

Golgi Apparatus

A stack of flattened membranes and associated vesicles close to the nucleus; packages, modifies and segregates proteins for secretion

Microtubules

Cylindrical structures made of tubulin proteins; support the cell and give it shape; involved in intracellular and cellular movements; forms centrioles, cilia and flagella; help with cell division; constantly growing, disassembling and reassembling

Exocrine Glands

Externally secreting; secrete products onto body surfaces or into cavities (i.e. mucous, sweat, oil, saliva)

Unicellular Exocrine Glands

No ducts; found in epithelial linings of intestinal and respiratory tracts; mucous and goblet cells; exocytosis

Characteristics of Connective Tissue

Common Origin - arise from mesenchyme (embryonic tissue); Degrees of Vascularity; Extracellular Matrix - largely composed of nonliving extracellular matrix which separates living cells; allows tissue to bear weight

CT Fibers - Reticular

Collagenous fibers; delicate network; surround blood vessels and support soft tissue of organs

Dense Irregular CT

Description: same as regular, but collagen bundles are thicker and arranged irregularly

Function: withstand tension exerted in many directions; structural strength

Location: dermis of the skin, submucosa of DT and fibrous capsules of organs and joints

Osmolarity

Total concentration of all solute particles in a solution (mOsmol/L)

Secondary Active Transport

Energy needed to drive transport process is provided by the electrochemical gradient of another molecule; Ex: Na⁺K⁺ pump stores energy by creating a steep concentration gradient for Na⁺, as Na⁺ diffuses back into the cell through a membrane protein, it drives glucose against its concentration gradient into the cell

Exocytosis

Secretion of substances (i.e. hormones, neurotransmitters); substance is enclosed in a vesicle which migrates to plasma membrane, fuses with it and then ruptures

Special Features of the Neuron

Extreme Longevity - with good nutrition, they can function for a lifetime

Amitotic - they cannot reproduce through mitosis

High Metabolic Rate - high need for oxygen and glucose

Large, Complex Cells - all have a cell body and one or more processes

Factors That Generate Resting Membrane Potentials

Differences in Ionic Composition - concentration of Na^+ and K^+ is different on either side of the membrane; K^+ is higher and Na^+ is lower in cell

Differences in Plasma Membrane Permeability - Na^+K^+ pumps maintain concentration gradients resulting in the resting membrane potential

Graded Potentials

Short-lived, localized changes in membrane potential; stimulus generates depolarization which spreads but is quickly lost due to leakage channels and the current dies out; essential in initiating action potentials

Electrical Synapses

Less common; consist of gap junctions; channel proteins connect neurons and allow ions to flow directly from neuron to neuron; abundant in embryonic nervous tissue; responsible for rapid eye movement

3 Types of Muscle Tissue

Skeletal Muscle - attach to and cover skeleton; responsible for movement; contracts rapidly; longest muscle cells, striated; voluntary

Cardiac Muscle - only found in heart; striated; involuntary; neural input can change rate

Smooth Muscle - found in walls of hollow organs; forced substances through body channels; nonstriated; involuntary; slow, sustained contractions

Isometric Contraction

Muscle is attached to a weight that exceeds the muscle's peak tension-developing capabilities; when stimulated, the tension increases to the muscle's peak tension-developing capacity, but the muscle does not shorten

Not studied (100)

You haven't studied these terms yet!

Select these 100

Mitochondria

Double-membrane structures; site of ATP synthesis; powerhouse of cell

Ribosomes

Dense particles consisting of two subunits, each composed of ribosomal RNA and protein; free or attached to rough ER; sites of protein synthesis

Rough Endoplasmic Reticulum

Membranous system coiling through the cytoplasm; externally studded with ribosomes; synthesizes proteins and phospholipids; these proteins are bound in vesicles and sent to the Golgi apparatus

Smooth Endoplasmic Reticulum

Membranous system of sacs and tubules; free of ribosomes; site of lipid and steroid synthesis, lipid metabolism and drug detoxification

Peroxisomes

Membranous sacs of catalase and oxidase enzymes; enzymes break down toxic substances (i.e. hydrogen peroxide)

Lysosomes

Sacs containing acid hydrolases; site of intracellular digestion (i.e. digest bacteria, viruses and toxins)

Intermediate Filaments

Protein fibers, composition varies; resist mechanical forces acting on the cell; found in cells that need sturdiness (keratin, collagen)

Microfilaments

Fine filaments composed of actin; involved in muscle contraction and other types of intracellular movement; help form cell's cytoskeleton

Inclusions

Storage for nutrient, wastes, and cell products (i.e. glycogen granules found in liver and muscle cells)

