

Organismal Biology

Life Processes

Life Processes	Prokaryotes	Eukaryotes			
		Protozoa	Arthropods	Cnidarian	Annelids
Reproduction	Binary Fission [Conjugation allows bacteria to exchange genetic materials with each other; Transduction involve virus carrying genes across]	Asexual Reproduction; Mitosis; involving duplication of cells and organelles	Sexual reproduction; with Meiosis producing gametes and then fertilization take place to produce viable offspring	Sexual or Asexual; by gametes exchange as well as budding, where unequal cytokinesis takes place	
Nutrition	Absorb nutrients in the form of raw compounds (fungi) or manufacturing them from chemical compounds (chemoautotrophs)	Intracellular digestion; cilia sweep food into oral groove or food engulfed into a vacuole that would then join the lysosomes	Similar to annelids except they utilize jaws for chewing and salivary glands for better digestion	Intra and extracellular digestion; food brought near the mouth where enzymes are released then gastrovascular cells engulf the food – undigested food are released	Food goes through the tube with mouth, pharynx, esophagus, crop (to store food), gizzard (to grind food), intestine (a large dorsal fold for surface area increase) and anus
Circulation	Diffusion into the cytoplasm as well as some active exchanges on the cell surface	Simple diffusion - cyclosis	Open circulatory system with blood flowing through open spaces called sinuses; with a simple beating tube heart, it moves blood through a dorsal vessel and then into sinuses (which bathe cells directly)	Simple diffusion - cyclosis	Closed circulatory, with aortic arches that force blood down ventral vessel from dorsal vessel; no red blood cells but with hemoglobin-like pigments dissolved in blood
Immune System	Cell surfaces, inhibition of certain exchanges; lysosomes move around cell to engulf foreign particles				
Respiration	Direct gas exchange with surroundings		Respiratory tubules (tracheae) open to outside in the form of pairs of openings (spiracles). Inside the	Same as protozoa	Skin mucus provide moist surface for gaseous exchange via

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			tracheae, spaces are divided into smaller and smaller branches (similar to alveoli) for direct gas exchange.		diffusion
Thermoregulation	Limited thermoregulation				
Excretion	Via Exocytosis	Same as cnidarians	Excreted in the form of solid uric acid crystals; mineral sales and uric acid accumulate in Malphigian tubules then transported to intestines and expelled with solid waste	Contracile vacuole for water excretion via active transport	2 pairs of nephridia tubules in each body segment excrete urea
Endocrine System	Limited Endocrine system				
Nervous System	Limited Coverage on nervous system (absent for most type of stated organisms)				
Motor System	Cilia and flagella that are of different structure from that of eukaryotes	Same as cnidarians	Exoskeletons composed of chitin, formed from non-cellular materials secreted by the epidermis. Require periodic molting to permit growth – muscles attach to interior of exoskeleton	Cilia and flagella facilitates movement with a protein motor with eleven cylindrical microtubules with 9 circling around 2 main stalks	Hydrostatic skeleton allows longitudinal muscles and circular muscles to contract against the fluid pressure, producing peristaltic motion

Animals/Humans Life Processes

Life Processes	Male	Female
Reproduction	Germ Cells divide mitotically to create primary spermatocytes which continuously undergo meiosis to form 4 haploid spermatids. Spermatids then mature to develop the acrosome at its tip. Sertoli cells in the seminiferous tubules support the sperm and Leydig cells secrete testosterone.	Ova progress to meiotic prophase I in 1 st round of meiotic cell division and then become arrested. An ovum would mature during each menstrual cycle; producing a smaller cell that would divide later to create 2 polar bodies as well as a larger cell that pauses in the 2 nd meiotic division then released during ovulation. After fertilization it completes meiosis and releases its last polar body.
Nutrition	Mechanical digestion at oral cavity ; salivary glands also produce amylase and start chemical digestion; pass to stomach through esophagus via peristalsis ; protein break down by proteases in stomach ; pass to duodenum for digestion of maltose and other sugars with input of bile from gall bladder as well as pancreatic enzymes from pancreas ; pass to jejunum and then ileum for absorption before entering the cecum and then the colon and to the rectum and finally anus . Absorption takes place on the villi of the ileum, with fats stored as chylomicrons passing into the lymphatic system through the lacteal while glucose, amino acids and small fatty	

