the region that binds substrate molecules. This is crucial for the enzyme's catalytic activity.

Enzymes are proteins that drastically increase the speed of chemical reactions by lowering their activation energy. They do this by interacting with chemical reactants – the substrates – in ways that make them more likely to undergo their chemical reaction. This interaction is carried out at the active site, where the enzyme binds the substrates to increase their chances of reacting.

Active transport- Active transport is the process of transferring substances into, out of, and between cells, using energy. In some cases, the movement of substances can be accomplished by passive transport, which uses no energy. However, the cell often needs to transport materials against their

concentration gradient. In these cases, active transport is required.

Aerobic Respiration- Aerobic respiration is the process by which organisms use oxygen to turn fuel, such as fats and sugars, into chemical energy. In contrast, anaerobic respiration does not use oxygen.

Respiration is used by all cells to turn fuel into energy that can be used to power cellular processes. The product of respiration is a molecule called adenosine triphosphate (ATP), which uses the energy stored in its phosphate bonds to power chemical reactions. It is often referred to as the “currency” of the cell.

Aerobic respiration is much more efficient, and produces ATP much more quickly, than anaerobic respiration. This is because oxygen is an excellent electron acceptor for the chemical reactions involved in generating ATP.

Algae- Algae is a term used to describe a large, diverse group of eukaryotic, photosynthetic organisms. Algae can be unicellular, live in colonies, or even be multicellular. The wide variety algae makes them hard to classify. Algae span both terrestrial and marine environments, growing almost anywhere there is water and sunlight. Algae, like plants, are photosynthetic organisms. One group of algae, the green algae, is even classified with the plants because of how similar the organisms are.

Allele- An allele is specific variation of a gene. Bacteria, because they have a single ring of DNA, have one allele per gene per organism. In sexually reproducing organisms, each parent gives an allele for each gene, giving the offspring two alleles per gene. Because alleles are just variants of specific genes, different alleles are found on the same locations on the chromosomes of different individuals. This is important because it gives organisms to be incredibly varied in the functions of their various alleles, while at the same time being able to reproduce. This create variety caused by mutations in specific genes gives rise to a wide number of alleles for any trait in a given population.

Amino Acids- Amino acids are the building blocks of polypeptides and proteins and play important roles in metabolic pathway, gene expression, and cell signal transduction regulation. A single organic amino acid molecule contains two functional groups – amine and carboxyl – and a unique side chain. Humans require twenty different amino acids; eleven are synthesized in the body and nine obtained from dietary sources.

Ammonification- Ammonification is part of the five-step nitrogen cycle, which is crucial for providing living organisms with the essential nitrogen that they need. Ammonification itself takes place thanks to the existence of decomposers, which break down animal and plant cells into simpler substances, making nutrients available in the ecosystem. The process of ammonification converts organic nitrogen, which is the way nitrogen is contained in compounds in living organisms, into inorganic ammonia (NH₃) or ammonium ions (NH₄⁺). Some examples of nitrogen-containing compounds in us and in other living organisms are proteins, nucleic acids like our DNA, vitamins like B-vitamins, and urea. The decomposers in this case are different bacteria and fungi that feed on these compounds, releasing ammonia, which in turn forms ammonium compounds in the soil to be taken up by plants. You can make yourself familiar with the nitrogen cycle by looking at the diagram below. Notice how the decomposers are shown feeding on plant and animal matter to produce ammonium.

Amoeba- An amoeba is a highly motile eukaryotic, unicellular organism. Typically belonging to the kingdom protozoa, it moves in an “amoeboid” fashion. As such, microbiologists often use the term “amoeboid”, to refer to a specific type of movement and amoebae interchangeably. Interestingly, amoebae are not a distinct taxonomic group and are, instead, characterized based on their “amoeboid” movement rather than distinct morphological characteristics. Moreover, even members of the same species can appear dissimilar. Amebae species can be found in all major

eukaryotic lineages, including fungi, algae, and even animals.

Amphipathic- An amphipathic molecule is a molecule that has both polar and non-polar parts. Phospholipids, for example, have non-polar fatty acid “tails” and polar phosphate “heads.” “Polarity” is an important property of molecules that determines how they will interact with other molecules. Polarity is created when some atomic nuclei in a molecule attract electrons more strongly than others. The result is that the negative charge of the electrons congregates more around one atom than another, while the other atom possesses a slight positive charge because the electrons are closer to the first atom. Polar molecules often contain elements like oxygen and sulfur, whose nuclei attract electrons very strongly. This allows them to pull some electrons away from their partner atoms.

Anabolism- Anabolism collectively refers to all the processes of chemical reactions that build larger molecules out of smaller molecules or atoms; these processes are also known as anabolic processes or anabolic pathways. The opposite of anabolism is catabolism, the set of processes that breaks down larger molecules into smaller ones. Anabolism and catabolism are the two types of metabolic pathways. Metabolic pathways are series of chemical reactions that take place in the cell. Anabolic pathways use energy, while catabolic pathways release energy.

Anaerobic Organism- Anaerobic organisms are those that live in an anoxic environment – one which lacks oxygen. While most living things require oxygen to survive – they’re aerobic – oxygen can actually be toxic to anaerobic organisms. The great majority of organisms produce energy molecules called ATP (adenosine triphosphate) through a process of aerobic cellular respiration. This complex set of chemical interactions takes place in the cytoplasm and cell membrane of prokaryotes, and in the mitochondria of eukaryotes. During respiration, oxygen acts as the final electron acceptor at the end of an electron transport chain, which is why aerobic organisms must breathe air containing oxygen

in order to survive. However, anaerobic organisms use either fermentation or anaerobic cellular respiration to produce ATP. In this case, an atom other than oxygen is the final electron acceptor. For example, some anaerobic bacteria that live deep in mud in swampy areas use a sulfate ion instead of oxygen, and hydrogen sulfide is produced as a byproduct, rather than water. This explains the sulfurous smell in many swamps and mudflats.

Anaphase- Anaphase is a stage during eukaryotic cell division in which the chromosomes are segregated to opposite poles of the cell. The stage before anaphase, metaphase, the chromosomes are pulled to the metaphase plate, in the middle of the cell. Although the chromosomes were heavily condensed in the start of cell division, they continue to condense through anaphase. Anaphase starts after the cell passes the spindle formation checkpoint, which allows chromosomes or chromatids to separate. As the microtubules shorten that connect the chromosomes to the centrosomes, the chromosomes are pulled toward the centrosome until they form a semi-circle around it. In the next stage of cell division, telophase, the cell reforms the nucleus and prepares to divide.

Angiosperm- Angiosperms are a major division of plant life, which make up the majority of all plants on Earth.

Angiosperm plants produce seeds encased in “fruits,” which include the fruits that you eat, but which also includes plants you might not think of as fruits, such as maple seeds, acorns, beans, wheat, rice, and corn.

Angiosperms are also known as “flowering plants” because flowers are a characteristic part of their reproductive structure – though again, you may not always recognize their flowers as the pretty, colorful petaled things you think of when you hear the word.

Animal Cell- Animal cells are the basic unit of life in organisms of the kingdom Animalia.

They are eukaryotic cells, meaning that they have a true nucleus and specialized structures called organelles that carry out different functions. Animal cells do not have plant-specific organelles like cell walls, which support the plant cell, or chloroplasts, the organelle that carries out photosynthesis.

Antibody- An antibody is a specialized defense protein synthesized by the vertebrate immune system. These small structures are actually made of 4 different protein units. The ends of the molecule are variable, and can be adapted to bind to any molecule. The shape is determined by the antigens in the system which are causing damage. Special immune cells detect these antigens and create a reciprocal antibody. This generalized structure is repeated many times, to flood the system with antibodies. These proteins bind to and surround the antigens, preventing further spread or infection.

Anticodon- Anticodons are sequences of nucleotides that are complementary to codons. They are found in tRNAs, and allow the tRNAs to bring the correct amino acid in line with an mRNA during protein production.

During protein production, amino acids are bound together into a string, much like beads on a necklace. It's important that the correct amino acids be used in the correct places, because amino acids have different properties. Putting the wrong one in a spot can render a protein useless, or even dangerous to the cell.

Antioxidant- Antioxidants are molecules that prevent the oxidation of other molecules. Oxidation is a chemical reaction in which electrons are lost. In living things, this process can be harmful, leading to the breakdown of organic molecules.

One challenge of life on Earth is that the same thing that makes oxygen a great electron acceptor, making chemical reactions such as cellular respiration possible, also makes it highly reactive in potentially damaging ways.

Archaeobacteria- Archaeobacteria are a type of single-cell organism which are so different

from other modern life-forms that they have challenged the way scientists classify life.

Arthropods- An "arthropod" is an invertebrate animal that has an exoskeleton, a segmented body, and jointed appendages. The following families of organisms are all examples of arthropods:

Insects such as ants, dragonflies, and bees

Artificial Selection- Artificial selection or selective breeding describes the human selection of breeding pairs to produce favorable offspring. This applies to all organisms – from virus to four-footer, and from pet to food source. Artificial selection aims to increase the productive or esthetic value of an organism to our advantage.

Asexual Reproduction- Asexual reproduction occurs when an organism makes more of itself without exchanging genetic information with another organism through sex.

In sexually reproducing organisms, the genomes of two parents are combined to create offspring with unique genetic profiles. This is beneficial to the population because genetically diverse populations have a higher chance of withstanding survival challenges such as disease and environmental changes.

Asexually reproducing organisms can suffer a dangerous lack of diversity – but they can also reproduce faster than sexually reproducing organisms, and a single individual can found a new population without the need for a mate.

ATP Synthase- ATP synthase is an enzyme that directly generates adenosine triphosphate (ATP) during the process of cellular respiration. ATP is the main energy molecule used in cells. ATP synthase forms ATP from adenosine diphosphate (ADP) and an inorganic phosphate (Pi) through oxidative phosphorylation, which is a process in which enzymes oxidize nutrients to form ATP. ATP synthase is found in all lifeforms and powers all cellular activities.

Autotroph- Autotrophs are organisms that can produce their own food, using materials from inorganic sources. The word "autotroph"

comes from the root words “auto” for “self” and “troph” for “food.” An autotroph is an organism that feeds itself, without the assistance of any other organisms.

B

Bacteria- Bacteria are single-celled microorganisms with prokaryotic cells, which are single cells that do not have organelles or a true nucleus and are less complex than eukaryotic cells. Bacteria with a capital B refers to the domain Bacteria, one of the three domains of life. The other two domains of life are Archaea, members of which are also single-celled organisms with prokaryotic cells, and Eukaryota. Bacteria are extremely numerous, and the total biomass of bacteria on Earth is more than all plants and animals combined.

Bilateral Symmetry- Bilateral symmetry refers to organisms with body shapes that are mirror images along a midline called the sagittal plane. The internal organs, however, are not necessarily distributed symmetrically.

The vast majority of animals display bilateral symmetry; also known as plane symmetry, this is a trait that applies to 99% of all animals, in the majority of phyla: Chordata, Annelida, Arthropoda, Platyzoa, Nematoda, and most Mollusca.

Bile Salts- Bile salts are found in bile, a secretion produced by liver cells to aid digestion. Although bile is 95% water, bile salts are its most prominent organic solutes and play a major role in fat emulsification. Human bile contains at least twelve bile salts. Only two of these are primary or synthesized in the liver. Secondary bile salts are synthesized by the intestinal flora.

Bilirubin- Bilirubin is a molecule formed from the breakdown of red blood cells, and other cells with porphyrins. Red blood cells carry special molecules, called hemes (a type of

porphyrin), which hosts an iron atom. This arrangement allows the red blood cell to carry oxygen. When blood cells break down, they release the heme into the blood, which could do damage if not controlled.

Binary Fission- Binary fission is the process through which asexual reproduction happens in bacteria. During binary fission, a single organism becomes two independent organisms. Binary fission also describes the duplication of organelles in eukaryotes. Mitochondria and other organelles must reproduce via binary fission before mitosis so each cell has ample organelles.

