# Biology Final Exam Study Guide (FULL)

Chapter One

*Evolution accounts for the unity and diversity of life, and also for the match of organisms to their environments.

*Hierarchy of life: Biosphere>Ecosystem>Community>Population>Organism>Organ System>Organ>Tissue>Cell>Organelle>Molecule>Atom

*Energy flows through an ecosystem. Energy flows from sunlight to producers to consumers.

*Cells are an organism's basic unit of structure and function. **Eukaryotic Cell** – Type of cell w/membrane-enclosed organelles.

**Prokaryotic Cell –** Type of cell lacking membrane-enclosed organelles.

*The continuity of life is based on heritable information in the forms of DNA.

**DNA** – (Deoxyribosenucleic Acid) Double-stranded, helical nucleic acid molecule consisting of nucleotide monomers with a deoxyribose sugar and the nitrogenous bases (A,C,G,T); capable of being replicated and determining the inherited structure of a cell's protein.

**Genes** – Discrete unit of hereditary information consisting of a specific nucleotide sequence in DNA

*****Feedback mechanisms regulate biological systems

**Positive Feedback** – End product stimulates the production of more product

**Negative Feedback** – Accumulation of an end product slows the process that makes the product.

*****Science can not answer the possibility of supernatural phenomena, hypothesis must be testable and the experiment must be repeatable.

Chapter Two

*Matter consists of chemical elements in pure form and in combinations called compounds.

**Element** – Substance hat can not be broken down to other substances.

**Compound** – Substance composed of two or more elements. **Matter** – Anything that takes up space and has mass.

*An Element's properties depend on the structure of its atoms

**Atom** – Smallest unit of matter that still retains the properties of an element.

**Protons(+), Neutrons(no charge) and Electrons(-) are subatomic particles.**

**Isotope** – A different atomic form of an element(# of neutrons change).

**Energy** – The capacity to cause change.

**Electron Shell** – An energy level of electrons at characteristic average distance from the nucleus of an atom.

*****The formation and function of molecules depend on chemical bonding between atoms

**Chemical Bonds** – Attraction between two atoms results from sharing of outer-shell electrons or the presence of opposite charges on atoms.

*****The strongest chemical bonds are covalent and ionic. **Covalent bonds** – <u>STRONG</u> chemical bonds in which 2 atoms share 1 or more pairs of valence electrons.

*****Valence equals the # of unpaired electrons required to complete the atom's outermost shell.

**Electronegativity** – Attraction of a particular kind of atom for the electrons of a covalent bond

**Polar Covalent Bond –** Electrons NOT shared equally

**Nonpolar covalent bond –** Electrons shared equally

**Ion** – Charged Atom, (+) = Cation, (-) = Anion

**Ionic Bond** – Chemical bond resulting from the attraction between oppositely charged ions.

**Ionic Compounds** –Compound resulting from formation of ionic bonds (Salts)

**Hydrogen Bonds –** WEAK chemical bond formed when slightly (+) hydrogen atom of a polar covalent bond in one molecule is attached to the slightly(-) atom of a polar covalent bond in another molecule (Water has hydrogen bonds)

*Chemical Reactions make and break chemical bonds

*96% of all living matter is made of carbon, hydrogen, nitrogen and oxygen.

Chapter Three

*The polarity of water molecules result in hydrogen bonding.

**Polar Molecule –** Two ends of a molecule have opposite charges (polar loves water)

*Four emergent properties of water contribute to Earth's fitness for life

1) COHESION: Hydrogen bonding keeps water molecules close to each other, hydrogen bonding is also responsible for surface tension.

2) MODERATION of TEMP: Heat is absorbed when hydrogen bonds break. Heat is also reabsorbed when hydrogen bonds form.

3) WATER IS INSULATED BY FLOATING ICE.

4) WATER IS THE SOLVENT OF LIFE.

**Hydrophilic –** Water loving

**Hydrophobic** – Water fearing

**Aqueous Solution** – Solution where water is the solvent. *****Acidic and basic conditions affect living organisms.

**Acid –** Substance that increases the hydrogen concentration of a solution.

**Base –** Reduces the hydrogen ion concentration of a solution

**pH Scale –** Ranges from 0-14 (0=basic,7 =neutral,14=acidic) **pH = –logH+**

**Buffer –** Substances that minimize changes in the concentration of H+(acidic) and OH-(basic)

*****Accepts H+ ions when solution is too acidic

*****Donates H+ ions when solution is too basic

Chapter Four

*Carbon is the backbone of life. *What carbon can build is unlimited.

*Organic Chem is the study of carbon compounds.