	acids enter capillaries.
Circulation	<p>Closed respiratory with a chambered heart pumping blood through arteries into capillaries in tissues then blood pass into veins and back into the heart. Fish have 2-chambered heart with 1 atria and 1 ventricle (pumping 1 way to the gills, then to the rest of body and back to heart. Amphibians have 3-chambered heart while birds and mammals have 4-chambered hearts (2 atria and 2 ventricles).</p> <p>Human Heart – Deoxygenated blood arrives at the right atrium through the vena cava, to be sent to the lungs via the pulmonary artery through the right ventricle; the lungs deliver the oxygenated blood back to the left atrium through the pulmonary vein and the heart pumps the blood out of the left ventricle to the rest of the body through the aorta.</p> <p>Systole – Ventricles contract; Diastole – Ventricles relax</p> <p>Arteies – Thick-walled, muscular, elastic, conduct blood at high pressure; have pulse</p> <p>Capillaries – Thin-walled, only one endothelial cell thick; some liquid components of blood seeps from capillaries to bathe cells with nutrients directly.</p> <p>Veins – Relatively thin-walled, conduct blood at low pressure, no pulse and with valves to prevent backflow of blood (movement of blood assisted by contraction of muscles).</p> <p>Blood Contents: Plasma, Blood cells – Erythrocytes (red), platelets, Lymphocytes (white)</p>
Immune System	<p>Lymphatic System – Lymph vessels separate system independent of blood system, carries extra-cellular fluid ('lymph' at this stage) at very low pressure. Lymph nodes filter lymph and get rid of foreign particles; maintaining balance of fluids in tissues of the body. The system also transports chylomicrons (rather large lipo-proteins); it eventually empties the lymph back into the blood system via the thoracic duct.</p> <p>Passive Immunity – Skin, mucus, cilia to trap particles and remove them</p> <p>Active Immunity – Phagocytes engulfing bacteria, Lymphocytes (B & T cells) involved in immune responses. B-cells produce antibodies or immunoglobins, which would detect foreign molecules, identifying virus or bacteria and tagging them for attack. Helper T cells coordinate the immune response and Cytotoxic (killer) T cells directly kill cells that are infected. These lymphocytes are all antigen-specific.</p>
Respiration	<p>Lungs are in sealed cavity with the diaphragm controlling the volume of the cavity (thoracic cavity) and thus drawing air in and out of the lungs by altering this cavity volume.</p> <p>Air enters the nose/mouth, into the pharynx then larynx, trachea, bronchi, bronchioles, and the alveoli. Nose hair filters particles and the nasal passage moistens and warms the incoming air. Alveoli have thin film of water to facilitate gaseous exchange with the blood in the capillaries.</p>
Thermoregulation	<p>60% of energy from the oxidation of nutrients are transformed into heat (as they are not captured into ATP); ectoterms quickly loses the heat to surroundings, thus surviving with a body temperature equals to that of the surroundings while homeoterms have hairs and fur that retards heat loss and maintain body temperature above that of surroundings.</p> <p>Heat can be conserved through other means like reduction of sweat, subcutaneous fat insulating body, rapid contraction of muscles to generate heat (shivering) and vasoconstriction. Panting helps remove heat through evaporation of water from respiratory passage and Hibernation offers a chance for the animals to continue surviving under normal body temperatures.</p>
Excretion	<p>When proteins are burnt in Kreb's cycle, nitrogen is enzymatically removed and released as ammonia. The liver converts the ammonia to urea and releases it into the bloodstream. Blood pass from the renal artery into the glomerulus (located in the</p>

