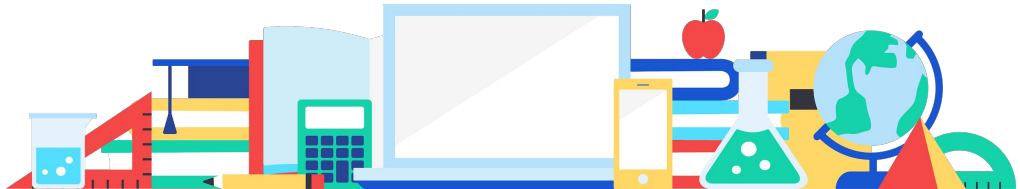
Biology Concepts & Vocab

July 2020



Topics to Discuss

- Biochemistry
- The Cell
- Cell Division
- Cellular Respiration
- Photosynthesis and Plants
- Classical Genetics
- Molecular Genetics
- Ecology
- Evolution and Taxonomy
- Human Physiology and Anatomy
- Animal Behavior and Physiology

Biochemistry

- Basic chemistry
- Bonding/IMFs
- Behavior of water
- pH
- Organic compounds/macromolecules
- Energy
- Enzymes

Biochemistry

Additional resources

Skeletal notes for biochemistry

Video (brief) for basic chemistry

Video (longer) for biochemistry lecture with presentation slides

Basic chemistry: Chemistry is the making and breaking of bonds.

Bonding/IMF's

When two atoms share electrons, a bond is formed. Energy is released when a bond is broken. Ionic bonds result from a transfer of electrons, while covalent bonds result from a share of electrons.

Intermolecular forces (IMF's) are not chemical bonds; they are the forces that determine the chemical properties of a substance. Van der Waals forces, dipole-dipole interactions, and hydrogen bonds are three main IMF's. The difference between chemical bonds and IMF's is explained here.

Behavior of water

Water molecules are asymmetrical and highly polar; hydrogen bonds explain the attraction between the positive hydrogen and negative oxygen poles. The five important properties of water are: 1) high specific heat, 2) high heat of vaporization, 3) universal solvent, 4) cohesion tension, 5) ice floats.

pH

pH measures how basic (alkaline) or acidic a solution is. Solutions with pH greater than 7 are acidic, while solutions with pH less than 7 are basic. pH is the negative log of the hydrogen ion concentration in moles per liter. So, a solution of pH 2 is 10 times more acidic than a solution of pH 3.

Comparison of Bonding and Attractive Forces

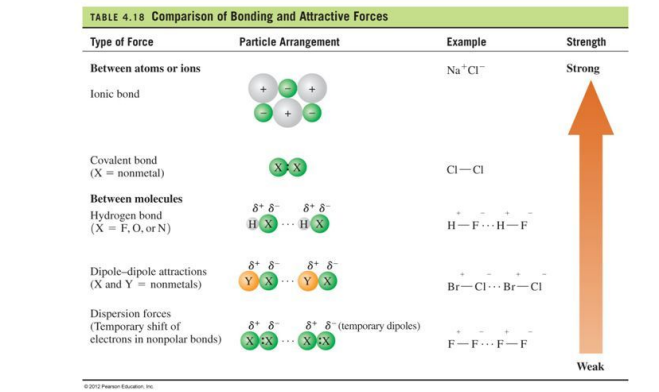


TABLE 4.18 Comparison of Bonding and Attractive Forces

Type of Force	Particle Arrangement	Example	Strength
Between atoms or ions		Na^+Cl^-	Strong
Ionic bond			
Covalent bond (X = nonmetal)		Cl—Cl	
Between molecules			
Hydrogen bond (X = F, O, or N)		H—F···H—F	
Dipole–dipole attractions (X and Y = nonmetals)		Br—Cl···Br—Cl	
Dispersion forces (Temporary shift of electrons in nonpolar bonds)	(temporary dipoles)	F—F···F—F	

Weak

Biochemistry

Additional resources

Skeletal notes for biochemistry

Video for biological molecules

Video for enzymes

Name of Compound	Elements	Monomer/Sub Unit	Polymer	Function
Carbohydrate	Carbon hydrogen oxygen (CHO)	monosaccharide	disaccharide AND polysaccharide	Quick Energy AND Messenger
Lipid	carbon hydrogen oxygen (CHO)	fatty acid AND glycerol	phospholipid AND triglyceride	Stored Energy AND Structure
Protein	carbon hydrogen oxygen nitrogen (CHON)	amino acid	polypeptide	Builds Muscle AND Enzymes
Nucleic Acid	carbon hydrogen oxygen nitrogen phosphorous (CHONP)	Nucleotides A T C G U	DNA AND RNA	Carries genetic Info

Source: http://sscbiology.weebly.com/

Organic compounds/macromolecules
The four classes of organic compounds (also known as organic macromolecules) are carbohydrates, lipids, proteins, and nucleic acids. Be familiar with their different properties and respective monomers/subunits, polymers, and functions.

Energy
Lipids and carbohydrates both store energy. Lipids store twice as much energy (measured in calories per gram) than carbohydrates. Nucleotides also have some metabolic functions -- ATP (adenosine triphosphate) is a nucleotide that supplies energy because of two unstable phosphate bonds are easily broken.

The law of conservation of energy (that energy can only be transferred, not created or destroyed) and the second law of thermodynamics (that the universe becomes more disordered with greater entropy) govern the energy transformations in living systems. Endothermic reactions are energy absorbing, while exothermic reactions are energy releasing.

Enzymes
Enzymes are proteins that catalyze chemical reactions by lowering the activation energy needed; enzymes themselves are not energy sources! They are substrate-specific, often requiring helpers like cofactors (inorganic) or coenzymes (vitamins). The induced-fit model describes how enzymes work. Enzymes influence chemical reactions through competitive inhibition, noncompetitive inhibition, allosteric inhibition, cooperativity, and more.

The Cell

- Cellular Structure (plant and animal)
- Cell functions
- Transport
- Cell Junctions

Cellular Structure and Function

Cells are divided into two categories: prokaryotic and eukaryotic.

Prokaryotes have no nucleus or internal membranes; all bacteria are prokaryotes.

Eukaryotes have internal membranes and a nucleus; human cells are eukaryotic.