Nucleus

Largest organelle; surrounded by nuclear envelope; contain fluid nucleoplasm, nucleoli and chromatin; control center of the cell; responsible for transmitting genetic info and providing instructions for protein synthesis

Functions of Epithelia

Protection (mechanical, chemical, infectious) (skin), absorptions (GI tract), filtration (kidneys), excretion (kidney), secretion (glands) and sensory reception (taste buds)

5 Special Characteristics of Epithelial Tissue

1. Polarity - apical and basal surfaces; apical surface often specialized (i.e. cilia and microvilli); basal lamina acts as a selective filter and as scaffolding
2. Specialized Contacts - cells are tightly bound together (tight junctions, desmosomes, gap junctions)
3. Supported by Connective Tissue - basement membrane is composed of a basal lamina (underlying supportive sheet of primarily glycoproteins) sitting on top of a reticular lamina (network of collagen fibers); reinforces epithelial sheet, helps resist tearing and defines epithelial boundary
4. Innervated but Avascular - epithelial cells are nourished by substances diffusing from blood vessels
5. Regeneration - able to reproduce rapidly b/c they're exposed to friction or damaged by external environment

2 Criteria Used to Classify Epithelial Cells

Cell shape: squamous - flattened, scale-like; cuboidal - boxlike, uniform; columnar - tall, column shaped

Layers: simple epithelia - single layer, found where absorption, secretion or filtration occur; stratified epithelia - two or more layers, high -abrasion areas

Simple Squamous Epithelium

Single layer of flattened cells; diffusion, filtration and secretion; found in kidneys, lungs, heart, blood vessels, lymphatic vessels and serosae

Simple Cuboidal Epithelium

Single layer of cuboidal cells; secretion and absorption; found in kidney tubules, ducts and secretory portions of small glands and ovary surface

Simple Columnar Epithelium

Single layer of tall cells; many have microvilli or cilia; may contain mucus-secreting unicellular glands; absorption and secretion; found in digestive tract, gallbladder, excretory ducts, small bronchi, uterine tubes and regions of the uterus

Pseudostratified Columnar Epithelium

Single layer of cells of differing heights (all touch basement mem., not all reach surface); may contain mucus-secreting cells and bear cilia; secrete substances (particularly mucus); nonciliated in sperm-carrying ducts and ducts of large glands; ciliated line trachea

Stratified Squamous Epithelium

Basal cells are cuboidal or columnar and metabolically active, surface cells are squamous; protects underlying tissues in areas subjected to abrasion; linings of esophagus, mouth and vagina, skin

Stratified Cuboidal Epithelium

Rare in the body; found in sweat and mammary glands; has 2 layers of cuboidal cells

Stratified Columnar Epithelium

Rare; small amounts found in pharynx, male urethra and glandular ducts; occurs in transition areas; only apical layer is columnar

Transitional Epithelium

Basal cells are cuboidal or columnar; surface cells dome shaped (squamous-like); stretches readily; lines ureters, bladder and part of urethra

Endocrine Glands

Internally secreting; ductless (empty hormonal products into blood); mostly compact multicellular organs, some unicellular

Multicellular Exocrine Glands

Consist of an epithelium-derived duct and secretory unit; supportive CT surrounds secretory unit, supplies it with blood vessels and nerve fibers

Merocrine Glands

Secrete products by exocytosis; pancreas, salivary glands and most sweat glands

Holocrine Glands

Accumulate products until they rupture; replaced with underlying cells; sebaceous (oil) glands

Apocrine Glands

Accumulate products just beneath the free surface; apex of cell pinches off, releasing secretory granules; controversial; mammary glands are both holocrine and apocrine

Functions of Connective Tissue

Binding and supporting (ligaments, bones); protecting (bone, adipose); insulating (fat tissue); storing reserve fuel; transporting (blood)

CT Ground Substance

Unstructured material that fills the space between the cells and contains fibers; composed of interstitial fluid, cell adhesion proteins (CT glue) and proteoglycans (trap water, GAGs); molecular sieve for nutrients and other substances to diffuse through to capillaries/cells

CT Fibers - Collagen

Cross-linked; extremely tough

CT Fibers - Elastic

Branching network; snap CT back into place after being stretched

CT Cells

Immature (-blast) cells are actively mitotic (CT proper - fibroblast; cartilage - chondroblast; bone - osteoblast) ; mature (-cyte) cells maintain health of the matrix; fat cells store nutrients; white blood cells are concerned with tissue response to injury; mast cells detect foreign microorganisms and initiate inflammatory responses; macrophages devour a foreign materials

Loose CT - Areolar CT

Description: gel-like matrix with all 3 fiber types, cells - fibroblasts, macrophages, mast cells and some WBCs, loose arrangements of fibers, reservoir of water and salts

Function: cushions organs, role in inflammation and fluid reservoir

Location: found under epithelia, surrounds organs and capillaries; most common CT