	<p>Bowman's Capsule) where salts, amino acids, glucose, water and urea are filtered out.</p> <p>The filtrate then travels through the proximal convoluted tubule that pumps glucose, amino acids, salts and proteins back into bloodstream. Water follows back into the bloodstream via osmosis through the loop of Henle (which dips down into the medulla of the kidney that has high extracellular sodium content). The filtrate then goes on to the distal convoluted tubule before entering the collecting duct, whose permeability is controlled by the ADH and thus concentrating urine when permeability is high. Blood leaves kidney via the renal vein.</p>
Endocrine System	See table on 'Human Hormones'
Nervous System	<p>Resting potential of -70mV (maintained by ion pumps that push out Na⁺ and K⁺ ions); when the membrane receives sufficient depolarization at the dendrites, say up to -55mV, the voltage-gated sodium ion channels will open and cause sodium ions to rush through, moving the membrane towards a voltage of 0. The depolarization moves down the axon of the neuron, at the nodes of Ranvier as the myelin sheath (on Schwann Cells) prevents the entry of sodium ions at discrete sites along the axon.</p> <p>Synapses – Axons ends with synaptic knobs with synaptic terminal where the neurons release neurotransmitters into the synaptic cleft; these chemical will diffuse towards the target cells and bind to the receptors on the target cell membrane.</p>
Sensory System	<p>Sight – Cones & Rods with the mental processing of the image captured by the vision of both allows perception of color, depth, focused and right-side-up images.</p> <p>Hearing & Balance – Corti in the cochlea of the ear contains hair cells that generate action potentials based on the mechanical pressure sensed at the different regions of the cochlea. The semi-circular canals also have hair cells that sense the endolymph (a fluid) levels and changes the nerve impulses sent by the vestibule nerve to the brain.</p> <p>Taste – Taste buds with a taste pore on the surface where taste hairs (microvilli) protrude; sour, salty, sweet and bitter taste are transmitted by these neurons.</p> <p>Smell – Olfactory receptors on the olfactory membrane on the upper part of the nostrils; odorous substances bind to the receptors in the cilia in the nasal passage.</p>
Motor System	<p>Endoskeleton consist of skeletal muscles, cartilages (firm, flexible bones without nerves), bones (growth maintained by a balance of osteoclast that reabsorb bones and osteoblast that deposits new bones). Compact bone forms the exterior, withstands longitudinal stress and consists of cylindrical units called Haversian systems (cells radiating around a central capillary within a Haversian canal); spongy bone fills the center of the bone, itself consisting of a network of hard spicules separated by marrow-filled spaces, withstands lateral stress.</p>

Human Hormones

Glands	Hormone	Function
Hypothalamus	Gonadotropin-releasing Hormone (GnRH)	Activates Pituitary to secrete FSH & LH
	Thyrotrophin Releasing Hormone (TRH)	Stimulates the release of thyroid-stimulating hormone and prolactin by the anterior pituitary
Anterior Pituitary	Growth Hormone	Effects of growth hormone on the tissues of the body is generally described as anabolic (building up); it increases calcium retention, protein synthesis and so on
	Thyroid Stimulating Hormone (TSH)	Stimulates the thyroid gland to secrete the hormones thyroxine (T4) and triiodothyronine (T3)
	Adrenocorticotrophic	Often produced in response to biological stress; principal effects

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	Hormone (ACTH)	are increased production of androgens and cortisol
	Prolactin	Act of an infant suckling the nipple stimulates the production of prolactin, which fills the breast with milk via a process called lactogenesis, in preparation for the next feed
	Follicle Stimulating Hormone (FSH)	In females, in the ovary FSH stimulates the growth of immature Graafian follicles to maturation. Graafian follicles are the mature follicle. Primary follicles mature to Graafian follicles. As the follicle grows, it releases inhibin, which shuts off the FSH production. In males, FSH enhances the production of androgen-binding protein by the Sertoli cells of the testes, and is critical for spermatogenesis.
	Luteinizing Hormone (LH)	In the female, an acute rise of LH (the LH surge) triggers ovulation. In the male, where LH had also been called Interstitial Cell Stimulating Hormone (ICSH), it stimulates Leydig cell production of testosterone.
Posterior Pituitary	Anti-diuretic Hormone (ADH) or Vasopressin	Released when the body is dehydrated and causes the kidneys to conserve water, thus concentrating the urine, and reducing urine volume; also raises blood pressure by inducing moderate vasoconstriction
	Oxytocin	Released in large amounts after distension of the cervix and vagina during labor, and after stimulation of the nipples, facilitating birth and breastfeeding, respectively
Thyroid	Thyroxine	Thyroxine is a prohormone and a reservoir for the active thyroid hormone triiodothyronine ; Involved in controlling the rate of metabolic processes in the body and influencing physical development
Parathyroid	Parathyroid Hormone	Regulate calcium & phosphate balance
Pancreas	Insulin (Beta Cells)	Encourage body cells to take up glucose from blood stream and convert into glycogen for storage; stop using fats as energy source – lower blood sugar
	Glucagon (Alpha Cells)	Stimulate the liver to convert stored glycogen into glucose and release it into the bloodstream – raise blood sugar
Adrenal Cortex	Corticosteroids	Wide range of physiologic systems such as stress response, immune response and regulation of inflammation, carbohydrate metabolism, protein catabolism, blood electrolyte levels, and behavior. Eg. Aldosterone: Causes the tubules of the kidneys to retain sodium and water, increasing the volume of fluid in the body, and drives blood pressure up
	Androgens	Stimulates or controls the development and maintenance of masculine characteristics
Adrenal Medulla	Epinephrine (Adrenaline)	A "fight or flight" hormone, and plays a central role in the short-term stress reaction [boosts the supply of oxygen and glucose to the brain and muscles, while suppressing other non-emergency bodily processes (digestion in particular)]; also acts as neurotransmitters. Note that Norepinephrine is psychoactive (affect mood, perception and behaviour).
	Norepinephrine (Noradrenaline)	