Binomial Nomenclature- Binomial nomenclature is the system of scientifically naming organisms developed by Carl Linnaeus. Linnaeus published a large work, *Systema Naturae* (The System of Nature), in which Linnaeus attempted to identify every known plant and animal. This work was published in various sections between 1735 and 1758, and established the conventions of binomial nomenclature, which are still used today. Binomial nomenclature was established as a way to bring clarity to discussions of organisms, evolution, and ecology in general. Without a formalized system for naming organisms the discussion of them, even between peers that speak the same language, becomes nearly impossible. The number of different colloquial names for a single species can be staggering.

Biopsy- A biopsy is the removal of tissue or cell samples for the purpose of examination using various biological techniques to gain information regarding the disease status of a particular tissue. Biopsies are typically conducted by surgeons or other interventional specialists (e.g., radiologists or cardiologists). The biopsied tissue sample can be stained and microscopically examined by experts who determine if there are any histological abnormalities or score the sample to evaluate the extent of disease (see the image below for an example of a histological sample obtained from a biopsy).

Biotic Factors- Biotic factors are the living parts of an ecosystem. Because of the way

ecosystems work – as complex systems of competition and cooperation, where the action of every life form can effect all the others – any living thing within an ecosystem can be considered a biotic factor. Biotic factors such as soil bacteria, plant life, top predators, and polluters can all profoundly shape which organisms can live in an ecosystems and what survival strategies they use. Biotic factors, together with non-living abiotic factors such as temperature, sunlight, geography, and chemistry, determine what ecosystems look like and what ecological niches are available.

Blood Urea Nitrogen (BUN) Test- A blood urea nitrogen (BUN) test analyzes the level of urea through the detection of the nitrogen within the molecule. High levels of urea within the blood can be a sign that certain body systems are not functioning properly, especially the kidneys.

Body Cavity- A body cavity is a space created in an organism which houses organs. It is lined with a layer of cells and is filled with fluid, to protect the organs from damage as the organism moves around. Body cavities form during development, as solid masses of tissue fold inward on themselves, creating pockets in which the organs develop. An example of a body cavity in humans would be the cranial cavity, which houses the brain.

Branched Chain Amino Acids-The branched-chain amino acids or BCAAs, leucine, isoleucine, and valine are three of the nine nutritionally essential amino acids. These three ingredients form a popular health supplement primarily consumed by sports enthusiasts as it is believed they contribute to muscle tissue synthesis; however, the true value of BCAA supplements has yet to be proved.

Bronchioles- The bronchioles are tubes in the lungs which branch off from the larger bronchi that enter each lung, from the large and singular trachea which connects to the mouth. As such, bronchioles are one of the smallest airways in the respiratory tract, and lead directly to the alveolar ducts which house the alveoli responsible for exchanging gases

with the blood. These structures can be seen in the following image, with the bronchioles being labeled as number 5.

Bryophyte- Bryophytes are a group of plant species that reproduce via spores rather than flowers or seeds. Most bryophytes are found in damp environments and consist of three types of non-vascular land plants: the mosses, hornworts, and liverworts.

Bystander Effect- The bystander effect, also called bystander apathy, is a term in psychology that refers to the tendency of people to take no action in an emergency situation when there are others present. This phenomenon is highly studied in the field of sociology.

C

Carbon Cycle- The carbon cycle is the cycle by which carbon moves through our Earth's various systems. The carbon cycle is influenced by living things, atmospheric changes, ocean chemistry, and geologic activity are all part of this cycle. The levels of carbon are at an all-time high, largely due to human activities.

Carbonyl Group- A carbonyl group is a functional group characterized by a carbon atom double bonded to an oxygen, found within a larger carbon-based molecule. The electronegativity of oxygen creates a resonance hybrid structure in which the electrons are continuously redistributed. This allows the molecule to participate in more reactions.

Carboxyl Group- A carboxyl group is one of many functional groups that attaches to larger molecules and gives them certain properties. The carboxyl group is seen in many organic molecules known as carboxylic acids, which have a variety of functions. The carboxyl group consists of a carbon, bonded to both an oxygen and a hydroxyl group. Hydroxyl groups

are simply an oxygen bonded to a hydrogen. The structure of a carboxyl group can be seen below.

Cardiac Cycle- The cardiac cycle is the series of contractions in the heart that pressurize different chambers, causing blood to flood in one direction. There are two stages during the cardiac cycle. During diastole, the ventricles relax and fill with blood. The muscles contract during systole, pushing blood through the arteries.

Carotenoids- Carotenoids are a type of accessory pigment, created by plants to help them absorb light energy and convert it to chemical energy. There are two types of carotenoids, xanthophylls and carotenes, which differ only in their oxygen content. Carotenoids have a similar base structure consisting of 8 isoprene molecules. Isoprene molecules have 5 carbons, and 8 of them together has 40 carbons. All carotenoids share this structure, and as such are also called tetraterpenoids.

Cartilage- Cartilage is a semi-rigid but flexible avascular connective tissue found at various sites within the body. With a pliable structure composed primarily of water, this tissue type is also extremely tough. Cartilage is found throughout the human body in areas such as the joints, nose, airway, intervertebral discs of the spine, and the ear.

Catabolism- Catabolism is the part of the metabolism responsible for breaking complex molecules down into smaller molecules. The other part of the metabolism, anabolism, builds simple molecules into more complex ones. During the catabolism energy is released from the bonds of the large molecules being broken down. Typically, that energy is then stored in the bonds of adenosine triphosphate (ATP). The catabolism increases the concentration of ATP in the cell as it breaks down nutrients and food. The ATP, in such high concentrations, becomes much more likely to give up its energy in the release of a phosphate. The anabolism then uses this energy to combine simple precursors into complex molecules that add to the cell and store energy for cell division.

Cell- Cells are the basic unit of life. In the modern world, they are the smallest known world that performs all of life's functions. All living organisms are either single cells, or are multicellular organisms composed of many cells working together.

Cells are the smallest known unit that can accomplish all of these functions. Defining characteristics that allow a cell to perform these functions include:

A cell membrane that keeps the chemical reactions of life together.

At least one chromosome, composed of genetic material that contain the cell's "blueprints" and "software."

Cytoplasm – the fluid inside the cell, in which the chemical processes of life occur.

Below we will discuss the functions that cells must fulfill in order to facilitate life, and how they fulfill these functions.

Cell Nucleus- The cell nucleus is a large organelle in eukaryotic organisms which protects the majority of the DNA within each cell. The nucleus also produces the necessary precursors for protein synthesis. The DNA housed within the cell nucleus contains the information necessary for the creation of the majority of the proteins needed to keep a cell functional. While some DNA is stored in other organelles, such as mitochondria, the majority of an organism's DNA is located in the cell nucleus. The DNA housed in the cell nucleus is extremely valuable, and as such the cell nucleus has a variety of important structures to help maintain, process, and protect the DNA.

Cell Plate- The cell plate is a structure that forms in the cells of land plants while they are undergoing cell division.

The cells of land plants, unlike animal cells, have a cell wall made of stiff sugars which surround their cell membranes. In addition to protecting the cell from damage, the cell walls

help to maintain the plant's rigid upright structures, such as leaves and stems.

These rigid support structures allow plants to grow tall and spread their leaves wide, obtaining more sunlight. In most plants, the cell wall is made of cellulose – an arrangement of glucose molecules that forms hard, rigid surfaces.

Interestingly, the cellulose that makes up cell walls is not digestible to humans or animals – but it can be broken down into sugar by some methane-producing archaeobacteria. This is one reason for the symbiotic relationship between many animals and the archaeobacteria in our gut.

Cell Wall- A cell wall is an outer layer surrounding certain cells that is outside of the cell membrane. All cells have cell membranes, but generally only plants, fungi, algae, most bacteria, and archaea have cells with cell walls. The cell wall provides strength and structural support to the cell, and can control to some extent what types and concentrations of molecules enter and leave the cell. The materials that make up the cell wall differ depending on the type of organism. The cell wall has evolved many different times among different groups of organisms.

Cellular Respiration- Cellular respiration is the process through which cells convert sugars into energy. To create ATP and other forms of energy to power cellular reactions, cells require fuel and an electron acceptor which drives the chemical process of turning energy into a useable form.

Central Nervous System- The central nervous system (CNS) consists of the brain and spinal cord. This body system is responsible for integrating and coordinating the activities of the entire body. Through these physical structures, thought, emotion, and sensation are experienced, and body movements are coordinated.

Chemosynthesis- Chemosynthesis is the conversion of inorganic carbon-containing compounds into organic matter such as sugars

and amino acids. Chemosynthesis uses energy from inorganic chemicals to perform this task.

The inorganic “energy source” is usually a molecule that has electrons to spare, such as hydrogen gas, hydrogen sulfide, ammonia, or ferrous iron. Like photosynthesis and cellular respiration, chemosynthesis uses an electron transport chain to synthesize ATP.

Chitin- Chitin is a large, structural polysaccharide made from chains of modified glucose. Chitin is found in the exoskeletons of insects, the cell walls of fungi, and certain hard structures in invertebrates and fish. In terms of abundance, chitin is second to only cellulose. In the biosphere, over 1 billion tons of chitin are synthesized each year by organisms. This extremely versatile molecule can form solid structures on its own as in insect wings, or can combine with other components like calcium carbonate to make even stronger substances like the shell of a clam.

Chlorophyll- Chlorophyll is a molecule produced by plants, algae and cyanobacteria which aids in the conversion of light energy into chemical bonds. Chlorophyll is known as a pigment, or molecule that reflects some wavelengths of light, while absorbing others. Pigments produce a variety of colors in the plant and animal world. Chlorophyll is a green pigment, and is responsible for the green color of plants and algae.

Chloroplast- The chloroplast, found only in algal and plant cells, is a cell organelle that produces energy through photosynthesis. The word chloroplast comes from the Greek words khloros, meaning “green”, and plastes, meaning “formed”. It has a high concentration of chlorophyll, the molecule that captures light energy, and this gives many plants and algae a green color. Like the mitochondrion, the chloroplast is thought to have evolved from once free-living bacteria.

Chromatid- When a cell is preparing to divide, it makes a new copy of all of its DNA, so that the cell now possesses two copies of each

chromosome. The two copies of the cell's original chromosome are called "sister chromatids."

During anaphase of cell division, the two chromatids will be pulled apart, and chromatid will be apportioned to the cytoplasm of each daughter cell.

A "chromosome" is defined as a large amount of DNA that is physically connected into a single structure.

Chromatography- Chromatography is a method of separating the constituents of a solution, based on one or more of its chemical properties. This could be charge, polarity, or a combination of these traits and pH balance. In essence, the solution is passed through a medium which will hinder the movement of some particles more than others. This draws the different molecules apart as they travel through the medium. Often, different dyes are used to represent the different parts, or fractions of the media.

Chromosome- A chromosome is a string of DNA wrapped around associated proteins that give the connected nucleic acid bases a structure. During interphase of the cell cycle, the chromosome exists in a loose structure, so proteins can be translated from the DNA and the DNA can be replicated. During mitosis and meiosis, the chromosome becomes condensed, to be organized and separated. The substance consisting of all the chromosomes in a cell and all their associated proteins is known as chromatin. In prokaryotes, there is usually only a single chromosome, which exists in a ring-like or linear shape. The chromatin of most eukaryotic organisms consists of multiple chromosomes, as described later in the article. Each chromosome carries part of the genetic code necessary to produce an organism.

Circulatory System- The circulatory system, also known as the cardiovascular system, consists of the organs and fluids that transport materials across the body. All vertebrates, including humans, have a closed circulatory system, which means that blood

remains within blood vessels and does not directly interact with body tissues.

Coevolution- In the context of evolutionary biology, coevolution refers to the evolution of at least two species, which occurs in a mutually dependent manner. Coevolution was first described in the context of insects and flowering plants, and has since been applied to major evolutionary events, including sexual reproduction, infectious disease, and ecological communities. Coevolution functions by reciprocal selective pressures on two or more species, analogous to an arms race in an attempt to outcompete each other. Classic examples include predator-prey, host-parasite, and other competitive relationships between species. While the process of coevolution generally only involves two species, multiple species can be involved. Moreover, coevolution also results in adaptations for mutual benefit. An example is the coevolution of flowering plants and associated pollinators (e.g., bees, birds, and other insect species).