*Carbon Atoms can form diverse molecules by bonding to four other atoms. **Isomers –** Compounds that have the same # of atoms of the same elements but different structure and different properties.

**Hydrocarbons** – Organic molecules consisting of only carbon and hydrogen.

*****A Small # of chemical groups are key to the functioning of biological molecules.

**Functional Groups** – A specific configuration of atoms commonly attached to the carbon skeletons of organic molecules and usually involved in chem reactions.

*****ex:(hydroxyl, carbonyl, carboxyl,amino,sulfhydryl, phosphate, methyl) *****ATP: An important source of energy for cellular processes

**Adenosine Triphosphate (ATP) –** An adenine-containing nucleoside triphosphate that releases free energy when its phosphate bonds are hydrolyzed: This energy is used to drive endergonic reactions in cells.

Chapter Five

**Macromolecules –** A giant molecule formed by the joining of smaller molecules, usually by a condensation reaction. Polysaccharides, proteins, and nucleic acid are macromolecules.

*Macromolecules are polymers that are built from monomers.

**Polymer –** long molecule consisting of many similar or identical building blocks linked by covalent bonds.

**Monomer –** The repeating units that serve as the building blocks.

**Condensation Reaction –** 2 molecules become covalently bonded to each other thru the loss of water. (Aka dehydration reaction)

**Hydrolysis** – When polymers are disassembled to monomers. Reverse of above.

**Enzymes –** Specialized macromolecules that speed up chemical reactions in cells.

*Carbohydrates serve as fuel and building material.

**Carbohydrates –** Both sugars and polymers of sugars.

**Monosaccharidees –** Simplest carbs.

**Disaccharides –** 2 or more monosaccharides joined.

**Polysaccharides –** Few 100 to few 1000's of monosaccharides. (Starches)

**Cellulose –** Major component of the tough cell walls that enclose plant cells.

*Lipids are a diverse group of *hydrophobic* molecules.

*****Fats/Phospholipids/Steroids *Phospholipids make up cell membrane. *Steroids contain hormones. (Cholesterol)

*Proteins have many structures, resulting in a wide range of functions. (repair, catalyze, provide structural support…)

*Monomers are amino acids. Polymers are polypeptides. *4 levels of structure (Primary, Secondary, Tertiary, Quaternary

***Denaturation** – Protein wears down/becomes inactive.

*Nucleic acids store and transmit hereditary information. *2 types: DNA and RNA

DNA: (deoxyribose) (C, G, A, T) (Double-Stranded)
Stores all hereditary information.

RNA: (Ribose) (C, G, A, U) (Single-Stranded)
*Nucleic Acids carry protein coding instructions from DNA to protein synthesizing machinery.

Chapter Six

*Eukaryotic Cells have internal membranes that sort out their functions.

*Both eukaryotic and prokaryotic cell have plasma membrane.

*Plants and animal cell have most of the same organelles.

*Eukaryotic cell's genetic instructions are housed in the nucleus and carried out by ribosomes.

*Nucleus contains most of the genes in the eukaryotic cell. *Nucleur envelope encloses the nucleus.

**Chromosomes –** Units of DNA that carries the genetic info.

*Ribosomes serve as "protein factories" of the cell.

*The endomembrane system regulates protein traffic and performs metabolic functions in the cell.

*****(Endoplasmic Reticulum, Golgi Apparatus, Lysosome, Vacuoles-plants only) *Mitochondria and chloroplasts change energy from one form to another

**Mitochondria –** Site for cellular respiration. (Powerhouse of the cell) **Chloroplast –** Site of photosynthesis in plant cell

*The cytoskeleton is a network of fibers that organizes structures and activities in the cell.

**Cytoskeleton –** Network of fibers that extend throughout the cytoplasm.

*Cytoskeleton provides = support, motility, and regulation.

*Cilia and Flagella are responsible for motion of the cell.

*Extra cellular components and connections between cells help coordinate cellular activities

**Cell Wall –** Extracellular structure of the plant cell that distinguishes them from eukaryotic cell

*****Animals have Extracellular Matrix.

*****Functions in support, adhesion, movement, and regulation. *****Cells in an animal or plants are organized into tissues, organs, and organ systems.

Chapter Seven

*The plasma membrane of the cell exhibits **selective permeability** that is to allow some substances to cross it more easily than others.

*Cellular membranes are fluid mosaics of lipids and proteins

*Phospholipids and proteins move laterally within the membrane.

*Membrane Proteins

**Integral Proteins –** Tran membrane protein w/hydrophobic regions that extend into and often span the *hydrophobic interior* of the membrane and the hydrophilic regions in contract with the aqueous solution on either side of the membrane. (Cell-to-cell recognition.