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Big Human Organs

Organs	Functions
Liver	Detoxification of toxins, storage of iron and vitamin B-12, destruction of old erythrocytes, synthesis of bile, synthesis of various blood proteins, defense against various antigens, beta-oxidation of fatty acids into ketones, interconversion of carbohydrates, fats and amino acids.

Plant Hormone

Hormone	Parts of Plant	Functions
Auxin	Stem	Phototropism; stimulating stems to point towards light. Negative Geotropism; direct shoots to grow upwards
	Roots	Positive Geotropism; direct roots to turn downwards, away from the surface of the ground
Gibberellins	Stem	Stimulate rapid stem elongation and formation of phloem; inhibit formation of new roots
	Seeds & Buds	Terminate dormancy of seeds & buds; inducing biennial plants to flower in the first year of growth
Cytokinins	Growth regions	Promote cell division, break seed dormancy and expands leaves.
Ethylene	Fruits	Stimulates fruit ripening
Antiauxins	-	Regulate the activity of auxins

Plant Reproduction

Names	Reproduction Means	Examples
Pterophytes	Spores	Ferns
Gymnosperms	Seeds without fruits; naked seeds	Conifers, Pines
Angiosperms	Seeds through fruits and flowers	All flowering plants

Asexual Plant Reproduction

Propagation	Description	Examples
Natural Means of Propagation		
Bulbs	Underground vertical shoots	Onion, tulips
Tubers	Underground stems with buds	Potatoes
Runners	Stems running between plants above ground	Strawberries
Rhizomes	Woody underground stems	Ferns & Irises
Artificial Means of Propagation		
Cutting	A piece of stem is cut and put in moist ground to stimulate roots formation	Geranium & Willow
Layering	Bending the stems into the ground , covering it with soil stimulates roots formation and then the offshoot can be cut and planted as another plant	Blackberry & Raspberry bushes
Grafting	Stem of one plant is attached to the rooted stem of another closely related plant; 2 parts of the grafted plants remains genetically distinct but the undifferentiated cells at the cambium of both stems would merge their vascular system.	

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Plant Phyla

Phyla	Description	Examples
Nontracheophytes/Bryophytes	Non-vascular tissues, with only tissues that close reproductive system but no vascular tissues that circulates fluids; reproduce only by spores	Moss
Tracheophytes	Plants with lignified tissues for conducting water, minerals and photosynthetic products through the plants	Higher plants

Animal Phyla

Phyla	Description	Examples
Ponifera	Motile at larve stage and then sessile (immobile) when matured	Sponges
Cnidaria	Characteristic tentacles with stinging cells with nematocysts (harpoon-like structures with toxins; used to capture prey)	Hydra, sea anemone, jellies
Platyhelminthes	Triploblastic (organs formed out of 3 germ cell layers) and bilaterally symmetrical; often parasites with haptor (a sucker-like structure that allows it to attach to its host)	Flatworms like Planaria
Nematoda	Has a pseudocoelom, unsegmented, triploblastic and bilaterally symmetrical; only possess longitudinal muscles	Roundworms
Annelida	Hydrostatic skeleton, with movement aided by the longitudinal & circular muscles that contract against hydrostatic pressure; with full coelom complete with circulatory and digestive systems	Segmented worms like earthworms & leaches
Arthropoda	Characterised by jointed legs and cuticles normally formed by chitin; with open circulatory systems and compound eyes	Crustaceans, insects, arachnids
Mollusca	Muscular foot, mantle that secretes a shell & rasping tongue named radula (chitinous)	Clams, squids, snails
Echinodermata	Spiny, with water-vascular systems and regenerative; exhibits radial symmetry	Sea stars & sea urchins
Chordata	Any organism with stiff solid dorsal rod (notochord) at some stage of embryologic development & gill slits	All vertebrates and some other invertebrates

Embryo Division & Naming

Types	Deuterostomes	Protostomes
Description	Embryo cleaved in a radial pattern	Embryo divide in a spiral pattern
Examples	Echnioderms Chordates	Annelids Arthropods Mollusks Roundworms