Cofactor- A cofactor is a non-protein chemical that assists with a biological chemical reaction. Co-factors may be metal ions, organic compounds, or other chemicals that have helpful properties not usually found in amino acids. Some cofactors can be made inside the body, such as ATP, while others must be consumed in food.

Cognitive Development - Cognitive development is the study of childhood neurological and psychological development. Specifically, cognitive development is assessed based on the level of conception, perception, information processing, and language as an indicator of brain development. It is generally recognized that cognitive development progresses with age, as human awareness and understanding of the world increases from infancy to childhood, and then again into adolescence. The process of cognitive development was first described by Jean Piaget, in his Theory of Cognitive Development.

Commensalism- Commensalism is a relationship between two organisms in which

one organism benefits, and one is unaffected. This can be contrasted with other types of symbiosis, such as mutualism and parasitism. The supposed difference between commensalism and other types of symbiosis is that in commensalism, the second party or host remains unaffected. Some scientist argue that this is likely improbable, and that most commensalism will be found to be mutualism or parasitism once the effects on the host can be appropriately studied. Other scientists argue that commensalism does exist when the effect on the host is imperceptible.

Common Descent- Common descent is a term within evolutionary biology which refers to the common ancestry of a particular group of organisms. The process of common decent involves the formation of new species from an ancestral population. When a recent common ancestor is shared between two organisms, they are said to be closely related. In contrast, common descent can also be traced back to a universal common ancestor of all living organisms using molecular genetic methods. Such evolution from a universal common ancestor is thought to have involved several speciation events as a result of natural selection and other processes, such as geographical separation.

Community- A biotic community, also known as a biota or 'biocoenosis', is the group of organisms that live together and interact with each other within an environment or habitat. Together, the biotic community and the physical landscape or abiotic factors make up an ecosystem.

Communities consist of a group of different species, which partake in direct and indirect biotic interactions, such as predator-prey interactions, herbivory, parasitism, competition and mutualisms. Alternatively, the interrelationships may take a more diffuse route, such as an organism that creates certain necessary climatic conditions, or one that acts as a substrate for another organism.

Control Group- In scientific experiments, the control group is the group of subject that receive no treatment or a standardized treatment. Without the control group, there

would be nothing to compare the treatment group to. When statistics refer to something being "X times more likely to happen" they are referring to the difference in the measurement between the treatment and control group. The control group provides a baseline in the experiment. The variable that is being studied in the experiment is not changed or is limited to zero in the control group. This insures that the effects of the variable are being studied. Most experiments try to add the variable back in increments to different treatment groups, to really begin to discern the effects of the variable in the system.

Controlled Variable- A controlled variable is a commonly used term in the field of scientific research, where finding evidence to support a theory is rarely straightforward. In the case of the natural sciences, some research features are constant, but the majority of these have inconsistencies. These inconsistencies are known as variables.

Convergent Evolution- Convergent evolution is the process in which organisms that are not closely related independently evolve similar features. Adaptions may take the form of similar body forms, colors, organs and other adaptions which make up the organism's phenotype.

Convergent evolution creates analogous structures or 'homoplasies', those which have similar forms or functions between diverged species, but were not present in the common ancestor of the two. On the other hand, homologous structures, i.e., a specific organ or bone which appears throughout many different organisms, albeit often in a slightly different form or shape, can indicate a divergence from a common ancestor.

Crossing Over- Crossing over is the exchange of genetic material between non-sister chromatids of homologous chromosomes during meiosis, which results in new allelic combinations in the daughter cells.

Each diploid cell contains two copies of every chromosome, one derived from the maternal gamete and the other from the paternal

gamete. These pairs of chromosomes, each derived from one parent, are called homologous chromosomes. When diploid organisms undergo sexual reproduction, they first produce haploid gametes through meiosis. During prophase I of meiosis, homologous chromosomes align with each other and exchange genetic material, so that some of the resultant chromosomes are recombinants – containing a mixture of genes derived from the maternal as well as the paternal chromosomes.

Cytokinesis- Cytokinesis is the final process in eukaryotic cell division, which divides the cytoplasm, organelles, and cellular membrane. Cytokinesis typically occurs at the end of mitosis, after telophase, but the two are independent processes. In most animals, cytokinesis begins sometime in late anaphase or early telophase, to ensure the chromosomes have been completely segregated. The movements of cytokinesis seen in the cell are caused by the same spindle network that was responsible for the separation of the chromosomes. Parts of the spindle responsible for moving chromosomes break down in late cell division, to be used in restructuring the two new cells..

Cytolysis- Cytolysis, also known as osmotic lysis, occurs when a cell bursts and releases its contents into the extracellular environment due to a great influx of water into the cell, far exceeding the capacity of the cell membrane to contain the extra volume. This is a concern particularly for cells that do not have a tough cell wall to resist internal water pressure.

Cytoplasm- Cytoplasm refers to the fluid that fills the cell, which includes the cytosol along with filaments, proteins, ions and macromolecular structures as well as the organelles suspended in the cytosol.

In eukaryotic cells, cytoplasm refers to the contents of the cell with the exception of the nucleus. Eukaryotes have elaborate mechanisms for maintaining a distinct nuclear compartment separate from the cytoplasm. Active transport is involved in the creation of

these subcellular structures and for maintaining homeostasis with the cytoplasm. For prokaryotic cells, since they do not have a defined nuclear membrane, the cytoplasm also contains the cell's primary genetic material. These cells are usually smaller in comparison to eukaryotes, and have a simpler internal organization of the cytoplasm.

Cytoskeleton- The cytoskeleton is a network of filaments and tubules that extends throughout a cell, through the cytoplasm, which is all of the material within a cell except for the nucleus. It is found in all cells, though the proteins that it is made of vary between organisms. The cytoskeleton supports the cell, gives it shape, organizes and tethers the organelles, and has roles in molecule transport, cell division and cell signaling.

Cytosol- Cytosol is the liquid found inside of cells. It is the water-based solution in which organelles, proteins, and other cell structures float.

The cytosol of any cell is a complex solution, whose properties allow the functions of life to take place. Cytosol contains proteins, amino acids, mRNA, ribosomes, sugars, ions, messenger molecules, and more!

D

Deciduous Forest- A deciduous forest is a biome dominated by deciduous trees which lose their leaves seasonally. The Earth has temperate deciduous forests, and tropical and subtropical deciduous forests, also known as dry forests. Another name for these forests is broad-leaf forests because of the wide, flat leaves on the trees. Trees in tropical deciduous forests lose their leaves in the dry season and regrow them in the rainy season. In temperate deciduous forests, trees lose their leaves in the fall and regrow them in the spring.

Deletion Mutation- A deletion mutation is a mistake in the DNA replication process which removes nucleotides from the genome. A deletion mutation can remove a single nucleotide, or entire sequences of nucleotides. Deletions are thought to occur when the enzyme that synthesizes new DNA slips on the template DNA strand, effectively missing a nucleotide. This enzyme, polymerase, must attach the template DNA nucleotides in its active site for DNA replication to occur. Larger strands of DNA can undergo a deletion mutation during crossing-over, which takes place in meiosis. If the segments of DNA that are exchanged are not the same size, large sections may experience a deletion mutation, as seen below.

Denature- Denaturing a biological molecule refers to the loss of its three-dimensional (3-D) structure. Since molecules like proteins and DNA depend on their structure to accomplish their function, denaturation is accompanied by a loss of function. However, denaturation has no impact on the amino acid sequence of the protein itself.

Deoxyribose- Deoxyribose is the five-carbon sugar molecule that helps form the phosphate backbone of DNA molecules. DNA, or deoxyribonucleic acid is a polymer formed of many nucleic acids. Each nucleic acid is composed of a deoxyribose molecule bound to both a phosphate group and either a purine or a pyrimidine. Purines have two carbon and nitrogen rings, while pyrimidines only have one ring. The purines are adenine (A) and guanine (G) while the pyrimidines are cytosine and thymine in DNA. In RNA, the pyrimidines are cytosine (C) and uracil (U). Connected to deoxyribose and a phosphate group, these molecules are known as deoxyribonucleotides and are the direct precursors to DNA. The bonds between nucleotides are known as phosphodiester bonds because they take place between the phosphate group of one nucleotide and the deoxyribose sugar of the next nucleotide.

Dicotyledon- Dicotyledon, or dicot for short, refers to one of two main groups into which

flowering plants (angiosperms) are categorized. Most flowering plants are traditionally divided into two different categories: monocots and dicots. Members of each group tend to share similar features.

Dicots, as their name implies, are named for the number of cotyledons, or embryonic leaves, found in the seed embryo—they have two (di-) cotyledons. Unlike monocots, dicots are not a monophyletic group—meaning that the evolutionary history of dicot plants cannot be traced to a single most common recent ancestor. Instead, a number of lineages diverged earlier than the monocots did.

Diploid- Diploid describes a cell or nucleus which contains two copies of genetic material, or a complete set of chromosomes, paired with their homologs (chromosome carrying the same information from the other parent). By maintaining two copies of the genetic code, diploid organisms obtain an advantage by having greater genetic variation within their population, as each individual can express two alleles for each gene. Other organisms cycle between diploid and haploid lifecycles.

Disaccharide- A disaccharide, also called a double sugar, is a molecule formed by two monosaccharides, or simple sugars. Three common disaccharides are sucrose, maltose, and lactose. They have 12 carbon atoms, and their chemical formula is $C_{12}H_{22}O_{11}$. Other, less common disaccharides include lactulose, trehalose, and cellobiose. Disaccharides are formed through dehydration reactions in which a total of one water molecule is removed from the two monosaccharides.

DNA- Deoxyribonucleic acid, or DNA, is a biological macromolecule that carries hereditary information in many organisms. DNA is necessary for the production of proteins, the regulation, metabolism, and reproduction of the cell. Large compressed DNA molecules with associated proteins, called chromatin, are mostly present inside the nucleus. Some cytoplasmic organelles like the mitochondria also contain DNA molecules.

Domain- In biology, a domain refers to the largest of all groups in the classification of life. There are currently 3 agreed groups at this level, the Archaea domain, Bacteria domain, and Eukarya domain. Each domain contains a collection of organisms with similar properties and evolutionary histories, as scientists have organized them. It should be noted that while the three domain system is widely accepted and taught, it has been contested by a number of scientists. The supposed relationships between the three domains is discussed below.

Dominant Allele- A dominant allele is a variation of a gene that will produce a certain phenotype, even in the presence of other alleles. A dominant allele typically encodes for a functioning protein. The allele is dominant because one copy of the allele produces enough enzyme to supply a cell with plenty of a given product. Some traits rely on a product being created, like pigment molecules for hair color, ion-channels for proper cell function, and other traits that rely on a functioning enzyme. Other traits rely on the lack of an enzyme, or an enzyme that is not functioning efficiently. The lack of the product of the enzyme creates an entirely different phenotype.

Dominant Trait- A dominant trait is an inherited characteristic that appears in an offspring if it is contributed from a parent through a dominant allele. Traits, also known as phenotypes, may include features such as eye color, hair color, immunity or susceptibility to certain diseases and facial features such as dimples and freckles.

E

Echinoderm- An echinoderm is a member of the phylum Echinodermata which contains a number of marine organisms recognized by

their pentamerous radial symmetry, calcareous endoskeleton, and a water vascular system which helps operate their small podia. Podia are small extensions of flesh which are operated by water pressure and muscles, and controlled by the nervous system of the echinoderm. The calcareous endoskeleton is made of many small plates that overlap under the skin, forming an armor and a structural form for the organisms. Examples of an echinoderm include a starfish, a sand dollar, a brittle star, a sea urchin, and a sea cucumber. There are around 7,000 echinoderm species, and they can range from less than an inch to over three feet in diameter.