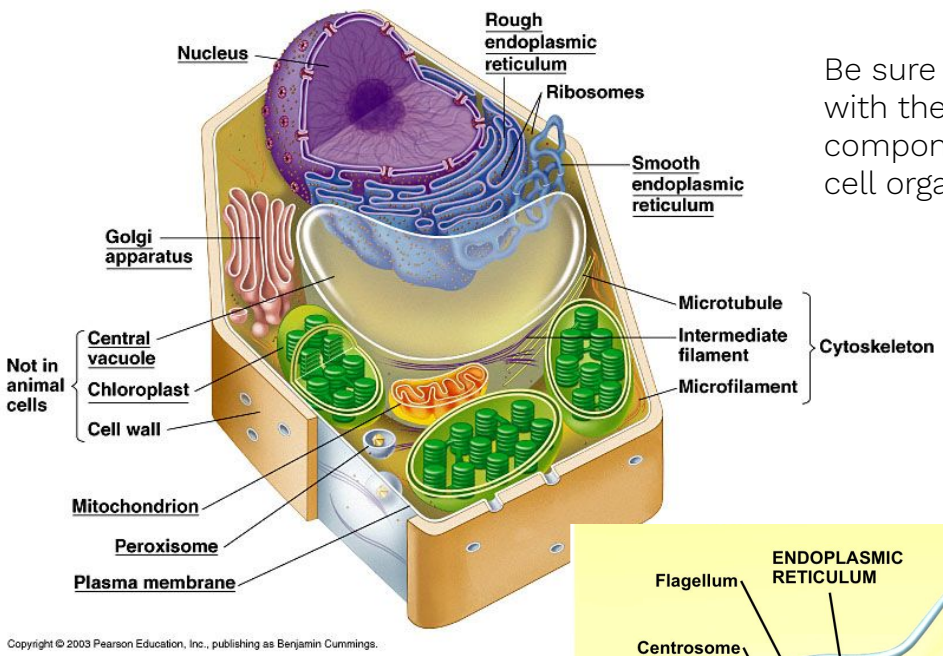
For more about cell organelles and their functions:

Diagrams of cell organelles

Video for tour of the cell

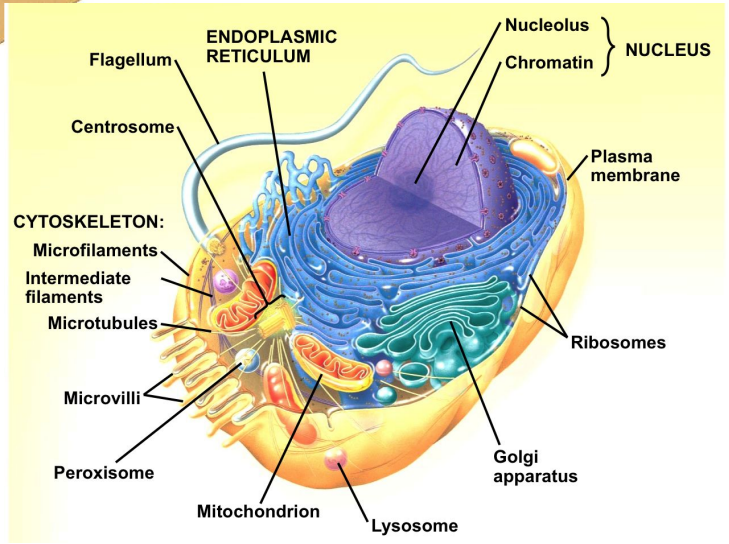
Video lessons for cell structure

Brief notes and vocabulary list for cell structure



Be sure to be comfortable with the function of and components making up each cell organelle.

Also, be comfortable with big picture concepts like the difference between plant and animal cells.



Cell Transport and Junctions

Additional resources

Brief article on cell transport

Video on membranes and cell transport

Video on cell transport with lecture slides (longer)

Brief article on cell-cell junctions

Cell transport

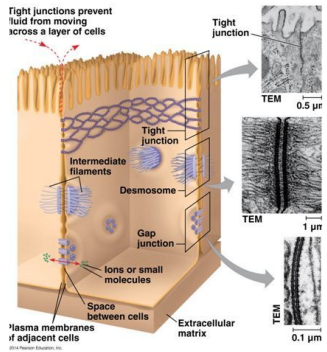
Transport in and out of the cell can either be passive or active, which means requiring energy. Examples of passive transport include osmosis and diffusion; terms like hypertonic, isotonic, hypotonic, and water potential help describe how passive transport works.

Active transport carries molecules against the gradient, meaning from low concentration to high concentration, thus requiring energy. Examples of active transport include pumps, contractile vacuoles, exocytosis, pinocytosis, phagocytosis, and receptor-mediated endocytosis.

Cell junctions

Four types of cell junctions include tight junctions, desmosomes, gap junctions, and plasmodesmata. Cell junctions are one example of cell communication that enables individual cells in a multicellular organism to work together cohesively.

Cell Junctions – Animal Cells



- **Tight junctions** – bound by proteins, forms a continuous seal that prevents leakage across epithelial cells
- **Desmosome**s – like rivets, creating strong attachments between cells – in muscles
- **Gap junctions** – like plant **plasmodesmata**, connect cytoplasm to neighboring cytoplasm

Plasmodesmata are found in plant cells, while gap junctions are found in animal cells. Both enable cell transport and communication.

Cell Division

- Cell cycle
- Mitosis
- Meiosis

Cell Cycle & Mitosis

Additional resources

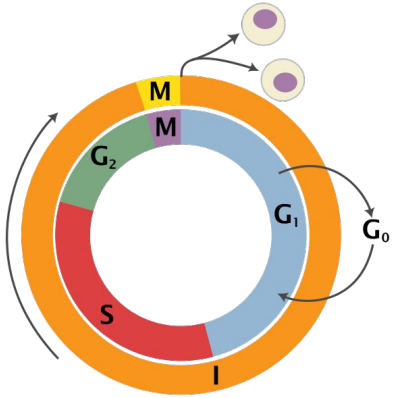
Video for the cell cycle

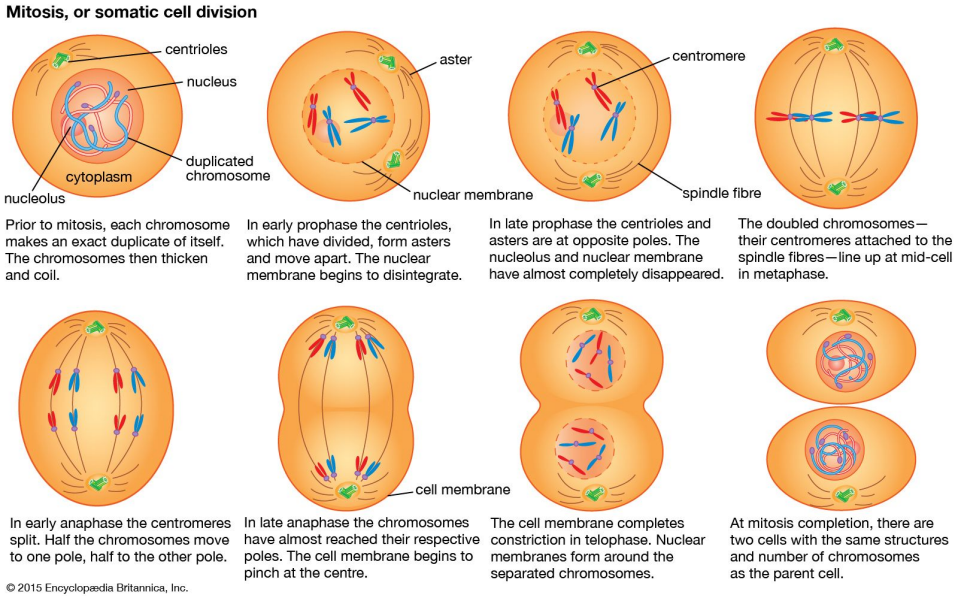
Video for mitosis with diagrams

Notes and key terms for mitosis

Cell division enables organisms to grow, reproduce, and repair damaged cells. The cell cycle control system regulates the rate at which cells divide. Checkpoints and molecules cyclins and cyclin-dependent kinases regulate the timing.