**Peripheral Protein –** A protein loosely bound to the surface of a membrane or to part of an integral protein and *not embedded* in the bilipid layer.

*Membrane structure of the cell, results in selective permeability.

*A cell must exchange molecules and ions with its surrounding, a process controlled by the plasma membrane.

*Hydrophobic substances can pass through the cell's lipid bilayer rapidly. *To cross a cell's membrane, substances generally require transport proteins. *Passive transport is diffusion of a substance across a membrane that DOES NOT require energy.

**Diffusion –** The movmement of molecules of any substance so that they spread out evenly into an available space.

**Passive Transport** – The diffusion of a substance across a biological membrane.

**Osmosis** – The diffusion of water across a selectively permeable membrane.

*Active transport USES ENERGY to move solutes against their gradients. *Bulk transport across the plasma membrane occurs by exocytosis and endocytosis.

Chapter Eight

*An organism's metabolism transforms matter and energy

**Metabolism –** The totality of an organism's chemical reactions, consisting of catabolic and anabolic pathways, which manage the material and energy resources of the organism.

*Energy is the capacity to cause change; some forms of energy do work by moving matter.

**Exergonic Reaction –** Energy Outward (Available energy to the environment)

**Endergonic Reaction** – Energy Inward (Takes energy)

*ATP powers the cell by coupling exergonic reactions to endergonic reactions

*Enzymes speed up metabolic reactions by lowering energy barriers

**Substrate** – The reactant in which an enzyme acts on

Chapter Nine

*Catabolic pathways yield energy by OXIDIZING organic fuels

**Fermentation –** Partial degradation of sugars that occurs with out the use of oxygen

**Aerobic Respiration –** A catabolic pathway that consumes (O2) and organic molecules, producing ATP. *MOST EFFICIENT*, carried out in many eukaryotic and prokaryotic organisms.

**Cellular Respiration** – The catabolic pathways of aerobic and anaerobic respiration, which break down organic molecules for the production of ATP

LEO says GER: Losing electrons = oxidation / Gaining electrons = reduction

Redux - Oxidation and reduction

*Cellular Respiration has 3 stages

1) **Glycosis** – Splitting of glucose into pyruvate.

2) **Citric Acid Cycle** – Completes the metabolic breakdown of glucose molecules begun in glycosis by oxidizing pyruvate to carbon dioxide (occurs in the mitochondrion)

3) **Oxidative Phosphorylation –** The production of ATP using energy derived from the redox reactions of an electron transport chain couple. (Occurs in the mitochondrion)

*Fermentation and anaerobic respiration enable cells to produce ATP without the use oxygen.

Chapter Ten

*__Photosynthesis__ – The conversion of light energy to chemical energy that is stored in sugars or other organic compounds

**Autotroph –** Self-feeders

**Heterotroph –** Depend on others for food (Organic molecules)

*Photosynthesis converts light energy to the chemical energy of food.

*__Chloroplasts__ are the sites of photosynthesis in plants.

*The light reactions convert solar energy to the chemical energy of ATP and NADPH * The Calvin Cycle uses ATP and NADPH to convert O2 to sugar

**Calvin Cycle** – The second of two major stages in photosynthesis (following the light reactions), involving the fixations of atmospheric CO2 and reduction of fixed carbon into carbohydrate.

*Calvin Cycle does not require sunlight

Chapter Twelve

*****Cell Division functions in reproduction, growth & development, and tissue renewal.

*Unicellular organisms reproduce by cell division; multicellular organisms depend on cell division for their development from a fertilized egg and for growth and repair.

**Cell Division –** Reproduction of cells

**Cell Cycle –** An ordered sequence of events in the life of a cell, from its origin in the division of a parent cell until its own division into two.

*****Cell division results in genetically identical daughter cells.

*Cells duplicate their genetic material before they divide, ensuring that each daughter cell receives an exact copy of the genetic material, DNA.

*DNA is partitioned among chromosomes. Eukaryotic chromosomes consist of **chromatin**, a complex of DNA and protein that condenses during mitosis. In Animals, **gametes** (sperm & egg) have one set of chromosomes, and somatic cells have two sets.

*Eukaryotic cell division consists of **mitosis** (Division of the nucleus) and **cytokinesis** (division of the cytoplasm)

**Meiosis** – A modified type of a cell division in *sexually* reproducing organisms consisting of two rounds of cell division (meiosis I and meiosis II) but only one round of DNA replication. It results in cells with half the number of chromosomes as the original cell.