Ecology- Ecology is the branch of biology that studies how organisms interact with their environment and other organisms. Every organism experiences complex relationships with other organisms of its species, and organisms of different species. These complex interactions lead to different selective pressures on organisms. The pressures together lead to natural selection, which causes populations of species to evolve. Ecology is the study of these forces, what produces them, and the complex relationships between organisms and each other, and organisms and their non-living environment.

Ectoderm- The ectoderm is a germ layer, or tissue layer, that forms in an animal embryo during development. As the name suggests, the ectoderm is the germ layer that covers the outside of the embryo ('ecto' meaning outside). The ectoderm then goes on to give rise to a number of both internal and external structures. The ectoderm is one of the two tissue layers present in diploblasts, along with the endoderm, and one of the three layers found in triploblasts, along with the endoderm and mesoderm.

Embryo- An embryo refers to the early developmental stage of eukaryotic organisms following the fertilization of an egg (derived from a female) by sperm (derived from a male) as a method of sexual reproduction. In animals, the initial diploid cell that results from the fusion of the egg and the sperm

contains half the genetic information (DNA) from each of the parental cells and is termed a zygote. As the zygote begins to divide by mitosis, the early multicellular organism is termed an embryo. In humans, the embryonic stage of development is defined as the period from week 5 to week 11 of gestation. After this stage, the embryo transitions into a fetus. In plants, the process of embryogenesis extends from the time of fertilization until dormancy.

Endergonic Reaction- An endergonic reaction is a reaction in which energy is absorbed. In chemistry terms, this means that the net change in free energy is positive – there is more energy in the system at the end of the reaction than at the beginning of it.

Endocrine Glands- Endocrine glands are tissues or organs that excrete chemical substances (hormones) directly into the blood. Common endocrine glands are the hypothalamus, pineal, and adrenal glands. Endocrine glands secrete hormones directly into the bloodstream or into the intercellular space, allowing the hormones to reach their target.

Endocytosis- Endocytosis is the process of actively transporting molecules into the cell by engulfing it with its membrane. Endocytosis and exocytosis are used by all cells to transport molecules that cannot pass through the membrane passively. Exocytosis provides the opposite function and pushes molecules out of the cell. Like all systems in the human body, the need for homeostasis enables an equal flow of molecules in and out of the cell. This means the amount of molecules entering the cell by endocytosis is equal to the amount of molecules exiting the cell via exocytosis. The two processes combined ensure there is a balance of nutrients and waste for regular cell life and function.

Endoderm- The endoderm is an embryonic germ layer that gives rise to tissues that form internal structures and organs. The endoderm is found in both vertebrate and invertebrate embryos, and is responsible for the formation of the gut and associated organs. Endoderm

cells are present in both diploblasts and triploblasts.

Endoplasmic Reticulum- The endoplasmic reticulum (ER) is a large organelle made of membranous sheets and tubules that begin near the nucleus and extend across the cell. The endoplasmic reticulum creates, packages, and secretes many of the products created by a cell. Ribosomes, which create proteins, line a portion of the endoplasmic reticulum.

Endoskeleton- An endoskeleton is a skeleton found within the interior of the body; it provides structural support and protection for the internal organs and tissues of an organism.

Endoskeletons can take several forms, and can differ in complexity, shape and function, depending on the requirements of the animal. Most vertebrates have an endoskeleton, which is comprised of mineralized tissue in the form of bone and cartilage. This ‘true skeleton’ is formed from the mesoderm during embryogenesis.

Energy Pyramid- An energy pyramid (sometimes called a trophic pyramid or an ecological pyramid) is a graphical representation, showing the flow of energy at each trophic level in an ecosystem.

The width of each bar represents the units of energy available within each trophic level; the height is always the same. The flow of energy moves through the layers of the energy pyramid from the bottom-up, and is gradually reduced as energy is used up by the organisms at each level.

Enzyme Substrate Complex- The enzyme substrate complex is a temporary molecule formed when an enzyme comes into perfect contact with its substrate. Without its substrate an enzyme is a slightly different shape. The substrate causes a conformational change, or shape change, when the substrate enters the active site. The active site is the area of the enzyme capable of forming weak bonds with the substrate. This shape change can force two or more substrate molecules together, or split individual molecules into

smaller parts. Most reactions that cells use to stay alive require the actions of enzymes to happen fast enough to be useful. These enzymes are directly coded for in the DNA of the organism.

Epithelial Tissue- Epithelial tissues are thin tissues that cover all the exposed surfaces of the body. They form the external skin, the inner lining of the mouth, digestive tract, secretory glands, the lining of hollow parts of every organ such as the heart, lungs, eyes, ears, the urogenital tract, as well as the ventricular system of the brain and central canals of the spinal cord.

The cells making up epithelia are often closely bound to one another through specialized structures called tight junctions. They are also free from blood vessels and nerves and are supported by a connective tissue called the basement membrane. They have polarity with a distinct basal domain facing the basement membrane and the other apical surface facing the lumen of an organ or the external environment.

Eubacteria- Eubacteria, or “true” bacteria, are single-celled prokaryotic microorganisms that have a range of characteristics and are found in various conditions throughout all parts of the world. All types of bacteria fall under this title, except for archaeobacteria. Since eubacteria is so common, it comprises one of the three domains of life; the three domains are Archaea, Bacteria, and Eukarya.

Eukaryote- Eukaryotes are organisms whose bodies are made up of eukaryotic cells, such as protists, fungi, plants and animals. Eukaryotic cells are cells that contain a nucleus and organelles, and are enclosed by a plasma membrane. Organisms with eukaryotic cells are grouped into the biological domain Eukaryota (also sometimes called Eukarya). The other two domains of life, Archaea and Bacteria, have prokaryotic cells, which are simpler and lack organelles except for ribosomes, which make proteins.

Eukaryotic Cell- Eukaryotic cells are cells that contain a nucleus and organelles, and are enclosed by a plasma membrane. Organisms

that have eukaryotic cells include protozoa, fungi, plants and animals. These organisms are grouped into the biological domain Eukaryota. Eukaryotic cells are larger and more complex than prokaryotic cells, which are found in Archaea and Bacteria, the other two domains of life.

Exon- An exon is a coding region of a gene that contains the information required to encode a protein. In eukaryotes, genes are made up of coding exons interspersed with non-coding introns. These introns are then removed to make a functioning messenger RNA (mRNA) that can be translated into a protein.

F

Fat- Fat is a term used to describe a class of macro nutrients used in metabolism called triglycerides. These make up one of three classes of macronutrients including proteins and carbohydrates. Fats provide a means of storing energy for most eukaryotes, as well as act as a food source. Fats have the highest energy storage potential of the macronutrients, and are very chemically stable, making them ideal for storing energy for later use. Macronutrients does not refer to the size of the molecule, but to the amount needed to sustain life. Vitamins and minerals are considered micronutrients.

Fatty Acids- Fatty acids are comprised of hydrocarbon chains terminating with carboxylic acid groups. Fatty acids and their associated derivatives are the primary components of lipids. The length and degree of saturation of the hydrocarbon chain is highly variable between each fatty acid, and dictates the associated physical properties (e.g., melting point and fluidity). Moreover, fatty acids are responsible for the hydrophobic properties (insoluble in water) exhibited by lipids.

Fetus- Fetal development occurs between the embryonic stage of development and birth in humans. This stage begins after 11 weeks of gestation, when the embryo begins to exhibit human characteristics, and lasts until birth. Typically, all the major organs and tissues can be observed; however, they are not yet fully developed or appropriately situated within the body.

Flagellum- A flagellum is a microscopic hair-like organelle used by cells and microorganisms for movement. The word flagellum in Latin means whip, just like the whipping motion flagella (plural) often use for locomotion. Specialized flagella in some organisms are also used as sensory organelles that can detect changes in temperature and pH.

Formaldehyde- Formaldehyde is a simple organic compound with the formula CH_2O . It is of interest to doctors and scientists, as well as to many other industries, because of its unique chemical properties.

Fossil Record- A fossil record is a group of fossils which has been analyzed and arranged chronologically and in taxonomic order. Fossils are created when organisms die, are incased in dirt and rock, and are slowly replaced by minerals over time. What is left is a mineral impression of an animal which once existed. Many fields and specialties are utilized to categorize and arrange these fossils, including comparative anatomy, radiometric dating, and DNA analysis. Using the data from the fossil record, scientist try to recreate phylogenies, or trees describing the relationships between animals, both alive and extinct. The fossil record helps inform how different groups of animals are related through evolution.

Fungi- Fungi (singular: fungus) are a kingdom of usually multicellular eukaryotic organisms that are heterotrophs (cannot make their own food) and have important roles in nutrient cycling in an ecosystem. Fungi reproduce both sexually and asexually, and they also have symbiotic associations with plants and bacteria. However, they are also responsible

for some diseases in plants and animals. The study of fungi is known as mycology.

G

Gamete- Gametes are haploid reproductive cells in sexually reproducing organisms that fuse with one another during fertilization. Fertilization produces a diploid cell that undergoes repeated rounds of cell division to produce a new individual. Gametes are the physical carriers of genetic information from one generation to the next. They carry recombinant chromosomes produced at the end of meiosis.

Often, species that reproduce sexually have two morphologically distinct types of individuals that produce different gametes. The larger gamete produced by the female is usually called the egg or ovum. The smaller one is the sperm. Similar distinctions also exist in the plant world, with the female gamete being called the ovule and the male gamete going by the name of pollen.

Gene- A gene is an extremely specific sequence of nucleotide monomers that has the ability to completely or partially control the expression of one or more traits in every type of living organism. Genes are formed from deoxyribonucleic acid (DNA) and, in the case of some viruses, ribonucleic acid (RNA) polymers.

Genetic Recombination- Genetic recombination occurs when genetic material is exchanged between two different chromosomes or between different regions within the same chromosome. We can observe it in both eukaryotes (like animals and plants) and prokaryotes (like archaea and bacteria). Keep in mind that in most cases, in order for an exchange to occur, the sequences containing the swapped regions have to be homologous, or similar, to some degree.

Genotype- The genotype of an organism is the chemical composition of its DNA, which gives rise to the phenotype, or observable traits of an organism. A genotype consists of all the nucleic acids present in a DNA molecule that code for a particular trait. The outward appearance, or phenotype, is the result of interactions of proteins being created by the DNA. Modern DNA analyzing techniques have made it easier to identify which segments of DNA are responsible for various phenotypes.

A genotype has different alleles, or forms. The different alleles are produced by mutations to the DNA, and may give rise to beneficial or detrimental changes. In bacteria, the DNA exists in a ring and only one allele for each genotype is present. Sometime, an allele will mutate in a beneficial way, the organism will reproduce more and the genotype will increase in the population. In sexually reproducing organisms, there are two alleles present in each organism, which can have complex interactions with each other, and other genes. Mutations can occur in these alleles, new combinations can arise during meiosis, and infinite amount of variety can be created. These combinations of genotype give rise to the enormous variety of life on Earth.

Gland- A gland is a group of cells or a “secreting organ” that excretes a chemical substance. This substance can take the form of hormones, sweat, saliva, mucus, or acids (i.e. HCl acid in gastric glands). Glands are tasked with helping create the substance that they then secrete for further use or total elimination from the body.

Glycerol- Glycerol is a colorless, odorless liquid with a sweet taste. It is viscous at room temperature and non-toxic in low concentrations. Glycerol was discovered in 1779. It is also called glycol alcohol, glycerin or glycerine in some literature.

Glycerol is seen in biological systems as an intermediate in carbohydrate and lipid metabolism because surplus carbohydrate can be converted into long chain fatty acids and esterified with the three hydroxyl groups. Glycerol can influence immune reactions in the body through histamines, increased

antibody production and by enhancing immune cell activity and is therefore classified as an allergen. In the blood, glycerol can increase blood pressure by preferentially attracting the water from tissues into plasma and lymph. In nephrons, glycerol can increase urine volume by preventing water resorption.

Golgi Apparatus- The Golgi apparatus is an organelle in eukaryotic organisms that moves molecules from the endoplasmic reticulum to their destination. The organelle also modifies products of the endoplasmic reticulum to their final form. The Golgi apparatus is comprised of a series of flattened sacs that extend from the endoplasmic reticulum.