The cell cycle is a sequence of growth and division phases. In eukaryotic cells, the cell cycle consists of five major phases: G1, S, and G2 (those three together make up interphase), mitosis, and cytokinesis.





Mitosis produces two identical daughter cells, conserving the number of chromosomes (2n).

In contrast, meiosis (in the next slide) produces gametes, with half the number of chromosomes (n).

Mitosis consists of four phases: prophase, metaphase, anaphase, and telophase. The diagram to the left goes from left to right, top to bottom, and shows early and late stages of mitosis phases.

Be comfortable with these terms relating to mitosis and meiosis: sister chromatid, centromere, kinetochore, tetrad, synapsis, homologous chromosomes, karyotype, and chiasmata.

Meiosis

Additional resources

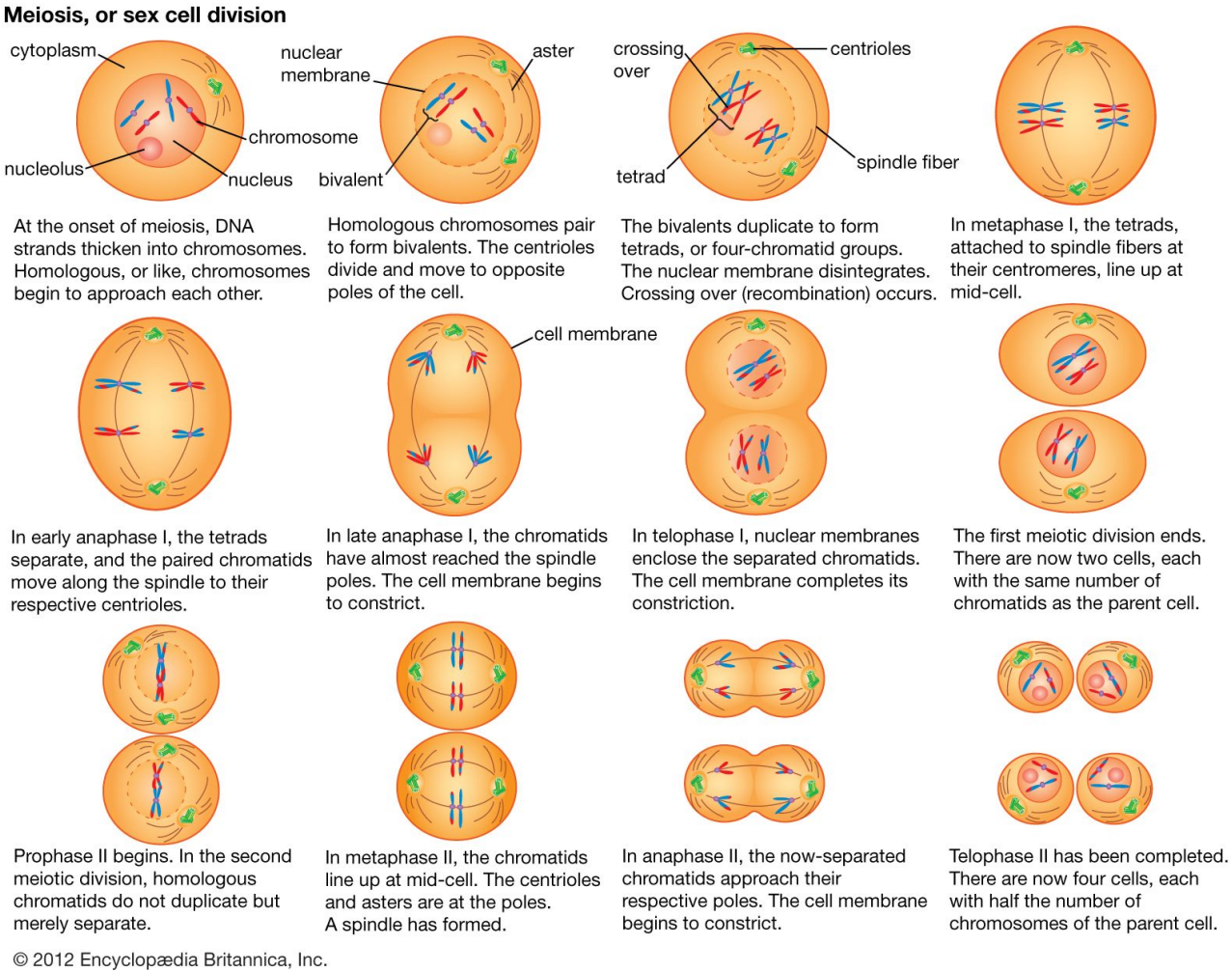
Video lecture for meiosis

Video for meiosis with diagrams

Notes and key terms for meiosis

Meiosis is a form of cell division that produces gametes, or sex cells, with haploid chromosomes (n). There are two stages of meiosis.

The three sources of genetic variation include independent assortment of chromosomes (metaphase 1), crossing over to create recombinant chromosomes (metaphase 1), and random fertilization.



Cellular Respiration

- ATP
- Anaerobic vs. aerobic respiration
- NAD and FAD
- Mitochondrion structure
- Steps of cellular respiration

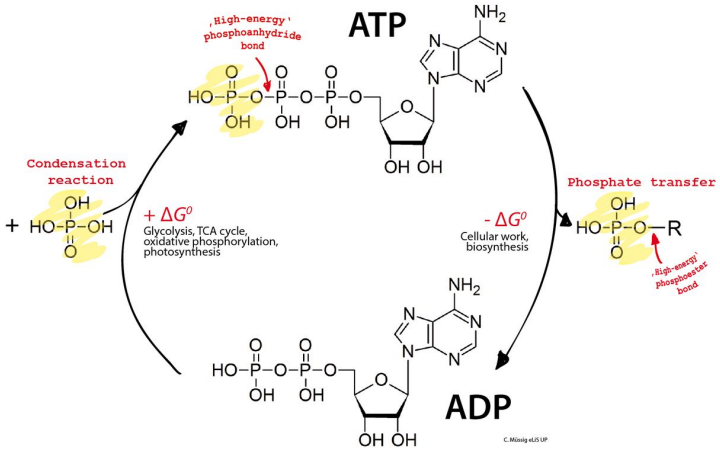
Cell Respiration

Additional resources

Video for ATP & Respiration

Cell respiration is the process by which cells convert energy stored in food to energy stored in a molecule called ATP, which stands for adenosine triphosphate.