Chapter Thirteen

**Heredity –** The transmission of traits from one generation to the next.

**Genetics** – Scientific study of heredity and hereditary variation.

*Offspring acquire genes from parents by *inheriting chromosomes*.

*Each gene in an organism's DNA exists at a specific locus on a certain chromosome. We inherit one set of chromosomes from out mother and one set from our father.

**Genes –** Forms of hereditary units.

*Gametes are the vehicles that transmit genes from one generation to the next.

*Comparisons of Asexual & Sexual Reproduction:

*In Asexual reproduction, a single parent produces genetically identical offspring by mitosis. Sexual reproduction combines sets of genes from two different parents, forming genetically diverse offspring.

*Fertilization and meiosis alternate in sexual life cycles.

*Normal human somatic cells (body cells) are diploid. They have 46 chromosomes made up of two sets of 23—one set from each parent. In human diploid cells, there are 22 homologous pairs of **autosomes** (other 22 chromosomes), each with a maternal and a paternal homolog. The 23$^{rd}$ pair, the sex chromosomes, determines whether the person is female or male.

**Diploid cell –** Any cell with 2 chromosome set (2n=46) (Somatic Cells)

**Haploid Cell –** Cells containing a single chromosome set (n=23) ) (Gametes)

**Fertilization –** The union of haploid gametes to produce a diploid zygote.

*Meiosis reduces the # of chromosome sets from diploid to haploid.

*The two cell division of meiosis produce 4 haploid daughter cells. The # of chromosome sets is reduced from two (haploid) to one (diploid) during meiosis I, the reductional division.

*Genetic variation produced in sexual life cycles contributes to evolution.

Chapter Fourteen

**True-breeding** – Plants that produce offspring of the same variety when they reproduce.

**Hybridization –** The mating, or crossing, of two true-breeding varieties.

P Generation (parental) >> F1 Generation (first) >> F2 Generation (second) **Alleles –** Alternative versions of a gene

*Dominant allele determines the organism's appearance, recessive has no effect

**Law of Segregation** – The two alleles for a heritable character, segregate during gamete formation and end up in different gametes.

**Homozygous –** An organism that has a pair of identical alleles for a character

**Heterozygous** – An organism that has 2 different alleles for a gene.

**Law of independent assortment –** Each pair of alleles segregate independently of each other pair of alleles during gamete formation.

**Epistasis –** One gene affects the expressions of others

**Polygenic inheritance –** A single phenotypic character is affected by 2 or more genes.

**Pedigree –** A diagram of a family tree showing the occurrence of heritable characters in parents and offspring over multiple generations.

*Can be used to deduce the possibility of genotypes of individuals and make predictions about future offspring.

Chapter Fifteen

*The behavior of chromosomes during meiosis accounts for Mendel's laws of segregation and independent assortment.

*Sex is an inherited phenotypic character usually determined by which sex chromosomes are present. Humans and other mammals have an X-Y system in which sex is determined by whether a Y chromosome is present.
*Sex chromosomes can carry genes from some traits that are *unrelated* to sex characteristics. (ex: colorblindness disease)
***Linked genes** tend to be inherited together because they are located near each other on the same chromosome.

**Genetic Recombination** – The production of offspring with combinations of traits that differ from those found in either parent.
**Crossing over** accounts for the recombination of linked genes.
**Genetic Map** – An ordered list of genetic loci (genes or other genetic markers) along a chromosome.

*The farther apart the genes are the more likely their allele combinations will be recombined during crossing over.

*Alternations of chromosome # or structure can cause genetic disorders *Examples:
Abnormal Chromosome # and Alternation of Chromosome Structure *Changes in the number of chromosomes per cell or in the structure of individual chromosomes can affect phenotype.

<u>Chapter Sixteen</u>
*****DNA is the genetic material *****Four nitrogenous bases in DNA

1) Adenine (A) - purine
2) Thymine (T) - pyrimidine
3) Guanine (G) - purine
4) Cytosine (C) pyrimidine

*These nitrogenous base pairs in a DNA double helix are held together by hydrogen bonds.
* A base pairs with G, C base pairs with T

*Many proteins work together in DNA replication and repair.
DNA Replication: 3 proposed models

1) Conservative Model (Don't need to know)
2) **Semi conservative model** (Correct one) – The parent molecule unwinds, and each strand the serves as a template strand for the synthesis of a new strand according to base-pairing rules.
3) Dispersive Model (Don't need to know)

**Origins or replication –** Site where the replication of a DNA molecule begins, consisting of a specific sequence of nucleotides *****DNA polymerases proofread DNA and replace incorrect nucleotides. **DNA Polymerases** – Catalyze the synthesis of new DNA by adding nucleotides to a preexisting chain.