Gradualism- In biology, gradualism is a theory that assumes large morphological changes in organisms occur via a number of smaller step over a number of years. The theory can be contrasted to punctuated equilibrium, which suggests that species remain relatively constant over time, until drastic events force quick evolutionary changes. Proponents of gradualism fall on a spectrum. Those who support phyletic gradualism endorse a slow, steady change through time which leads to drastic morphological changes. Punctuated gradualism, on the other side of the spectrum, suggests that the process is both gradual, and punctuated with drastic events.

Gravitropism- Gravitropism, also called geotropism, where geo- means the earth, and tropism refers to turning, is the growth of a plant’s organ or change in the direction of its growth in response to gravity. Plants can sense gravity due to the presence of cells called statocytes, which contain granules called statoliths in their root cap, or the covering at the tip of the root. The statoliths are denser than the cytoplasm around them, and they stimulate the production of auxin, a hormone that is crucial for regulating plant growth. Gravitropism is one of a few forms of tropism, such as phototropism, where the direction of growth changes in response to light.

Gymnosperm- Gymnosperms are a group of plants which produce seeds that are not contained within an ovary or fruit. The seeds

are open to the air and are directly fertilized by pollination.

“Gymnosperm”, from the Greek, gymnos, “naked” and sperma, “seed”, develop their seeds on the surface of scales and leaves, which often grow to form cone or stalk shapes, contrasting in characteristics from the angiosperms, flowering plants which enclose their seeds within an ovary.

H

Haploid- Haploid is the condition of a cell having a one set of chromosomes. Ploidy refers to the number of copies of the genome. Humans, and many other organisms, are diploid organisms. This means that the majority of their lifecycle is spent with two copies of the genome in every cell. Typically, haploid cells are created for reproductive purposes. By reducing the genome to one copy, different copies can be rearranged when creating a zygote. By reducing the DNA material in the gametes to haploid, many new combinations are possible within the offspring. This increases the genetic variation and helps populations adapt to their environment.

Heme- A heme is an organic, ring-shaped molecule. Due to its special structure, a heme is capable of holding, or “hosting” an iron molecule. A heme is made from 4 pyrroles, which are small pentagon-shaped molecules made from 4 carbons and 1 nitrogen. Four pyrroles together form a tetrapyrrole. If the tetrapyrrole has substitutions on the side chains which allow it to hold a metal ion, it is called a porphyrin. Thus, a heme is an iron-holding porphyrin.

Herbaceous- Herbaceous plants are non-woody plants, such as most ferns and grasses, which either form tiny amounts of hard woody tissue, or none at all. Unlike woody plants, such as trees, these plants don't have

a stem that will remain above the ground when their leaves die. Additionally, the body of an herbaceous plant is mainly made up of cellulose, which makes it relatively flexible and fragile, while the stems of a woody plant have lignin, which is far stronger, providing the plant with stiffness, and which lasts for years.

Heredity- Heredity is the passing of traits from parent to offspring. Molecules of DNA carry information that codes for various proteins. These proteins interact with the environment, causing observable patterns of life. The complex mechanisms that replicate and reproduce DNA and the organisms it creates can be recombined and mutated during the process, leading to new and various forms of life. All organisms, from the simplest bacteria to the largest eukaryotes, use DNA as the main form of heredity.

Hermaphrodite- A hermaphrodite is an organism with both male and female genitalia. In sexually reproducing organisms, males have organs that produce male gametes, usually sperm. Females have different sexual organs that produce female gametes, usually called eggs. In sexually dimorphic organisms, each organism only has type of reproductive organs, and the population is divided into genders. Sometimes the organisms are divided almost equally. In these cases, individuals must compete for mates. Sometimes the genders pair off equally, one male for one female. Other times, one male or female will breed with a large group of the other gender.

Homologous- “Homologous,” in biology, means a similarity in internal or chromosomal structures.

With internal structures, homology indicates organs that have similar positions, structures, or evolutionary origins. It's important to note, however, that organs do not have to have the same function to be homologous.

Hydrochloric Acid- Hydrochloric acid is a corrosive acid produced through the dissolving of hydrogen chloride (HCl) in water and is, therefore, an aqueous hydrogen halide

solution. Hydrochloric acid is used in various industries as a cleaning, pickling or pH-adjusting solution and is also found in a diluted form in gastric juice. Hydrogen chloride is sometimes referred to as muriatic acid, hydronium chloride, chlorane, spirits of salt or acidum salis.

Hydrolyze- To hydrolyze a bond is to break it apart with water. From the Greek words hydro and lysis, or “water break”, hydrolyze is literally just that. Water (or H₂O) breaks into two parts: a positive hydrogen, H⁺, and a negative hydroxide, (OH)⁻. These charged molecules are used to split larger molecules by means of attracting different parts of a bond. By doing this a bond can be split, the hydroxide bonding to one half and the positive hydrogen to the other.

Hydrophilic- A hydrophilic molecule or substance is attracted to water. Water is a polar molecule that acts as a solvent, dissolving other polar and hydrophilic substances. In biology, many substances are hydrophilic, which allows them to be dispersed throughout a cell or organism. All cells use water as a solvent that creates the solution known as cytosol. Cytosol contains many substances, most of which are hydrophilic on at least part of the molecule. This ensures that that can be transported about the cell easily. Substances that are hydrophobic, or repel water, are often transported through and between cells with hydrophilic proteins or structures attached to aid in their dispersal.

Hydrophobic- Hydrophobic literally means “the fear of water”. Hydrophobic molecules and surfaces repel water. Hydrophobic liquids, such as oil, will separate from water. Hydrophobic molecules are usually nonpolar, meaning the atoms that make the molecule do not produce a static electric field. In polar molecules these opposite regions of electrical energy attract to water molecules. Without opposite electrical charges on the molecules, water cannot form hydrogen bonds with the molecules. The water molecules then form more hydrogen bonds with themselves and the nonpolar molecules clump together.

The hydrophobic effect is caused by nonpolar molecules clumping together. Large macromolecules can have hydrophobic sections, which will fold the molecule so they can be close to each other, away from water. Many amino acids in proteins are hydrophobic, helping the proteins obtain their complicated shapes. The hydrophobic effect extends to organisms, as many hydrophobic molecules on the surface of an organisms help them regulate the amount of water and nutrients in their systems.

Hypertonic- In biology, hypertonic refers to muscles that are more toned, or have greater tension, than other muscles in a body or are more toned than a “normal” comparison model.

On the cellular and chemical levels, hypertonic fluids have a greater osmotic pressure than other fluids, and hypertonic solutions have a higher solution concentration than another, more diluted solution.

Hypertonic Solution- A hypertonic solution contains a higher concentration of solutes compared to another solution. The opposite solution with a lower concentration is known as the hypotonic solution. Scientists must describe cell contents compared to the environment. If a cell is placed in a hypertonic solution, the cell is considered hypotonic.

Hypotonic- Hypotonic can mean several things in biology. Its many definitions apply to both human biology and biochemistry.

When referring to humans or animals, hypotonic signifies a muscle’s having less tone, or shape, compared to a normal comparison model or when compared to another muscle in the same human body.

The biochemical fields take this concept to a molecular level. In these arenas, hypotonic refers to a solution’s having less osmotic pressure, or concentration, than another solution between a semi-permeable membrane. In more simpler terms, hypotonic can mean a solution that has a lower concentration of solutes than other solutions, made of the same solutes.

Hypotonic Solution- A hypotonic solution is a solution that has a lower solute concentration compared to another solution. A solution cannot be hypotonic, isotonic or hypertonic without a solution for comparison. Hypotonic is a description of the solute content of one solution in relation to another solution. It is used in biology to help scientist describe cells. Knowing the osmolarity (concentration of a solution in number of solutes per liter) of different solutions can show scientists which way the water gradient and solute gradients will form.

I

Interphase- Interphase is the longest stage in the eukaryote cell cycle. During interphase, the cell acquires nutrients, creates and uses proteins and other molecules, and starts the process of cell division by replicating the DNA. Interphase is divided into three distinct stages, Gap 1, Synthesis, and Gap 2, which are discussed below. The purpose of interphase in all cell types is to prepare for cell division, which happens in a different stage of the cell cycle.

Invertebrate- Invertebrates are animals that don't have a backbone. The vertebral column is another name for the backbone. Over 90% of all species on Earth are invertebrates, and invertebrate species have been found in the fossil record as far back as 600 million years ago. Molecular biology studies suggest that all invertebrates evolved from a single invertebrate group.

Isotonic Solution- An isotonic solution is one that has the same osmolarity, or solute concentration, as another solution. If these two solutions are separated by a semipermeable membrane, water will flow in equal parts out of each solution and into the other. The effect is zero water flow between the two solutions, although water is moving both ways. In biology, some cells must be

maintained in an isotonic solution to support cellular functions. Many animal cells, which lack a cell wall to provide support against the effects of water pressure, rely on the stability of the external environment to maintain their shape. Most animals maintain the pH and osmolarity of the fluids inside of their bodies to create isotonic solutions to bathe their cells in. This solution can carry nutrients and water, but only in proportions equal to that inside the cell.

K

Ketone Bodies- Ketone bodies, or simply ketones are substances produced by the liver during gluconeogenesis, a process that creates glucose in times of fasting and starvation. There are three ketone bodies produced by the liver. They are acetoacetate, beta-hydroxybutyrate, and acetone. These compounds are used in healthy individuals to provide energy to the cells of the body when glucose is low or absent in the diet.

Kingdom- In the study of taxonomy, the rank of kingdom is just below domain, as seen on the image below. All of life, thought to come from a single origin, can be broken down into lower levels of classification, such as a kingdom or phylum. Each consecutive level represents a more related group of organisms. This structure has evolved from only a few kingdom taxon with 3 or 4 lower divisions, to kingdom being the second highest division and having 6 divisions within that structure. This is to accommodate the growing number of recognized species and our understanding of how they are related.

Krebs Cycle- The Krebs Cycle, also called the citric acid cycle, is the second major step in oxidative phosphorylation. After glycolysis breaks glucose into smaller 3-carbon molecules, the Krebs cycle transfers the energy from these molecules to electron

carriers, which will be used in the electron transport chain to produce ATP.

L

Labia- Labia refers to a part of the female genital anatomy that comprises the external region of the vulva (shown below). There are two pairs of labia in human women, termed the labia minora and the labia majora. The labia minora are the inner folds of skin residing under the labia majora. The labia majora are larger than the labia minora, flat in shape, and are often visible. The function of the labia is to provide protection for the vagina, clitoris, and urethra.

Lactase- Lactase is an enzyme found in the mammalian small intestine that digests lactose, which is a sugar found in milk. Mammals use milk to feed their young, and in most mammals, the activity of lactase decreases after the young is weaned and can consume other foods. Lactose tolerance (also called lactose persistence), or being able to digest milk through adulthood, is a genetic mutation; the “default” state in humans, like other mammals, is lactose intolerance after childhood.

Law of Independent Assortment- The Law of Independent Assortment states that different genes and their alleles are inherited independently within sexually reproducing organisms. During meiosis, chromosomes are separated into multiple gametes. Genes linked on a chromosome can rearrange themselves through the process of crossing-over. Therefore, each gene is inherited independently.

Lesion- A lesion is an area of inflammation in a tissue that suffered trauma or the impact of chronic illness. Typically, a lesion involves an abnormal structural change to a tissue. So, it is often defined as a site of abnormal tissue change. These changes can take place in the

form of wounds or bruising, but is also a term used by oncologists to describe wounds caused by malignant or benign (innocuous) cancers.

Liposome- A liposome is a closed, spherical lipid bilayer, which forms an internal cavity capable of carrying aqueous solutions. A lipid bilayer is composed of two sheets of tightly arranged phospholipids. These molecules have a hydrophobic tail and a hydrophilic head region. When two single membranes come together, the hydrophobic tails attract toward each other, while the heads of both membranes are attracted to the surrounding water. This forms a double layer of phospholipid molecules, which exclude the internal solution from the outside. The solution can then be transported with the liposome where it is needed.