When ATP loses the third phosphate group during hydrolysis, it becomes the more stable molecule ADP (adenosine *di*phosphate) and energy is released.



Source: Wikimedia

Anaerobic respiration occurs in the absence of oxygen, while aerobic respiration occurs with oxygen. Aerobic respiration is highly exergonic, meaning it releases energy.

Aerobic respiration

Additional resources

Video for ATP & Respiration

Lesson series for cellular respiration and its phases

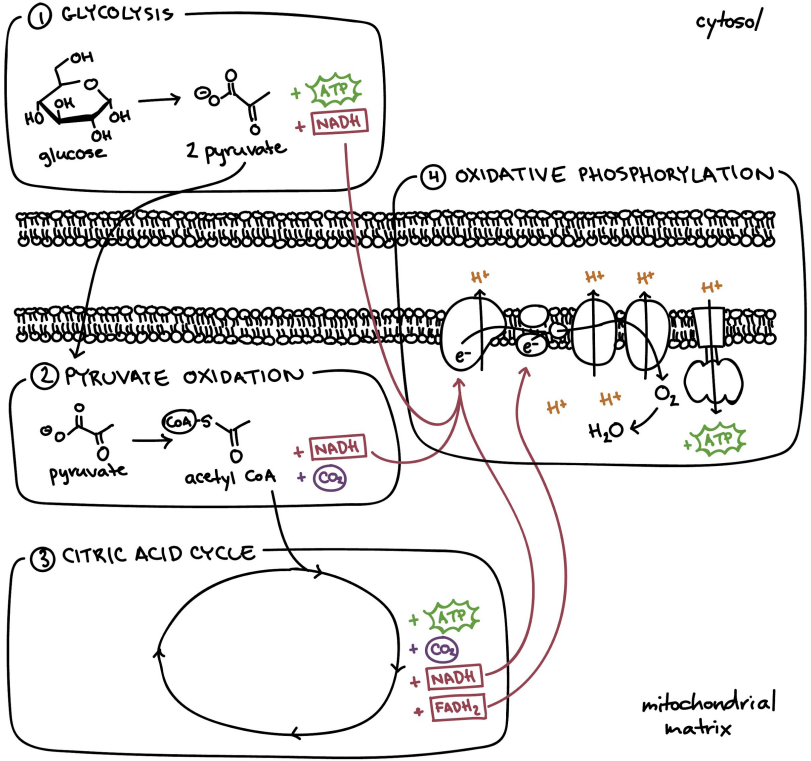
Video lecture for cell respiration

The purpose of cellular respiration is to break down glucose (sugar) into energy (ATP), providing cells the energy they need to function.

Steps of aerobic respiration

The oxidation of glucose in cellular respiration can be subdivided into three primary phases: glycolysis, the Citric Acid Cycle (Krebs Cycle) and oxidative phosphorylation (electron transport chain + chemiosmosis).

Most current sources estimate that the maximum ATP yield for one molecule of glucose is around 30-32 ATP through aerobic respiration.



NAD and **FAD** (labelled in maroon) are coenzymes that carry electrons or protons from glycolysis (1) and the Krebs Cycle (3) to oxidative phosphorylation (4). They are essential for aerobic respiration.

Anaerobic respiration

Additional resources

Video for ATP & Respiration

Lesson series for cellular respiration and its phases

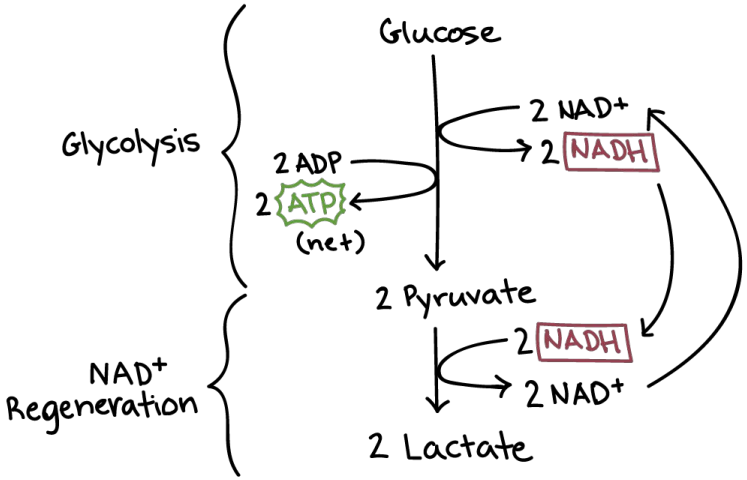
Video lecture for cell respiration

Video lecture for anaerobic cellular respiration

Anaerobic cellular respiration is similar to aerobic cellular respiration in that electrons extracted from a fuel molecule are passed through an electron transport chain, driving ATP synthesis.

In lactic acid fermentation, NADH transfers its electrons directly to pyruvate, generating lactase as a byproduct.

In alcohol fermentation, NADH donates its electrons to a derivative of pyruvate, producing ethanol.



Photosynthesis and Plants

- ➔ Chloroplast and leaf structure
- ➔ Steps of photosynthesis
- ➔ C3/C4/CAM photosynthesis
- ➔ Plants classification
- ➔ Plant evolution
- ➔ Plant anatomy and physiology
- ➔ Plant reproduction

Photosynthesis

Additional resources

Notes overview

Textbook outline

Article for leaf structure and summary of photosynthesis

Video for photosynthesis overview

Video for light reaction and Calvin cycle

Video for photosynthesis for the 9th grade level

Video for Calvin Cycle

Article for C3/C4/CAM photosynthesis

During photosynthesis, plants convert light energy into energy. The general formula is: $6CO_2 + 12H_2O \rightarrow (light)\ C_6H_{12}O_6 + 6H_2O + 6O_2$. The two main processes are the light-dependent (or, light reactions) and the light-independent reactions.

Photosynthesis involves pigments, namely chlorophyll and carotenoids, to absorb light energy.