*A chromosome consists of a DNA molecule packed together with proteins.

*DNA levels of packaging:
DNA>HISTONES>NUCLEOSOMES>CHROMATIN>CHROMOSOME

Chapter Seventeen

**Gene Expression** – The process by which DNA directs the synthesis of proteins (or in some cases, just RNAs)

*Genes specify proteins via the processes of TRANSCRIPTION and TRANSLATION

**Transcription –** The synthesis of RNA under the direction of DNA. (occurs inside the nucleus)

**Translation –** The synthesis of a polypeptide, which occurs under the direction of mRNA. (occurs outside the nucleus).

*****Genetic information is encoded as a sequence of nonoverlapping base triplets, or codons. A codon in messenger RNA either is translated into an amino acid (61 of the 64 codons) or serves as a stop signal (3 codons). Codons must be read in the correct reading frame. ***(More about codons on pg. 329)***

*****mRNA is read in a 5' to 3' direction. *****In RNA uracil (U) takes place of thymine (T).

*Eukaryotic cells modify RNA after transcription.

**RNA Processing** – Modification of RNA transcripts, including splicing out of **introns**, joining together of **exons**, and the alteration of 5' 3' ends.

**Introns –** *A none coding*, intervening sequence within a primary transcript that is removed from the transcript during RNA; also refers to the regions of DNA from which this sequence was transcribed.

**Exons –** Coding regions. A sequence within a primary transcript that remains in the RNA after RNA processing; also refers to the region of DNA from which this sequence was transcribed. ***(More about introns and exons on on pg.335)***

*****More on translation

*A cell translates an mRNA message into protein using transfer RNAs. After binding up specific amino acids, tRNAs line up via their anticodons at complimentary codons on mRNA. Ribosomes help facilitate this coupling with binding sites for mRNA and tRNA.

*****Point mutations can affect protein structure and function

*A point mutation is a change in one DNA base pair, which may lead to production of a non-functional protein. Base-pair substitutions can cause missense or nonsense mutations. Base-pair insertions or deletions may produce frameshift mutations.

***Mutagens** – A chemical or physical agent that can interact with DNA and cause mutation.

(Look over page 348 for a review, don't memorize)

Chapter Eighteen and Twenty

*[we didn't really go over these two chapters, so really just look over these definitions although he probably isn't even going to ask]*

Chapter Eighteen

*Cells control metabolism by regulating enzyme activity or the expression of genes coding for enzymes. In bacteria, genes are often clustered into operons, with one promoter serving several adjacent genes. An operator site on the DNA switches the operon on or off, resulting in coordinate regulation of the genes.

**Operons –** A unit of genetic function found in bacteria and phages (viruses), consisting of a promoter, an operator, and a coordinately regulated clusters of genes whose products function in a common pathway.

**Operator –** In bacterial DNA, a sequence of nucleotides near the start of an operon to which an active repressor can attach. The binding of the respressor prevents RNA polymerase from attaching to the promoter and transcribing the genes of the operon.

Chapter Twenty

**Biotechnology –** The manipulation of organisms or their components to make useful products.

**Genetic Engineering –** The direct manipulation of genes for practical purposes.

*DNA cloning yields multiple copies of a gene or other DNA segment

*DNA cloning and other techniques, collectively termed DNA technology, can be used to manipulate and analyze DNA and to produce useful new products.

Chapter Twenty-Two

*The Darwinian revolution challenged traditional views of a young Earth inhabited by unchanging species

*Charles Darwin proposed that life's diversity had arisen from ancestral species through natural selection

*Geologists have concluded that changes in Earth's surface can result from slow, continuous, actions still operating at the present time.

**Fossils –** The remains or traces of organisms from the past.

*****Decent with modification by natural selection explains the adaptation of organisms and the unity and diversity of life.

**Adaptations –** Characteristics of organisms that enhance their survival and reproduction in specific areas.

**Natural Selection –** A process in which individuals with certain inherited traits leave more offspring than individuals with other traits.

*****Three main points to natural selection

1) Individuals that are well-suited to their environment tend to leave more offspring than other individuals.

2) Over time, favourable traits accumulate in a population.

3) If an environment changes, or if individuals move to a new environment, natural selection may result in adaptation to these new condition, sometimes giving rise to new species in the process.

*Evolution is supported by a lot of scientific evidence.

*Fossils show that past organism differed from living organisms, that many species have gone extinct, and that species have evolved over long periods of time.