Lyse- To lyse is to break apart a larger particle into smaller pieces. Lysis, or the process of lysing, can occur both inside and outside of the cell. While localized lysis can result in a tiny puncture of a cell wall or cell membrane, harsher chemical lyses result in the expulsion of all cellular contents and cell death. A variety of lytic mechanisms exist, and can result in the disintegration of either cellular or extra-cellular components.

Lysosome- Lysosomes are specialized vesicles within cells that digest large molecules through the use of hydrolytic enzymes. Vesicles are small spheres of fluid surrounded by a lipid bilayer membrane, and they have roles in transporting molecules within the cell. Lysosomes are only found in animal cells; a human cell contains around 300 of them. Not only do they digest large molecules, they are also responsible for breaking down and getting rid of waste products of the cell. Lysosomes contain over 60 different enzymes that allow them to carry out these processes.

M

Mass Extinction- Mass extinction is an event in which a considerable portion of the world's biodiversity is lost. An extinction event can have many causes. There have been at least 5 major extinction events since the Cambrian explosion, each taking a large portion of the biodiversity with it.

Mass Spectrometry- Mass spectrometry is a tool used to quickly analyze the molecular composition of a sample, helping scientists determine the chemical structure. The process has several steps which serve to break the molecules apart and differentiate their size and charge.

Meiosis- Meiosis is the process in eukaryotic, sexually-reproducing animals that reduces the number of chromosomes in a cell before reproduction. Many organisms package these cells into gametes, such as egg and sperm. The gametes can then meet, during reproduction, and fuse to create a new zygote. Because the number of alleles was reduced during meiosis, the combination of two gametes will yield a zygote with the same number of alleles as the parents. In diploid organisms, this is two copies of each gene.

Mesoderm- The mesoderm is a germ layer present in animal embryos that will give rise to specialized tissue types. The mesoderm is one of three germ layers found in triploblastic organisms; it is found between the ectoderm and endoderm. All bilaterally-symmetrical animals are triploblasts, whereas some simpler animals such as cnidaria and ctenophores (jellyfish and comb jellies) have only two germ layers and are diploblasts. The mesoderm plays an important role in animal development. It goes on to form many central structures including the skeletal system, muscular system, and the notochord.

Metamorphosis- Metamorphosis is a process by which animals undergo extreme, rapid physical changes some time after birth. The result of metamorphosis may be change to the organism's entire body plan, such as a change in the animal's number of legs, its means of eating, or its means of breathing.

Metaphase- Metaphase is a stage in eukaryotic cell division in which the chromosomes align on the metaphase plate in the middle of the cell. The stages of prophase and prometaphase come before metaphase. In those stages of cell division, the chromosomes are condensed, the spindle fibers form, and the nuclear envelope is broken down. During metaphase and late prometaphase, the cell performs a series of checkpoints to ensure that the spindle has formed. The microtubules emanating from each side of the cell attach to each chromosome. As the microtubules are retracted, an equal tension is applied from each side of the cell to the chromosomes. This moves them to the middle of the cell. After metaphase, the sister chromatids that comprise the chromosomes are divided, and the process of cell division is completed.

Metaphase I- The first metaphase of meiosis I encompasses the alignment of paired chromosomes along the center (metaphase plate) of a cell, ensuring that two complete copies of chromosomes are present in the resulting two daughter cells of meiosis I. Metaphase I follows prophase I and precedes anaphase I.

Miosis- Miosis is a medical term referring to the constriction of the pupil. Miosis is also known as myosis. Both terms refer to the closing of the pupil through the actions of small muscles in the eye. Miosis reduces the amount of light that enters the eye, which is necessary in daily life as the levels of light change in an organism's environment. Miosis can also be induced by a wide variety of medicinal and recreational drugs, and is sometimes one of the diagnosing criteria for impaired driving arrests. Miosis is not to be confused with meiosis or mitosis, which are both forms of cell division.

Mitochondria- Mitochondria (singular: mitochondrion) are organelles within eukaryotic cells that produce adenosine triphosphate (ATP), the main energy molecule used by the cell. For this reason, the mitochondrion is sometimes referred to as "the powerhouse of the cell". Mitochondria

are found in all eukaryotes, which are all living things that are not bacteria or archaea. It is thought that mitochondria arose from once free-living bacteria that were incorporated into cells.

Mitosis- Mitosis is the step in the cell cycle that the newly duplicated DNA is separated, and two new cells are formed. This process is important in single-celled eukaryotes, as it is the process of asexual reproduction. In multi-celled eukaryotes, mitosis is how a single zygote can become an entire organism. Mitosis has several distinct stages, or phases, that will be discussed below. The other stages in the cell cycle include growth and the replication of DNA, both required for mitosis to take place. Below is a picture of where mitosis fits into the cell cycle.

Monocotyledon- Monocot- Monocotyledon, or monocot for short, refers to one of two groups of flowering plants, or “angiosperms.” Most flowering plants are traditionally divided into two different categories: monocots and dicots. Members of each group tend to share similar features.

Monocots, as the name implies, are defined by having seeds that contain a single (mono-) embryonic leaf known as a cotyledon. This is a monophyletic group that constitutes a majority of our agricultural biomass and include many important crop staples including, but not limited to, rice, wheat, corn, sugar cane, bamboo, onion, and garlic.

Monohybrid Cross- A monohybrid cross is a genetic mix between two individuals who have homozygous genotypes, or genotypes that have completely dominant or completely recessive alleles, which result in opposite phenotypes for a certain genetic trait.

Monohybrid crosses are used by geneticists to observe how the offspring of homozygous individuals express the heterozygous genotypes they inherit from their parents. Typically, this mix determines the dominant genotype.

Monomer- A monomer is a small molecule that reacts with a similar molecule to form a

larger molecule. It is the smallest unit in a polymer, which is often a macromolecule with high molecular weight.

Mutation- At the simplest level, a mutation is a change or transformation. In biology, mutations refer to changes in chromosomes and genes, which typically manifest physically.

Myofibril- A myofibril is a component of the animal skeletal muscle. Myofibrils are long filaments that run parallel to each other to form muscle (myo) fibers. The myofibrils, and resulting myofibers, may be several centimeters in length. The muscle fibers are single multinucleated cells that combine to form the muscle. Myofibrils are made up of repeating subunits called sarcomeres. These sarcomeres are responsible for muscle contractions.

N

Natural Selection- Natural selection is a pressure that causes groups of organisms to change over time. Animals inherit their genetics from their parents or ancestors, and the environment is constantly changing. So, no organism is perfectly adapted to its environment. Thus, natural selection is constantly influencing the evolution of species.

NMDA Receptor- NMDA receptors are neurotransmitter receptors that are located in the post-synaptic membrane of a neuron. They are proteins embedded in the membrane of nerve cells that receive signals across the synapse from a previous nerve cell. They are involved in signal transduction and control the opening and closing of ion channels. They are believed to play an important role in learning and memory formation.

Nocebo Effect- The nocebo effect, the opposite of the placebo effect, is a negative reaction caused by a non-medicated control

substance, such as a sugar pill. In the placebo effect, a patient experiences the benefits of a medicine under trial, without receiving the medicine. This is thought to be caused by the underlying belief of the patient that the treatment they are receiving will bring beneficial effects. The placebo effect is similar, in that the patient's expected outcomes can manifest real symptoms. Often, the placebo effect is observed when patients are told potential side-effects of a drug, but are only given the placebo, or non-medicated treatment. If patients manifest the side-effects they were told about and never took the drug, this is a clear example of the placebo effect.

Nuclear Membrane- The nuclear membrane, also called the nuclear envelope, is a double membrane layer that separates the contents of the nucleus from the rest of the cell. It is found in both animal and plant cells. A cell has many jobs, such as building proteins, converting molecules into energy, and removing waste products. The nuclear envelope protects the cell's genetic material from the chemical reactions that take place outside the nucleus. It also contains many proteins that are used in organizing DNA and regulating genes.

Nucleic Acid- A nucleic acid is a chain of nucleotides which stores genetic information in biological systems. It creates DNA and RNA, which store the information needed by cells to create proteins. This information is stored in multiple sets of three nucleotides, known as codons.

O

Omnivore- An omnivore is an organism that can feed on both plant and animal sources. Carnivores are animals that feed only on other animals. Herbivores feed exclusively on plant material. An omnivore can feed on both sources. Oftentimes, mostly herbivorous

animals supplement their diets with small amounts of insects or other animals. In other species, an almost equal amount of meat and plant materials are eaten. In other species, plants are used to supplement the diet when meat supplies are low. Many animals have evolved to eat whatever is available, be it plant or animal.

Organelle- The term organelle is derived from the word 'organ' and refers to compartments within the cell that perform a specific function. These compartments are usually isolated from the rest of the cytoplasm through intracellular membranes. These membranes could be similar to the plasma membrane or made from a different complement of lipids and proteins. The properties of a membrane are due to its origin, such as with mitochondria or plastids, or due to its specific function, as seen with the nuclear membrane. A few organelles are not membrane-bound and are present as large complexes made of RNA and protein, such as ribosomes.

Osmosis- Osmosis is a type of diffusion that, in biology, is usually related to cells. Diffusion is when molecules or atoms move from an area of high concentration to an area of low concentration. Osmosis is when a substance crosses a semipermeable membrane in order to balance the concentrations of another substance. In biology, this is usually when a solvent such as water flows into or out of a cell depending on the concentration of a solute such as salt. Osmosis happens spontaneously and without any energy on the part of the cell.

Osmotic Pressure- Osmotic pressure can be thought of as the pressure that would be required to stop water from diffusing through a barrier by osmosis. In other words, it refers to how hard the water would "push" to get through the barrier in order to diffuse to the other side.

Osmotic pressure is determined by solute concentration – water will "try harder" to diffuse into an area with a high concentration of a solute, such as a salt, than into an area with a low concentration.

Ovary- An ovary refers to the female reproductive organ in vertebrates that produces the female gametes (eggs/oocytes) and functions as an exocrine gland. The ovaries are typically found in pairs; however, both are not functional in all animals (e.g., birds and some fish species). The number of eggs produced by each species differs, with fish and amphibian species capable of producing millions of eggs throughout their lifetime. In addition, depending on the species, the eggs produced by the ovary may be small, and invisible to the naked eye (e.g., humans), or they may be large, encompassing the entire follicle (e.g., birds). In humans, one of the two ovaries (or both) will release an egg during ovulation each menstrual cycle.

Oxidizing Agent- An oxidizing agent is a chemical substance which causes another chemical species to lose electrons. Oxidation means the loss of electrons, the loss of a hydrogen atom, or the addition of an oxygen atom. The oxidizing agent has the ability to accept or transfer those electrons.

P

Paraphyletic- Paraphyletic is a term used in evolutionary biology to describe a group of animals which contains a common ancestor and some, but not all, of the descendants. Describing a group of organisms as a paraphyletic group implies that for some reason, some members of the natural group have been placed into another group. There are many reasons this could happen.

Parasitism- Parasitism is a type of symbiotic relationship, or long-term relationship between two species, where one member, the parasite, gains benefits that come at the expense of the host member. The word parasite comes from the Latin form of the Greek word παράσιτος (parasitos), meaning “one who eats at the table of another”.

Passive Immunity- A passive immunity is a resistance to a disease or toxin where the resistance was gained without the immune system producing antibodies. Any foreign body, whether it be a virus or a toxin, is likely to harm an organism’s cells. To preclude this outcome, organisms have developed both passive and active immunities to combat everyday threats. Unlike active immunities, passive immunities are present from birth.

Pedigree- A pedigree is a diagram that depicts the biological relationships between an organism and its ancestors. It comes from the French “pied de grue” (“crane’s foot”) because the branches and lines of a pedigree resemble a thin crane’s leg with its branching toes. A pedigree is used for different animals, such as humans, dogs, and horses. Often, it is used to look at the transmission of genetic disorders.