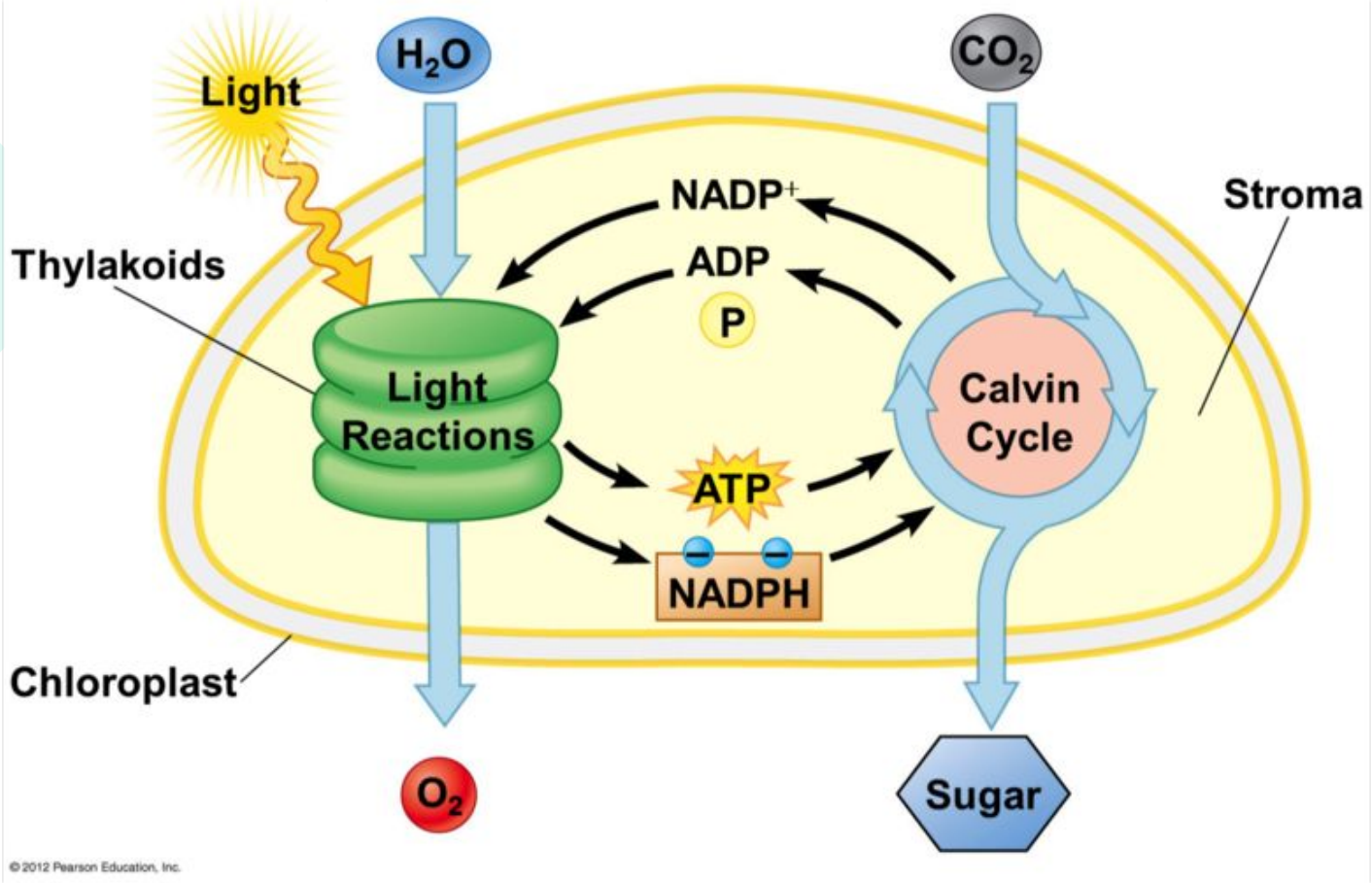
The chloroplast contains grana and stroma. Light reactions occur in the grana (which consist of thylakoids and photosystems I and II) and the light-independent reactions occur in the stroma.

Light reaction
Once light is absorbed by photosystem I or photosystem II, there are two possible routes for electron flow: cyclic and non-cyclic photophosphorylation. The light reaction creates ATP that powers light-independent reactions.

Calvin Cycle (light-independent reaction)
The Calvin Cycle produces the 3 carbon sugar PGAL. Carbon, in the form of carbon dioxide, enters the leaf through the stomates and to become fixed (meaning incorporated) in PGAL.

C3/C4/CAM photosynthesis
C3 plants fix carbon in 3-PGA, not PGAL, in the Calvin Cycle, resulting in a slightly less efficient photosynthesis and a separate photorespiration process. C4 and CAM plants have different forms of photosynthesis That are better suited for dry environments.

Photosynthesis



Plants

Additional resources

Skeletal notes for plant classification, evolution, tissues and organs, transportation, reproduction, responses to stimuli.

Video overviewing plant structure and physiology

Video for plant structure

Plant reproduction & development

Video for plant reproduction

Classification
Plants can be categorized as bryophytes (non-vascular) and tracheophytes (vascular). Tracheophytes include a) seedless plants, b) gymnosperms, c) angiosperms.

Evolution
In order to move from water to land, plants developed structural support, mechanisms to absorb water, and protection from water loss and environmental damage.

Structure and Physiology
The three main plant tissue systems are dermal, ground, and vascular tissue. The major plant organs include: roots, stems, leaves, and flowers.

Plants grow through primary growth and secondary growth. Plant transport happens through vascular tissues, xylem and phloem.

Plant hormones coordinate growth, development, and response to the environment. Tropisms are the tendency of a plant to grow away or towards something.

Reproduction
Plants can reproduce asexually and sexually. The life cycle of a plant is characterized by the alternation of generations between sporophyte and gametophyte stages.

Classical genetics

- ➔ Mendelian genetics
- ➔ Sex-linked genes
- ➔ Pedigrees and inheritance patterns
- ➔ Mutations

Classical genetics

Additional resources

Video for probability basics review

Video for heredity overview

Video for Mendelian genetics and practice problems

Video for introducing Punnett square

Textbook notes for Mendelian genetics

Powerpoint introduction to Mendelian genetics

Video for Hemophilia (sex-linked traits) example problem

Notes for cellular inheritance

Genetics is the study of heredity, which is the passing of characteristics from one generation to the next generation.

Mendelian genetics

The law of dominance relays the interaction between dominant and recessive traits; a Punnett square can help discern the genotype of offspring. The law of segregation explains how traits from parent cells or parent organisms are passed onto gametes. The law of independent assortment applies to dihybrid crosses.

Other types of inheritance patterns include: incomplete dominance, codominance, and multiple alleles. Gene interactions include pleiotropy, epistasis, and polygenic inheritance.

Basic probability theory underlies much of these ideas. When should you add or multiply two probabilities? Be sure to review those ideas if you're unsure.