*****Homology

*Organisms share characteristics b/c of common descent (homology) or because of natural selection affects independently evolving species in

similar environments in similar ways (convergent evolution).

***4 Evidences that account for Evolution (IMPORTANT)**

Direct Observation, Fossil Record, Homology, Biogeography (geographic dist. of species.)

Chapter Twenty-Three

*The smallest unit of evolution is *population.*

**Microevolution –** Evolutionary change below the species level; change in the allele frequencies in a population over generations

*****Mutation and sexual reproduction produce the genetic variation that makes evolution possible.

*Genetic variation includes variation among individuals within a population in distinct and quantitative characters, as well as geographic variation b/w populations.

***THE ONLY & MAIN SOURCE OF NEW ALLELES IS BY MUTATION.**

*In sexually reproducing organisms, most of the genetic differences among individuals result from crossing over, the independent assortment of chromosomes and fertilization.

*Hardy-Weinberg theorem (equation) can be used to tell whether a population is evolving or not. ( $p^2+2pq+q^2$)

*A population is united by its gene pool, the sum of all the alleles in the population.

*Natural selection, genetic drift and gene flow can affect allele frequencies in a population.

*Chance events such as (bottleneck effect and the founder effect tend to reduce genetic variation.

*Genetic exchange between populations tends to reduce differences between populations over time.

*Natural selection is the only mechanism that consistently causes adaptive evolution.

*It increases the frequencies of alleles that enhance survival and reproduction.

3 Modes of Natural Selection

1) Directional Selection
2) Disruptive Selection
3) Stabilizing Selection

Chapter Twenty-Four

* The Biological Species Concept – A biological species is a group of populations whose individuals have the potential to interbreed and produce viable, fertile offspring with each other but not with members of other species. The biological species concept emphasizes reproductive isolation through prezygotic and postzygotic barriers that separate gene pools.

**Hybrids –** offspring that result from interspecific meetings

**Reproductive isolation** – the existence of biological factors (barriers: post and pre-zygotic for ex.) that impede members of two species from producing, viable, fertile offsprings.

*Speciation can take place with or without geographic separation.

**Allopatric "other country" speciation** – occurs when two populations of one species become geographically separated from each other. One or both populations may

undergo evolutionary change during the period of separation, resulting in the establishment of prezygotic + postzygotic barriers.

**Sympatric "same country" speciation –** A new species can originate while remaining in a geographically overlapping area with the parent species.

**Hybrid Zones –** A geographic region in which members of different species meet and mate, producing at least some offspring of mixed ancestry.

Possible outcomes for hybrids in a HZ:

1) Reinforcement –strengthening of rep barriers, hybrids gradually cease to form
2) Fusion – weakening of the rep. barrier, the two species fuse
3) Stability – continued production of hybrid individuals.

*Speciation can occur rapidly or slowly and can result from changes in few or many organisms.

*New species can form rapidly once divergence begins—but it can take mil. of years for that to happen.

*Due to repeated events, small diff. between organisms can accumulate leading to the formation of new groups of organisms.

Chapter Twenty-Five

**Macroevolution** – Evolutionary change above the species level., including the origin of a new group of organisms or a shift in the broad pattern of evolutionary change over a long period of time.

*Conditions on early Earth made the origin of life possible

*The fossil record documents the history of life.

*The fossil record, based largely on fossils found in sedimentary rocks, documents the rise and fall of diff. groups of organisms over time.

*Key events in life's history

**Geologic Record –** The division of Earth's history into time periods, grouped into Eons—Archean, Proterozoic, and Phanerozoic—and further subdivided into eras, period, and epochs.

Three big eons:

1) Phanerozoic contains the Cenozoic Era (humans evolved)
2) Proteozoic contains the Mesozoic Era (age of reptiles)
3) Archean contains the (pre-cambrian life on earth)

**Continental Drift –** Plates move grad. Over time, altering the physical geo, and climate of earth

**Mass Extinctions –** 5 big mass extinctions so far (meteors, volcanic activity...)

**Adaptive Radiations –** Large increases in the diversity of life have resulted from adaptive radiations that followed mass extinctions.

*Major changes in body form can result from changes in the sequences and regulation of developmental genes.

*Hox gene – big dev. Gene in animals

*Developmental genes affect morphological diff. b/w species

*Evolutionary trends can be caused by factors such as natural selection in a changing environment or species selection. Like all aspects of evolution, evolutionary trends result from interactions b/w organisms and their current environments.

Chapter Twenty-Seven

*Bacteria come in 3 general shapes:

1) Spherical
2) Rod
3) Spiral

***Peptidoglycan** – A network of modified-sugar polymers cross linked by short polypeptides. Bacterial cell walls are made of this.