Peptide Bond- peptide bond is a covalent bond formed between two amino acids. Living organisms use peptide bonds to form long chains of amino acids, known as proteins. Proteins are used in many roles including structural support, catalyzing important reactions, and recognizing molecules in the environment. A peptide bond is therefore the basis of most biological reactions. Forming peptide bonds is a requirement for all life, and the process is very similar in all forms of life.

Perspiration- Perspiration, or sweating, is the secretion of fluid (sweat) from sweat glands. This word is both a noun and a verb; it can refer to the act of sweating or to the sweat itself. Sweat mostly consists of water, along with minerals, urea, and lactic acid. Only mammals perspire; some, such as humans, other primates, and horses, perspire relatively more than others because they have more sweat glands. Humans have between two and four million sweat glands. Sweating is one way of cooling the body temperature in warm weather or during exercise.

Pharynx- The pharynx is a five-inch long tube that starts near our nose and ends at our windpipe. The pharynx is generally considered a part of the throat in both vertebrate and invertebrate animals. In humans, it is a hollow

structure (or muscular cavity) lined with moist tissue. This is typical of all structures within our alimentary and digestive tracts. Having a moist lining with a mucus rich barrier allows us both to breathe and for our food to travel safely through our canal without damaging our sensitive tissues. The muscular pharynx effectively forms the entry for the esophagus, or our “food canal,” and the trachea, also known as our “windpipe.” For this reason, the pharynx is considered a part of both our respiratory and digestive systems.

Phenotype- A phenotype is the physical expression of DNA. In contrast, the genotype is the chemical makeup of DNA that causes a particular phenotype. DNA is first transposed into RNA, a slightly different information molecule, which can then be translated into a protein. Phenotypes are caused by the interactions of the many different proteins created by DNA. This process can get incredibly complicated. Even in the lowest lifeforms there are thousands of genes, creating thousands of different proteins. These proteins interact in complex ways with each other and the environment, allowing the organism to obtain energy from nutrients.

Photosynthesis- Photosynthesis is the biochemical pathway which converts the energy of light into the bonds of glucose molecules. The process of photosynthesis occurs in two steps. In the first step, energy from light is stored in the bonds of adenosine triphosphate (ATP), and nicotinamide adenine dinucleotide phosphate (NADPH). These two energy-storing cofactors are then used in the second step of photosynthesis to produce organic molecules by combining carbon molecules derived from carbon dioxide (CO₂). The second step of photosynthesis is known as the Calvin Cycle. These organic molecules can then be used by mitochondria to produce ATP, or they can be combined to form glucose, sucrose, and other carbohydrates. The chemical equation for the entire process can be seen below.

Phototropism- Phototropism is the ability of a plant, or other photosynthesizing organism, to

grow directionally in response to a light source.

Phytoplankton- Phytoplankton are a type of microscopic plankton capable of photosynthesis found in oceans, seas, and freshwater, and an essential component of aquatic ecosystems. Phytoplankton can range in size and shape, and since they are photosynthesizing autotrophic organisms, they inhabit waters exposed to sunlight. Although each organism is microscopic, in sufficient numbers, phytoplankton can be observed as colored patches at the surface of bodies of water, or where two currents meet, due to the presence of chlorophyll. Phytoplankton are often cultured to support aquaculture, and are critical for controlling carbon dioxide and oxygen levels in the Earth’s atmosphere since the Precambrian Era. Indeed, it is estimated that phytoplankton are responsible for as much as 85% of the oxygen in the atmosphere.

Placenta- The placenta is an organ which is responsible for nourishing and protecting a fetus during pregnancy. It is unique in that it is a temporary organ; it grows alongside the fetus during pregnancy, and then is expelled along with the fetus at birth. The placenta is also sometimes called “afterbirth,” as it is expelled through the vagina after the fetus has been delivered.

Pollen - Pollen refers to the powdery product synthesized by seed plants responsible for the production of the male gametes of the plant.

Polygenic Inheritance- Polygenic inheritance, also known as quantitative inheritance, refers to a single inherited phenotypic trait that is controlled by two or more different genes.

Polyp- In biology, polyp is a term with several meanings. It can refer to a stage in the development of certain species of invertebrates, or it can refer to a growth in the tissues of organs. Both are described below.

Polysaccharide - A polysaccharide is a large molecule made of many smaller monosaccharides. Monosaccharides are

simple sugars, like glucose. Special enzymes bind these small monomers together creating large sugar polymers, or polysaccharides. A polysaccharide is also called a glycan. A polysaccharide can be a homopolysaccharide, in which all the monosaccharides are the same, or a heteropolysaccharide in which the monosaccharides vary. Depending on which monosaccharides are connected, and which carbons in the monosaccharides connects, polysaccharides take on a variety of forms. A molecule with a straight chain of monosaccharides is called a linear polysaccharide, while a chain that has arms and turns is known as a branched polysaccharide.

Prokaryote- Prokaryotes are unicellular organisms that consist of a single prokaryotic cell. Prokaryotic cells are simple cells that do not have a true nucleus or other cell organelles. Bacteria and Archaea are the two domains of life that are prokaryotes. Prokaryotes can be contrasted with eukaryotes, which have more complex eukaryotic cells with a nucleus and organelles. Eukaryotes are the third domain of life, Eukaryota, and include all complex multicellular organisms such as plants, animals, fungi, and protozoa.

Prokaryotic Cell- Prokaryotic cells are cells that do not have a true nucleus or membrane-bound organelles. Organisms within the domains Bacteria and Archaea have prokaryotic cells, while other forms of life are eukaryotic. However, organisms with prokaryotic cells are abundant and make up much of Earth's biomass.

Prophase- Prophase is the starting stage of cell division in eukaryotes. Prophase, in both mitosis and meiosis, is recognized by the condensing of chromosomes and separation of the centrioles in the centrosome. This organelle controls the microtubules in the cell, and each centriole is one half of the organelle. During prophase, they separate to provide microtubule centers in each new cell. Organelles, chromosomes, and many other substances and structures are moved about the cell by microtubules and associated

proteins. These structures together are known as molecular motors and drive many cell processes. Prophase begins cell division by separating the centers for these molecular motors, and condensing the chromosomes.

Prophase I- Prophase I of meiosis I is a process that involves five different stages during which genetic material in the form of alleles crosses over and recombines to form non-identical haploid chromatids. Prophase I is the first stage of meiosis I, followed by prophase II, anaphase I, anaphase II, metaphase I and metaphase II.

Prophase II- During prophase II of meiosis II, four important steps occur. These are the condensing of chromatin into chromosomes, disintegration of the nuclear envelope, migration of centrosomes to either pole, and the reconstruction of the spindle apparatus. However, centrosomes are not present in all cells.

R

Receptor- A receptor is a protein which binds to a specific molecule. The molecule it binds is known as the ligand. A ligand may be any molecule, from inorganic minerals to organism-created proteins, hormones, and neurotransmitters. The ligand binds to the ligand-binding site on the receptor protein. When this binding happens, the receptor undergoes a conformational change. This change in shape slightly alters the protein's function. From this, a number of things can happen. The conformational change in the receptor can cause the receptor to become an enzyme and actively combine or separate certain molecules.

Recessive Allele- A recessive allele is a variety of genetic code that does not create a phenotype if a dominant allele is present. In a dominant/recessive relationship between two alleles, the recessive allele's effects are

masked by the more dramatic effects of the dominant allele. An allele is a specific variation of a gene, or specific segment of DNA. Different alleles produce slightly different proteins, which function in different ways.

Recessive Trait- A recessive trait is a trait that is expressed when an organism has two recessive alleles, or forms of a gene. Traits are characteristics of organisms that can be observed; this includes physical characteristics such as hair and eye color, and also characteristics that may not be readily apparent, e.g. shape of blood cells. Every organism that organizes its DNA into chromosomes has two alleles for a trait, one from their mother and one from their father. Alleles can be dominant or recessive. Dominant alleles mask the effects of recessive alleles, so a recessive trait is only expressed when an organism has two recessive alleles for a gene.

Recombinant DNA- Recombinant DNA is a molecule of DNA that has been modified to include genes from multiple sources, either through genetic recombination or through laboratory techniques. In the lab, bacteria can be transformed with recombinant DNA. Genetic recombination occurs during meiosis in a process known as crossing over.

Rhizome- A rhizome (also known as rootstocks) is a type of plant stem situated either at the soil surface or underground that contains nodes from which roots and shoots originate (shown below). Rhizomes are unique in that they grow perpendicular, permitting new shoots to grow up out of the ground. When separated, each piece of a rhizome is capable of producing a new plant.

Ribosomal RNA- Ribosomal ribonucleic acid (rRNA) is the RNA component of ribosomes, the molecular machines that catalyze protein synthesis. Ribosomal RNA constitute over sixty percent of the ribosome by weight and are crucial for all its functions – from binding to mRNA and recruiting tRNA to catalyzing the formation of a peptide bond between two amino acids. Even the structure of a ribosome is determined by the three-dimensional shape

of its rRNA core. Proteins present in the ribosome serve to stabilize this structure through interactions with the core.

S

Selective Breeding- Selective breeding is the process by which humans control the breeding of organisms in order to exhibit or eliminate a particular characteristic. Selective breeding uses artificial selection to direct the genetic transfer of desirable traits. As opposed to natural selection, selective breeding focuses on traits which will benefit humans.

Selective Permeability -Selective permeability is a property of cellular membranes that only allows certain molecules to enter or exit the cell. This is important for the cell to maintain its internal order irrespective of the changes to the environment. For example, water, ions, glucose and carbon dioxide may need to be imported or exported from the cell depending on its metabolic activity. Similarly, signaling molecules may need to enter the cell and proteins may need to be released into the extracellular matrix. The presence of a selectively permeable membrane allows the cell to exercise control over the quantum, timing and rate of movement of these molecules.

Semipermeable Membrane- A semipermeable membrane is a layer that only certain molecules can pass through. Semipermeable membranes can be both biological and artificial. Artificial semipermeable membranes include a variety of material designed for the purposes of filtration, such as those used in reverse osmosis, which only allow water to pass. The biological membranes of cells are created by two sheets of phospholipid, which contain a lipid tail attached to a polar head. The tail regions of each sheet cluster together, while the heads of the molecules point outward.

The polar heads point both outward toward the environment of the cell and inward toward the cytosol. In this way, a hydrophobic region of lipid tails separates the two bodies of solution. This can be seen in the image below.

Sex Chromosomes- Sex chromosomes are chromosomes that determine whether the individual is male or female. Though these two chromosomes pair with each other during meiosis, there is usually very minimal homology or recombination between them, primarily because of a large difference in their genetic content and size. Often one chromosome is smaller, and appears to retain only those genes that are necessary for sex determination.

Solute- A solute is a substance that can be dissolved by a solvent to create a solution. A solute can come in many forms. It can be gas, liquid, or solid. The solvent, or substance that dissolves the solute, breaks the solute apart and distributes the solute molecules equally. This creates a homogenous mixture, or solution that is equal throughout.

Solutes in solution are measured by their concentration. The concentration of a solute is the amount of solute divided by the total volume of solution. A solvent can dilute various amounts of solute, depending on how strong of a solvent is used and how easily the solute molecules come apart. This property of solutes to dissolve in a solvent is known as solubility.

Solution- A solution is a homogeneous mixture of solvent and solute molecules. A solvent is a substance that dissolves another substance by pulling the molecules apart through electrochemical interactions. The solute then diffuses through the solvent until the concentration is equal in all parts of the solution. A solution can be liquid, solid, or gaseous. Further, a solution can be a mixture of liquids, gases and solids. In some cases, like seawater, the solution consists of a great many different types of solutes, like salts, oxygen, and organic molecules.

Solvent- A solvent is a molecule that has the ability to dissolve other molecules, known as solutes. A solvent can be solid, liquid or gas. The molecules of the solvent work to put the solute molecules apart. Eventually, the molecules of solute become evenly distributed in throughout the solvent. This homogenous mixture is perfectly even, and cannot be separated physically. Heat or another chemical process must be applied to the solution to separate the solvent and solute.