Linked genes (and sex linkage)

Genes on the same chromosome are called linked chromosomes. Traits carried on the X chromosome are sex-linked; only females (individuals with two X chromosomes) can be carriers of recessive genes because males, who have one X chromosome, only inherit one copy of the gene, so they will express both recessive and dominant genes.

Classical genetics

Additional resources

Video for pedigrees

Video for pedigree practice problem 1

Video for pedigree practice problem 2

Notes for inheritance patterns (section 14.3)

Video that introduces mutations

Video for different types of chromosomal mutations

Video for different types of genetic mutations

Notes for genetic mutations

Pedigrees

Pedigrees are used to determine how a trait is inherited. A pedigree diagram is a family tree the indicates each family member's phenotype for a given trait. The carrier state is unknown as pedigrees focus on phenotype. Be sure to review practice problems with pedigrees to be able to confident discern sex-linked, recessive, and dominant traits.

Note that inheritance patterns are often more complex than predicted by classical Mendelian genetics -- recall concepts like incomplete dominance and gene interactions.

Mutations

The two types of mutations are gene mutations and chromosome mutations. Genetic mutations occur when there are changes to the DNA sequence. Unlike genetic mutations, chromosomal mutations can be observed under a microscope because the structure of chromosomes are affected.

Chromosomal mutations include deletion, inversion, translocation, and polyploidy. Nondisjunction is another error that occurs during meiosis, the production of gametes, and can lead to aneuploidy -- unusual ploidy numbers -- if those gametes are used during fertilization.

Genetic mutations include point mutations, deletion, insertion, and missense mutations. They occur spontaneously and are a source of genetic variation within a population.

Molecular genetics

- DNA structure and replication
- Central Dogma (RNA and protein synthesis pathway)
- Gene structure and regulation
- Genetic Engineering

Molecular Genetics

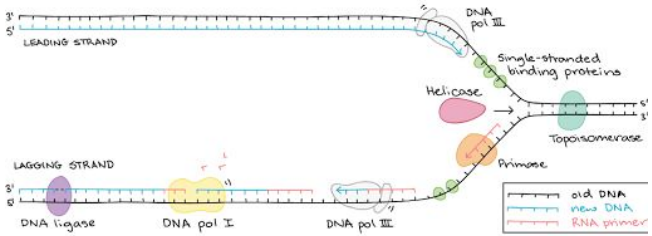
Additional resources

Videos on DNA, replication, transcription, and translation

Article on RNA

Article on protein synthesis

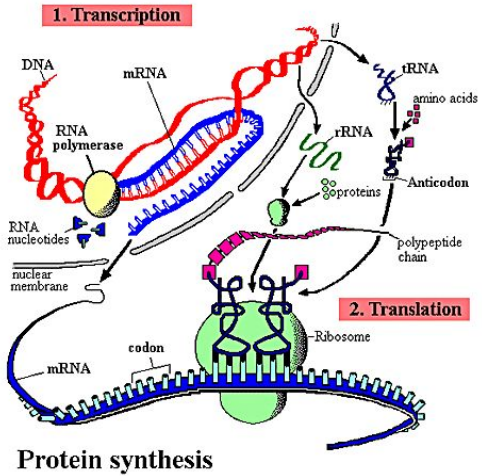
DNA structure and replication



DNA is found as a double helix in the nucleolus. It is made up of 4 nucleotides: A, C, G, T. A and T, and C and G are always paired. Replication occurs semi-conservatively in the 5' to 3' direction. As the replication fork is opened by a helicase, DNA polymerase III starts replication at an RNA-primer produced by primase. Pol-III then moves continuously on the leading strand and in short bursts on the lagging strand. The lagging strand fragments are joined with ligase and DNA pol I.

Image: khan academy

Central Dogma (RNA and protein synthesis pathway)



Genes are transcribed by RNA-polymerase II. In the presence of activating factors, such as proteins, RNA Pol-II begins at the transcription start site, and it pairs A with U, rather than T. The resulting RNA is processed to produce a mature messenger RNA. The mature mRNA exits the nucleus and is translated by a ribosome, which matches mRNA codons (non-overlapping 3 base-pairs) with tRNAs carrying amino acids, producing a protein via the genetic code. The ribosome and
tRNAs are made of different types of RNA.

Image: fourier.eng.hmc.edu

Molecular Genetics

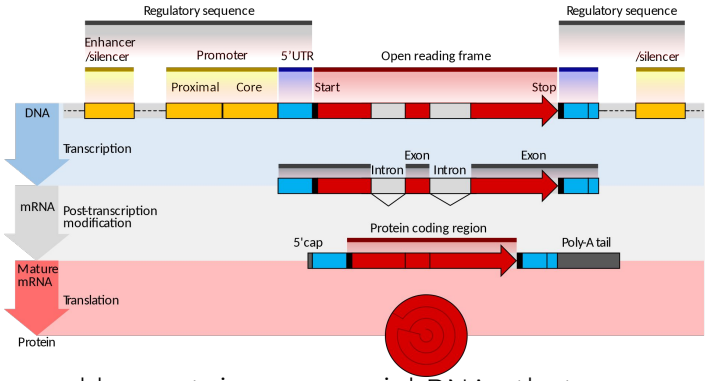
Additional resources:

Video lecture for overviewing molecular genetics

Video lecture for gene regulation

Video for genetic engineering

Gene structure and regulation



Genes are made up of introns, exons, and regulatory sequence. Introns are transcribed but excised during processing of the mRNA. Exons are kept and become proteinsor untranslated regulatory sequence. Regulatory sequence is bound by proteins or special RNAs that control whether and how much the gene is expressed. How tightly a gene is bound by nucleosomes and many other factors also influence gene expression.

Image: wikipedia

Genetic Engineering

Recombinant DNA is DNA that is combined from two sources. This can occur in nature, but scientists can also manipulate genes in laboratory. Tools and techniques that have been developed for genetic engineering include restriction enzymes, gel electrophoresis, DNA probe, and polymerase chain reaction (PCR), and complimentary DNA.

The use of cloned genes range from producing a protein product to replacing a faulty gene; the latter is known as gene therapy. Genetic engineering can also be used to create bacteria that can clean up the environment and create multiple copies of a gene for analysis.