*Bacteria move by flagellum.

*Prokaryotes can reproduce by binary fission very quick. Prokaryotic populations can evolve in short periods of time in response to changing environmental conditions.

*Rapid reproduction, mutation, and genetic recombination promote genetic diversity in prokaryotes.

*Mutations can quickly increase a population's genetic variation, enabling adaptive evolution.

*Genetic diversity in prokaryotes also can arise by recombination of the DNA from two different cells (in bacteria, via transformation, transduction, or conjugation.) Genetic variation can also promote adaptive evolution in prokaryotic populations.

*Prokaryotes have diverse nutrition and metabolism:

4 types of Nutrition:

Autophototroph
Autoheterotroph
Chemoautotroph
Chemoheterotroph

*Oxygen plays a role in prokaryotic metabolism

*Obligate aerobes require O2, obligate anaerobes are poisoned by O2, and facultative anaerobes can survive with or without O2.

*Role of Nitrogen in Metabolism

*Prokaryotes can metabolize a wide variety of nitrogenous compounds. Some can convert atmospheric nitrogen to ammonia in a process called **Nitrogen Fixation.**

*Many Prokaryotes depend on the metabolic activites of other prokaryotes.

*Archea inhabit extreme places on Earth. (Salty or hot places for ex)

*2 Largest groups of Bacteria: Gram-positive & Proteobacteria

*Prokaryotes play crucial roles in our biosphere

*Prokaryotes can cause harmful diseases in humans, but they also have benefical effects which are currently being researched on

Chapter Twenty-Eight

*Protists are unicellular eukaryotes.

Some are photoautotroph or heterotroph., but some are mixotrophs which means they are both photosynthetic and feed like animals.

***Secondary endosymbiosis** : ingested in the food vacuole of heterotrophic Eukaryotes and become the plastids themselves.

**5 Super groups of Protists :**

1 .Excavata
2 Chromalvetolata
3 Rhizaria
4 Archaeplastids – Green/Red Algae

5 Unikonta

*Each group has to be monophyletic which represent a valid clade : common ancestor has to be included, as well as all the descendants.
*Algae has a direct lineage to land plants.
***Alternation of Generation** : Two phases of sexually reproducing multi-cellular organisms, which are Haploid and Diploid, in these two stages the cells are both multi-cellular.
*Monophyletic essence of all clades : Must have one common ancestor, and must show all descendants.
*Unikonts are closely related to fungi and animals.
*Many protists create symbiotic relationships with other species. Most protists are producers.
*Protists play key roles in ecological relationships. Others are Symbiotic Protists, which means they form symbiotic associations with other species

Chapter Twenty-Nine and Thirty
*Gametophyte is named for its production by mitosis of haploid gametes
***Cuticle**, which consists of polyester and wax polymers. Permanently exposed to the air, land plants run a far greater risk of desiccation than their algal ancestors. The cuticle acts as waterproofing, helping prevent excessive water loss from the above ground plant organs, while also providing protection from microbial attacks.
*Early land plants lacked true roots and leaves. Without roots, how did these plants absorb water through the soil?
*One way to distinguish plants is by whether or not they have an extensive system of **vascular tissue,** cells joined into tubes that transport water and nutrients throughout the plant body. Most plants have a complex vascular tissue system and are therefore called **vascular plants**. Nonvascular plants are often informally called **bryophytes**. Although the term bryophyte is commonly used to refer to all nonvascular plants, debate continues over the relationships of liverworts, hornworts, and mosses to each other and to vascular plants.
*Vascular plants, which form a clade that comprises about 93% of all plant species, can be categorized further into smaller clades. Two of these clades are the **lycophytes** and the **pterophytes**. The plants in each of these clades lack seeds, which is why collectively the two clades are informally called **seedless vascular plants**. However seedless vascular plants are paraphyletic, not monophyletic.
***Gymnosperms** are grouped together as “naked seed” plants because their seeds are not enclosed in chambers.
***Angiosperms** are a huge clade consisting of all flowering plants. (90% of all living extant plants)
*Today there are three phylas representing the non-vascular plants today : **Liverworts, Hornworts, and Mosses**.
*Non-vascular plants (Brotophytes) have the smallest sporophytes of all extant plant groups.