Loose CT - Adipose CT

Description: closely packed fat-filled adipocytes with displaced nuclei, do not reproduce, sparse matrix

Function: fuel reservoir, insulation, supports and protects organs

Location: found under skin, around kidneys and eyeballs, in bones and within abdomen, in breasts

Loose CT - Reticular CT

Description: loose network of reticular fibers in a gel-like ground substance

Function: fibers form a soft internal skeleton that supports free blood cells

Location: lymphoid organs (lymph nodes, bone marrow, spleen)

Dense Regular CT

Description: bundles of collagen fibers running parallel to the direction of the pull

Function: withstands great tensile stress in one direction

Location: tendons (attach muscles to bones, ligaments (attach bones to bones) and aponeuroses

Dense CT - Elastic CT

Description: regular CT with a high proportion of elastic fibers

Function: allows tissue to recoil after stretching

Location: walls of arteries; within certain ligaments; within walls of bronchial tubes

Cartilage

Stands up to both tension and compression; tough but flexible; lacks nerve fibers and is avascular; ground substance contains lots of GAGs; large amounts of fluid

Bone

Supports and protects body structures; harder than cartilage b/c more collagen fibers and calcium; osteoblasts produce organic portion of matrix; well supplied by blood vessels

Blood

Classified as CT b/c it consists of cells surrounded by a nonliving fluid matrix (blood plasma); carries nutrients, wastes and respiratory gases

Membrane Proteins

Integral proteins - firmly inserted; peripheral proteins - attached loosely

Functions - transport, receptors for signal transduction, attachment to cytoskeleton and extracellular matrix, enzymatic activity, intercellular joining, cell-cell recognition

Cholesterol

Reduces general membrane fluidity and stabilizes its structure

Glycocalyx

Glycoproteins and glycolipids that form a fuzzy, sticky, coating; provides specific markers for cells to recognize each other

Tight Junctions

Fusion of adjacent plasma membranes to prevent passage of molecules; impermeable junction

Desmosomes

Anchoring junctions; act like velcro; molecular linking of cells to resist mechanical stress; reduced chance of tearing; found in skin

Gap Junctions

Molecular channels between cells that allow passage of cytoplasmic molecules; important for communication; found in heart

Simple Diffusion

Nonpolar and lipid-soluble substances diffuse directly through lipid bilayer (i.e. O₂, CO₂)

Facilitated Diffusion

Substances bind to protein carriers (i.e. amino acids, sugars) or move through protein channels (leakage channels - always open; gated channels - controlled by chemical or electrical signals)

Osmosis

Unassisted diffusion of water from an area of more water to one of less water across a semipermeable membrane; occurs whenever water concentration differs on 2 sides of a membrane

Tonicity

Ability of a solution to change the shape of cells by altering the cells' internal water volume

Isotonic

Same concentration outside and inside; cells retain normal shape

Hypertonic Solutions

Higher concentration outside; cells lose water and shrink

Hypotonic Solutions

Lower concentration outside; cells gain water and plump up

Symport System vs. Antiport System

2 substances move in the same direction vs. different directions

Primary Active Transport

Hydrolysis of ATP results in phosphorylation of transport protein; Ex: Na⁺/K⁺ Pump - 3 Na⁺ get pumped out of the cell with energy released from ATP, 2 K⁺ get pumped into the cell; pump is essential to maintain Na⁺/K⁺ concentration b/c they slowly leak down their concentration gradient through channels

Endocytosis

Means by which large particles can enter cell; also ATP-requiring; vesicle encloses substance; pinches off and moves into cytoplasm where contents may be digested; may also traverse cell to exit at the other side; receptor-mediated endocytosis allows cells to ingest specific substances

Neuron Cell Body

Large, spherical nucleus; extensive rough ER, Golgi bodies and mitochondria; clusters of cell bodies in the CNS are called nuclei, called ganglia in the PNS

Dendrites

Short, branching extensions; provide enormous surface area for receiving signals; conduct impulses toward cell body; short distance, graded potentials

Axon

Structure: each neuron has one axon; arises from axon hillock; branches at end (axon terminals); lack rough ER and Golgi bodies, depends on cell body to renew proteins and transport mechanisms to distribute them

Function: generates nerve impulses and transmits them; causes neurotransmitters to be released

Axonal Transport

Motor proteins and cytoskeletal elements allow substances to travel continuously along the axon; anterograde movement - away from cell body (mitochondria, cytoskeletal elements, membrane components and enzymes); retrograde movement - towards cell body (organelles, intracellular communication)