Ecology

- Properties of populations
- Population interactions
- Energy flow and food chain
- Ecological succession
- Biomes
- Chemical cycles, nutrient cycles
- Humans and the biosphere

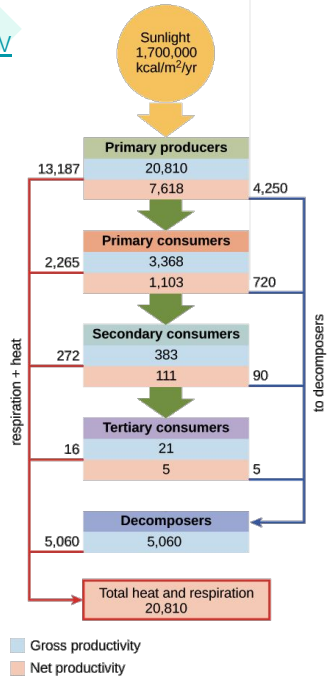
Ecology

Additional resources

[Video for population ecology]

[Video for community ecology]

[Video for energy flow]



Source: Khan Academy

Populations

A population is one group of individuals of the same species living in one area that can interbreed and interact with each other.

The 5 properties of a population include size, density, dispersion, survivorship curves, and age structure diagrams. Limiting factors and carrying capacity prevent population growth from being exponential.

The five types of population interaction are competition, predation, parasitism, mutualism, and commensalism.

Energy flow and food chain

Energy flow begins with the sun; 1% of solar radiation is absorbed by plants through photosynthesis. Gross primary productivity (GPP) is the amount of light energy converted into chemical energy (by photosynthesis) per unit time. Net primary productivity (NPP) is GPP minus the energy used by producers (like plants) for their own cellular respiration.

The food chain is the pathway along which food is transferred from one trophic or feeding level to another.

Ecological succession

Ecological succession is the sequential process of building up an ecosystem. Primary succession and secondary succession.

Ecology

Additional resources

Video for ecosystem ecology

Video for biochemical cycles

Article for biogeochemical cycles

Video for hydrologic and carbon cycles

Video for nitrogen and phosphorus cycles

Textbook for biogeochemical cycles

Biomes

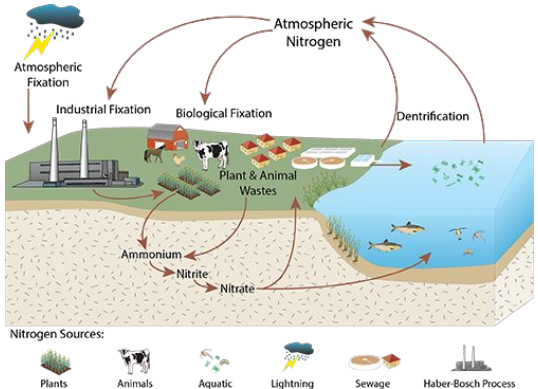
Biomes are large region of earth that are grouped together by the amount of rainfall and temperature of the region. Biomes have unique vegetation and animal life. Some of the major biomes of the world include marine, tropical rainforest, desert, and temperate deciduous forests.

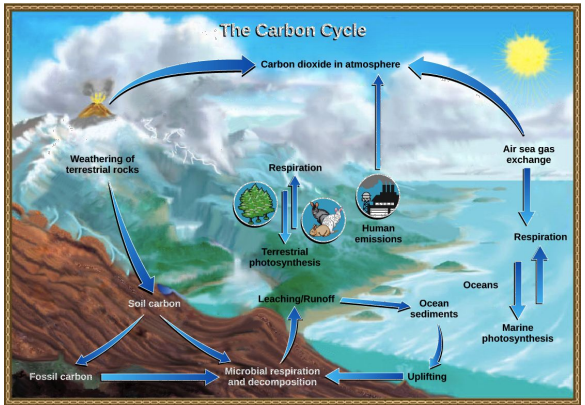
Chemical cycles/nutrient cycles

In ecosystems, chemicals and nutrients are finite and therefore constantly recycled, unlike energy from the sun. Important cycles are the water cycle, carbon cycle, nitrogen cycle and phosphorus cycle.

Humans and the biosphere

As the human population increases, the health of the biosphere is jeopardized due to pollution, consumption of natural resources, and ecosystem fragmentation. Important examples of negative human-biosphere interactions include global warming, acid rains, and pollution for toxins.





Evolution and Taxonomy

- Lamarck
- Darwin and natural selection
- Types of selection
- Hardy-Weinberg equation
- Evolution patterns
- Domains, Kingdoms, major phyla
- Evolutionary trends in animals
- Characteristics of major animal phyla

Evolution

Additional resources

Course notes for evolution biology

Video for historical context of evolution

Video for natural selection

Video for evolution and natural selection

Video for Hardy-Weinberg principle

Video for solving H-W problems

Video for H-W equations

Video for patterns in evolution

Historical context of evolution
Lamarck's theory of acquired characteristics said that through frequent use or disuse, animals could obtain acquired traits and pass on such traits to their offspring. Darwin developed the theory of natural selection and descent with modification.

Darwin's theory of natural selection
There are five parts to the theory of natural selection: (1) Populations grow exponentially, (2) Overpopulation leads to competition, (3) Populations have variation so each individual has a different chance of surviving, (4) Only the best-fit individuals could survive and reproduce, (5) Evolution occurs as "best-fit" traits accumulate in a population. The five types of selection are stabilizing, diversifying, directional, sexual, and artificial.

Hardy-Weinberg equilibrium
This equilibrium describes a stable and non-evolving population. The assumptions that must be met for a population to be in H-W equilibrium are: (1) Large population pool, (2) Population is isolated, (3) No mutations, (4) Random mating, (5) No natural selection.

Evolution patterns
There are five evolution patterns: divergent, convergent, parallel, co-evolution, and adaptive radiation. Two modern theories of evolution include gradualism and punctuated equilibrium.

Taxonomy

Additional resources

Video for taxonomy
(comprehensive overview)

Taxonomy course notes

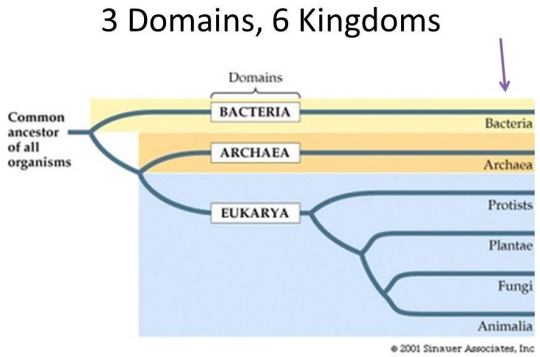
Taxonomy lecture notes with helpful diagrams

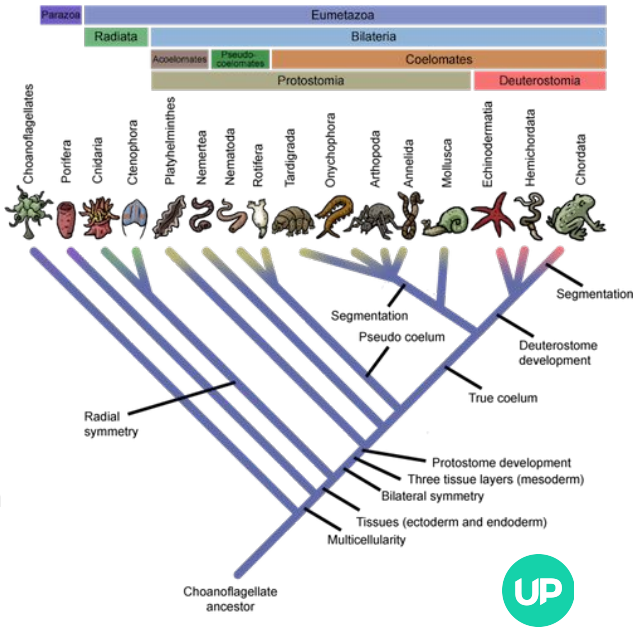
Three domain classification
Taxonomy is the naming and classification of species. The modern organization of all living organisms is classified in three systems: Bacteria, Archaea, and Eukarya. Can you recall the main characteristics of each domain? If not, be sure to consult the additional resources!