Species- A species is a group of organisms that share a genetic heritage, are able to interbreed, and to create offspring that are also fertile. Different species are separated from each other by reproductive barriers. These barriers can be geographical, such as a mountain range separating two populations, or genetic barriers that do not allow for reproduction between the two populations. Scientists have changed their definition of a species several times throughout history.

Sucrose- Sucrose, commonly known as “table sugar” or “cane sugar”, is a carbohydrate formed from the combination of glucose and fructose. Glucose is the simple carbohydrate formed as a result of photosynthesis. Fructose is nearly identical, except for the location of a double-bonded oxygen. They are both six-carbon molecules, but fructose has a slightly different configuration. When the two combine, they become sucrose.

Sulfuric Acid- Sulfuric acid (sulphuric acid) is a corrosive mineral acid with an oily, glassy appearance that gave it its earlier name of oil of vitriol. Other names are sulphine acid, battery acid, and hydrogen sulfate. The sulfuric acid formula, H_2SO_4 , indicates the presence of a sulfur atom surrounded by two hydroxide compounds and two oxygen atoms. This powerful acid is used in various industries, primarily in fertilizer and chemical production.

T

Taxonomy- Taxonomy is the branch of biology that classifies all living things. It was developed by the Swedish botanist Carolus Linnaeus, who lived during the 18th Century, and his system of classification is still used today. Linnaeus invented binomial nomenclature, the system of giving each type of organism a genus and species name. He also developed a classification system called the taxonomic hierarchy, which today has eight ranks from general to specific: domain, kingdom, phylum, class, order, family, genus, and species.

Telomerase- Telomerase is an enzyme found inside our cells, which may be related to the aging process. It adds short, repetitive “caps” to our DNA strands. These caps are called “telomeres.”

Telophase- Telophase is the final stage in cell division. During telophase, the nuclear envelopes reform around the new nuclei in each half of the dividing cell. The nucleolus, or ribosome producing portions of the nucleus return. As the cell has finished moving the chromosomes, the main parts of the spindle apparatus fall depolymerize, or fall apart. As telophase moves towards completion, the chromosomes release from their tightly bound structure back into loose chromatin. Telophase is ended by a process known as cytokinesis, which cleaves the cell into two new cells.

Three Parts of Cell Theory- The 3 parts, or tenets, of cell theory are a little outdated in terms of modern biology, but still serve as a good general model. The three tenets of cell theory are discussed in detail below.

1. All organisms are made of cells

Cells are the smallest unit of life. Each cell is a membrane of semi-permeable phospholipids wrapped around cytosol or a solution of water

and dissolved solutes. All cells rely on DNA to hold the information necessary to produce the molecules they use to obtain energy. Although the methods for obtaining energy vary widely, all organisms obtain energy to grow and reproduce. This first tenet of the cell theory is mostly true, but the discovery of viruses lead to complications. Viruses, while they use DNA or RNA to reproduce, do not have cells or cellular membranes. Viruses typically use a host cell to replicate. In this case, the virus appears to be living, but does not create its own cell. Some scientists argue that viruses are not living, thus cell theory is not violated.

2. Cells are the most fundamental unit of life

Organisms can be single cells, which hold all of the components necessary for a metabolism, or they can be more complex. More complex organisms divide the various metabolic tasks into different groups of cells, called tissues. These tissues are arranged in compartments with membranes that separate them from other tissues. These groups of tissues are called organs. A group of organs functioning together is an organism, or an individual creature. Each cell is distinct from the cells next to it, and each functions independently, while contributing to the output of the organism as a whole. Again, modern cell theory is a bit more complicated because advances in science have revealed many different organelles within cells. These organelles are bound in membranes themselves, and serve different functions for eukaryotic cells. Some scientists argue that these are more fundamental units, but other scientists argue that like an organ outside of an organism, they could not function without the cell.

3. Cells come from other cells

As far as we know, no cell on Earth currently has arisen spontaneously. All cells are the result of cell division. When a cell is large enough, it replicates its DNA and important components. These components can then be divided into two daughter cells, which are copies of each other. Variations in the DNA in each cell can lead to changes in how they

function, which can result in them dividing at different rates. The cell that reproduces more than the other cell will pass on more of its DNA. The purpose of every cell or organism is to reproduce the DNA in cells.

This third tenet of the cell theory has yet to be disproven. No scientist has ever created a functioning cell without replicating another cell, although some scientists are trying. If they were successful, it would give proof to how life could have evolved. It is thought that a self-replicating molecule mutated, developed the ability to produce a membrane, and thus the first cell was born. The cell was such a successful form of life that all life since has used the same basic template.

Tonicity- Tonicity is the concentration of a solution as compared to another solution. Concentration describes the amount of solutes dissolved by a solution. If a solution has a higher concentration of solutes (less water) than another it is said to be hypertonic. A hypotonic solution has a lower concentration of solutes and more water than another solution. Isotonic solutions contain the same concentration of solutes. In biology, the tonicity of the environment compared to the cell determines how water moves across the semipermeable membrane. The graphic below shows the tonicity of different environment, and which way water moves. Remember, water moves to balance the concentration gradient of the solutes. It will move from high solute concentration to low solute concentration.

Toxicity- Toxicity is a measurement of the dosage needed of a particular substance to damage a living organism. A substance becomes toxic at the dose which begins to damage an organism. Contrary to popular belief, all substances have a certain toxicity. Even water and oxygen are dangerous to organisms at certain concentrations. Furthermore, different species experience toxins in different ways. The toxicity of a certain substance, like sulfur for instance, will vary with the species. To humans, large doses of sulfur are fatal. However, to the organisms

living in the heat of volcanic vents at the bottom of the ocean, sulfur is a necessary and welcome nutrient.

Transcription- Transcription refers to the first step of gene expression where an RNA polymer is created from a DNA template. This reaction is catalyzed by enzymes called RNA polymerases and the RNA polymer is antiparallel and complementary to the DNA template. The stretch of DNA that codes for an RNA transcript is called a transcription unit and could contain more than one gene.

Translation- Translation refers to the process of creating proteins from an mRNA template. The sequence of nucleotides on the RNA is translated into the amino acid sequence of proteins and this reaction is carried out by ribosomes. Ribosomes and tRNA dock on a mature mRNA transcript and recruit multiple enzymes in an energy intensive process that uses ATP as well as GTP.

Transpiration- Transpiration is the evaporation of water from plants. Most of the water absorbed by the roots of a plant—as much as 99.5 percent—is not used for growth or metabolism; it is excess water, and it leaves the plant through transpiration. Transpiration is very important for maintaining moisture conditions in the environment. As much as 10 percent of the moisture in the Earth’s atmosphere is from transpiration of water by plants.

U

Unicellular- A unicellular organism is an organism that consists of a single cell. This means all life processes, such as reproduction, feeding, digestion, and excretion, occur in one cell. Amoebas, bacteria, and plankton are just some types of unicellular organisms. They are typically microscopic and cannot be seen with the naked eye.

Universal Solvent- Water is the substance that we refer to as the universal solvent. A solvent is simply a liquid that other substances can dissolve in, and the reason that water has gained the label of universal solvent is because no other solvent can dissolve as many substances as it can. That's mostly what makes it so critical to life on earth. Also, amazingly, every body of water found on earth, including ice, sustains one form of life or another that has adapted to the temperature and pressure found in that form of water.

Urinary System- The urinary system produces, stores, and excretes urine via a filtration mechanism in which potentially harmful molecules are removed from the body. It also plays a crucial role in water homeostasis, electrolyte and acid-base balance, and red blood cell production. The human urinary tract is comprised of two kidneys, two ureters, one bladder, two sphincters, and one urethra.

V

Vacuole- A vacuole is an organelle in cells which functions to hold various solutions or materials. This includes solutions that have been created and are being stored or excreted, and those that have been phagocytized, or engulfed, by the cell. A vacuole is simply a chamber surrounded by a membrane, which keeps the cytosol from being exposed to the contents inside. Because vacuoles are surrounded by semi-permeable membranes, they only let certain molecules through.

Vascular Tissue- Vascular tissue is an arrangement of multiple cell types in vascular plants which allows for the transport of water, minerals, and products of photosynthesis to be transported throughout the plant. Non-vascular plants, such as some algae and moss, do not have vascular tissue and therefore cannot easily transport water and nutrients.

Vascular plants use their vascular tissue to transport water and nutrients to great heights, able to feed the tops of trees hundreds of feet high.

Ventral Cavity- The ventral cavity, or ventral body cavity, is a fluid filled space surrounding the organs on the ventral side of humans and other tetrapods. The ventral cavity is one of two main cavities, the other being the dorsal cavity. The ventral cavity, in humans, is actually made up of two separate cavities, separated by the diaphragm, a thin muscle which helps control the expansion and contraction of the lungs.

The ventral cavity is sometimes referred to as a coelom, or true body cavity. While not all coelomates have a well-defined ventral cavity as in humans, all ventral cavities are coeloms. The coelom is a generic body cavity developed within a number of animal phyla, which is a "true cavity" in the sense that all surfaces are lined with a special membrane, sealing off the cavity from other parts of the body.

Vertebrae- Vertebrae are bones located within the vertebral column. In humans, they are a series of 33 bones that run from the base of the skull to the coccyx. The irregularly shaped bones form the roughly S-shape of the spinal cord. Between each vertebra is an intervertebral disc, which helps provide shock absorption and protect the vertebrae. Each vertebrate species, which gets its name from the vertebrae that make up its column, has a similarly shaped vertebrae. The biggest differences occur between land-dwelling and aquatic species because of their different movement requirements.

Vertebral Column- The vertebral column, also called the spine, is a series of bones known as vertebrae that are separated by intervertebral discs. The vertebral column is only found in vertebrates, or members of the subphylum Vertebrata, which is part of the phylum Chordata.

Virus- A virus is a chain of nucleic acids (DNA or RNA) which lives in a host cell, uses parts of the cellular machinery to reproduce, and releases the replicated nucleic acid chains to

infect more cells. A virus is often housed in a protein coat or protein envelope, a protective covering which allows the virus to survive between hosts.

Vital Capacity- Vital capacity is the amount of air that the lungs can expel after having been filled completely. The vital capacity represents the change in volume from completely emptied lungs to completely filled lungs. In human medicine, vital capacity is an important measure of a person's respiratory health. A healthy adult will have a vital capacity between 2 and 5 litres.

W

Water Cycle- The water cycle or hydrologic cycle describes the complex systems that allow water to move across the Earth and atmosphere. The most basic step of the water cycle is the change of state of water as a liquid, gas or solid in the atmosphere. However, the water cycle also envelops various methods of water transportation and water types such as plant uptake, transpiration, groundwater, precipitation, and percolation.

X

Xylem- Xylem is a type of tissue in vascular plants that transports water and some nutrients from the roots to the leaves. Phloem is the other type of transport tissue; it transports sucrose and other nutrients throughout the plant. Xylem and phloem give vascular plants their classification; they are the vascular tissues that transport substances throughout the plant.

Z

Zoology- Zoology, or animal biology, is the field of biology that involves the study of animals. The word zoology comes from the Greek words zōion, meaning "animal", and logos, meaning "the study of". It encompasses all aspects of scientific knowledge about animals, like embryonic development, evolution, behaviour, ecological distribution, and classification. Zoology is broken into many branches because there are so many different ways to study animals; it is also broken into branches based on which animals are being studied.

Zooplankton- Zooplankton (pictured below) are a type of heterotrophic plankton that range from microscopic organisms to large species, such as jellyfish. Zooplankton are found within large bodies of water, including oceans and freshwater systems. Zooplankton are drifting ecologically important organisms that are an integral component of the food chain.

Zygote- A zygote is the cell formed when two gametes fuse during fertilization. The DNA material from the two cells is combined in the resulting zygote. The cellular mechanisms present in the gametes also function in the zygote, but the newly fused DNA produces a different effect in the new cell. In single-celled organisms, the zygote becomes a fully functioning organism, and can divide through mitosis to produce offspring. The organism can also produce gametes to reproduce sexually with other cells.