*A **seed** consists of an embryo and its food supply, surrounded by a protective coat.
About 13,000 years ago, humans began to cultivate wheat, figs, corn, etc.
***Phylum Coniferophyta (largest in gymnosperms)**
*The **flower** is an angiosperm structure specialized for sexual reproduction. Flowers consist of: sepals, petals, stamens, and carpels.
*Until the late 1990s, most systematists divided flowering plants into two groups, based partly on the number of *cotyledons*, or seed leaves, in the embryo. Species with one cotyledon was called a **monocot**, and those with two were **dicots**. Monocots typically have parallel leaf veins (like a grass blade). Dicots have a net like vein pattern.

Chapter Thirty-One
*Like animals, fungi are heterotrophs.
*Fungi take on many roles in ecological communities. *Decomposer fungi* break down and absorb nutrients from non living organic materials. *Parasitic fungi* absorb nutrients from the cells of living hosts. *Mutualistic fungi* also absorb nutrients from the cells of a host, but they reciprocate with actions that benefit the host.
*The bodies of these fungi typically form a network of tiny filaments, which are called **hyphae.** *Fungal hyphae form an interwoven mass called a **mycelium**.
*Mutually beneficial relationships between fungi and plant roots are called **mycorrhizae**.
*Many yeasts and filamentous fungi have no known sexual stage. Mycologists have traditionally called such fungi **deuteromycetes**.
**The ancestor of fungi was an aquatic, single-celled, flagellated protist.*
*Chytrids are the oldest phylum of Fungi.
A Group of unicellular protists, the **nucleariids**, consists of amoebas that feed on algae and bacteria.
Fungi are heterotrophs that grow on or near their food and that feed by absorbstion.

Chapter Thirty-Two
*Animals are eukaryotes, and like plants and most fungi, animals are multicellular.
*Many animals have two types of specialized cells not seen in other multicellular organisms: muscle cells and nerve cells.
**Cleavage**, a succession of mitotic cell divisions without cell growth between division cycles.
**Gastrulation,** during which layers of embryonic tissues that will develop into adult body parts are produced.
.*A **larva** is a sexually immature form of an animal that is morphologically distinct from the adult.
***Metamorphosis**, a developmental transformation that turns the animal into a juvenile.
***Cambrian Explosion** a term referred to a population bloom back in the paleozoic era.
A **body plan** is a set of morphological and developmental traits, integrated into a functional whole—the living animal.

**Radial symmetry** have a top side, and a bottom side—no front, back or sides. (Sessile)
**Bilateral symmetry** has two axes of orientation: front to back, and top to bottom. (Motile)

**Points of agreement :**

1. All animals share a common ancestor
2. Sponges are basal animals
3. Eumetazoa is a clade of animals with true tissues
4. Most animal phyla belong to the clade Bilateria
5. Chordates and some other phyla belong to the clade Deuterostomia

Chapter Thirty-Three

***Calcarea and Silicea**

Animals of this phyla are informally called sponges, which lack true tissues

***Cnidaria**

Include corals, jellies, and hydras.

***Platyhelminthes**

Flatworms have bilateral symmetry and a central nervous system

***Rotifera**

Despite their microscopic size, rotifers have specialized organ systems, including an alimentray canal

***Mollusca**

Molluscs have a soft body that in many species is protected by a hard shell

***Annelida**

Segmented worms are distinguished from other worms by their body segmentation.

***Tardigrades**

Are sometimes are called water bears for their rounded shape and stubby limbs.

***Nematoda**

Roundworms are enormously abundant and diverse in the soil.

***Chordata**

Humans

*Sponges are **suspension feeders** which means they capture food particles suspended in the water that passes through their body.
*__Polyps__ are cylindrical forms that adhere to a substrate by the aboral end of their body (opposite the mouth end)
***Medusa** is a flattened, mouth-down version of the polyp.
*__Molluscs__ have a muscular **foot, a viceral mass,** and a **mantle.**
***Arthropods (HUGE DIVERISTY)**

Chapter Thirty-Four

***Derived characteristics of chordates**

Chordates are named for a skeletal structure, the notochord, present in all chordate embryos as well as in some adult chordates. The **notochord** is a longitudinal, flexible rod located between the digestive tube and the nerve cord. They also have **Hollow nerve cords, Pharyngeal slits,** and a **muscular, post anal tail.**

*__Tunicates__ (Urachordata) are more closely related to other chordates than are lanceletes. The characteristics are most apparent during their larval stage.
***Neural Crest** a collection of cells that appear near the dorsal margins of the closing neural tube in an embryo.
*The **amniotes** are a group of tetrapods whose extant members are the reptiles and mammals.
*The **amniotic egg**, which contains four specialized membranes: amnion, chorion, the yolk sac, and the allantois.
*Mammals are amniotes that have hair and produce milk
*Tetrapods – Four Feet
**See the end of the chaper for a more detailed review*