KPCOFGS
From general to specific, the hierarchical grouping of organisms, called *taxa*, is kingdom, phylum, class, order, family, genus, and species.

Evolutionary trends in animals
Animals, which are in the domain Eukarya, include a range of phyla that represent the development a new body plans. Important trends include: specialization of tissues, germ layers, body symmetry, cephalization, and body cavity formation.

Evolutionary trends in mammals and primates
Mammals have fur, are homeotherms, and nourish their babies with milk. Primates have opposable thumbs and front-facing eyes. They also devote much energy to parenting their young, the most intense parenting of any mammal.





Human Physiology and Anatomy

- Reproduction and development
- Human Immune System
  - Non-specific and specific immune defenses
  - Types of immunity
- Human organ systems

Physiology

Additional resources

Course notes for animal and human reproduction

Video for human reproductive system (4 parts)

Video lecture for human immune system

Video for human immune system (2 parts)

Course notes for human immune system

Course notes for gas exchange

Video for human anatomy and physiology (overview)

Reproduction and development
One advantage of sexual reproduction over asexual reproduction is the resulting genetic variation. Embryonic development consists of three phases: cleavage, gastrulation, and organogenisis. Different animals have different processes of embryonic development.

Immune system
Humans have three lines of defense. The first line of defense includes physical barriers like mucus and skin that prevent pathogens from entering. The second line of defense limits the spread of microbes from spreading once they enter the body and include phagocytes and the inflammatory response. The third line of defense, the specific defense, relies on B cells and T cells to recognize and attack specific antigens. The two types of immunity are passive and active.

Human organ systems (More about organ systems can be found on the animal physiology slide, slide 36.)

Humans have closed circulation system consisting of arteries, veins, and capilliaries. Blood is composed of plasma, red blood cells, white blood cells, and platelets.

The human nervous system has two parts: the central nervous system (CNS) that includes the brain and spinal cord; and the peripheral nervous system (PNS) that includes all the nerves outside of the CNS.

Humans use skin, lungs, kidney, and the liver for excretion of metabolic wastes. The nephron is the functional unit of a kidney and does the following four jobs: filtration, secretion, reabsorption, and excretion.

Animal Behavior and Physiology

- ➔ Innate vs. learned behavior
- ➔ Social behavior/communication
- ➔ Digestion
- ➔ Gas exchange
- ➔ Regulation
- ➔ Temperature regulation

Animal Behavior

Additional resources

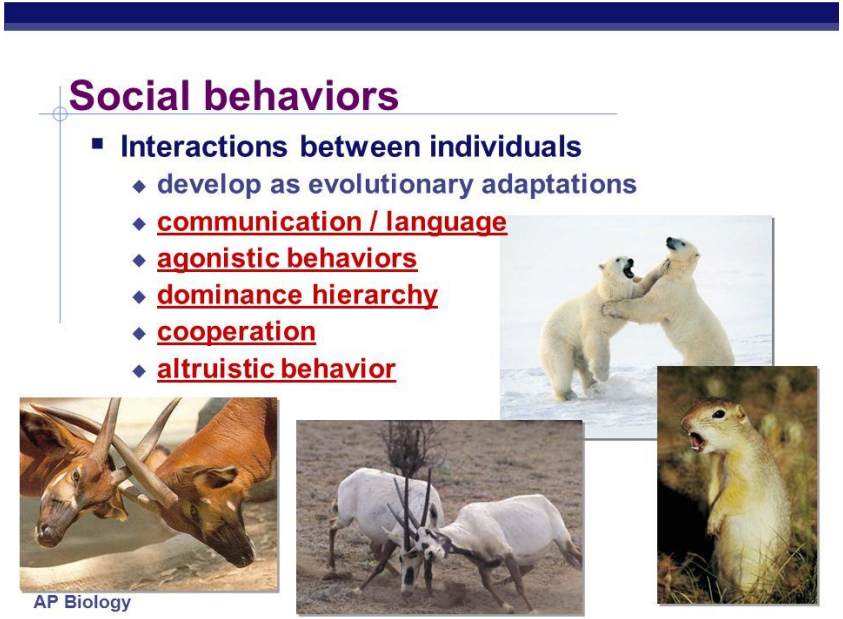
Video overview for animal behavior

Presentation slides for animal behavior (in-depth)

Innate vs. learned behavior

Fixed action patterns (FAP) are innate action patterns that animals do until completion, no matter how beneficial the behavior is. Learning is the process of Learning is a sophisticated process in which the responses of the organism are modified as a result of experience.

Social behavior and communication



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Animal Physiology

Additional resources

Video for digestion system (2 parts)

Video for respiratory system

Course notes for animal forms

Course notes for animal development

Course notes for gas exchange

Digestion
The process of digestion is different in different animals, like hydra, earthworms, and grasshoppers. In humans, the digestive system has two main purposes: digestion (breaking down large molecules) and absorption.

Gas Exchange
Respiration is the exchange of gases (carbon dioxide and oxygen) between an organism's cells and its environment; it occurs passively by diffusion, therefore requiring a respiratory surface that is thin, moist, and large in surface area.

Regulation
Animals have two regulatory systems that release chemicals: the endocrine system and the nervous system. The endocrine system secretes hormones, while the nervous system secretes neurotransmitters; however, there is some overlap between these separate systems. Epinephrine (adrenaline), for example, functions as the fight-or-flight hormone secreted by the adrenal gland and as a neurotransmitter that sends a message from one neuron to another. Osmoregulation is the management of an organism's bodily fluids and solute concentration. Aquatic and land animals face different challenges in maintaining the proper concentration of .

Temperature
Ectotherms are animals that gain most of their body heat from the environment, while endotherms use metabolic processes to generate most of their body heat. Endothermy is a metabolically expensive process.