Myelin Sheath

Fatty covering of nerve fibers; protects and electrically insulates fibers; increases transmission speed of impulses; in PNS, sheaths are formed by Schwann cells which wrap themselves around axon, Nodes of Ranvier are the gaps between Schwann cells; in CNS, oligodendrocytes form sheaths, coil around many axons at the same time; white matter (myelinated region of brain), gray matter (nonmyelinated)

Resting Membrane Potential

Potential difference in a resting neuron; voltage of -70mV (negative means cell is negatively charged relative to the outside)

Depolarization

Decrease in membrane potential; inside of membrane becomes less negative than resting potential; increases probability of producing nerve impulses

Hyperpolarization

Increase in membrane potential; inside becomes more negative; decreases chance of producing nerve impulses

Action Potential

Brief reversal of membrane potential (total amplitude of 100mV); do not decay with distance; typically generated in axons

Generating an Action Potential

1. Resting State - all Na⁺ and K⁺ channels are closed, leakage channels are open
2. Depolarization - Na⁺ channels open and it rushes into the cell, local patch of membrane depolarizes further, interior becomes less negative, becomes self-generating (positive feedback) when threshold is reached
3. Repolarization - Na⁺ channels inactivate, K⁺ channels open, K⁺ is rushed out of cell and internal negativity is restored
4. Hyperpolarization - some K⁺ channels remain open, Na⁺ channels reset, period of K⁺ permeability lasts longer than needed, creates dip in action potential curve

Threshold and the All-or-None Phenomenon

Threshold is membrane potential at which outward current of K⁺ movement is equal to inward current of Na⁺ movement; strong stimuli push the membrane potential beyond threshold; action potentials either happen completely or not at all

Propagation of an Action Potential

An action potential is self-propagating and continues along the axon at a constant velocity; following depolarization, each section of axon membrane repolarizes, restoring resting membrane potential

Absolute Refractory Period

From the opening of the Na⁺ channels until they begin to reset to their original resting state, the neuron cannot respond to another stimulus

Relative Refractory Period

When most Na⁺ channels have returned and some K⁺ are still open, the threshold for AP generation is higher so a stronger stimulus is required

Factors that effect the rate of impulse propagation:

Axon Diameter - larger the axon, the faster the impulse; less resistance to flow of local currents

Degree of Myelination - increases rate; prevents charge from leaking out and allows membrane voltage to change faster; APs jump from gap to gap in the myelin sheaths

Chemical Synapses

Most common; release and receive neurotransmitters; made up of axon terminal and receptor region; separated by synaptic cleft

Chemical Synaptic Transmission

1. Action potential arrives at axon terminal
2. Voltage-gated Ca^{2+} channels open and Ca^{2+} enters the axon terminal
3. Ca^{2+} entry causes synaptic vesicles to release neurotransmitters by exocytosis
4. Neurotransmitter diffuses across the synaptic cleft and binds to specific receptors on postsynaptic membrane
5. Binding of neurotransmitter opens ion channels, creating graded potentials
6. Neurotransmitter effects are terminated (reuptake, degradation or diffusion of neurotransmitters)

Excitatory Synapses and EPSPs

Neurotransmitter binding depolarizes membrane; postsynaptic membrane don't generate APs; excitatory postsynaptic potentials (EPSPs) occur instead; EPSPs are graded, but they help trigger APs at axon hillock

Inhibitory Synapses and IPSPs

Neurotransmitters reduce a postsynaptic neurons' ability to generate an AP; charge on inside becomes more negative, moves away from threshold; inhibitory postsynaptic potentials (IPSP)

Summation

Accumulation of EPSPs (or IPSPs) to influence activity of a postsynaptic neuron

Temporal Summation

Presynaptic neuron transmits impulses in rapidfire; first impulse produces small EPSPs, before it dissipates, successive impulses trigger more; stimulate and depolarize membrane

Spatial Summation

Postsynaptic neuron is stimulated simultaneously by a large number of terminals from many presynaptic neurons

Characteristics of Muscle Tissue

Excitability - ability to receive and respond to a stimulus

Contractility - ability to shorten when stimulated

Extensibility - ability to extend or stretch

Elasticity - ability to recoil and resume its resting length

Muscle Functions

Produce Movement - locomotion, manipulation, blood flow, respiration, propelling of food, etc.

Maintain Posture

Stabilize Joints

Generate Heat - generate heat as they contract

Nerve and Blood Supply to Muscles

One nerve, artery and one or more veins serve each muscle; enter near central part of muscle and branch through CT sheaths

Epimysium

Dense irregular CT; surrounds whole muscle

Perimysium

Dense irregular CT; surrounds fascicles (bundles of muscle cells)

Endomysium

Fine areolar CT; surrounds individual muscle fiber

Direct Muscle Attachments

Epimysium of muscle is fused to periosteum of a bone or perichondrium of cartilage

Indirect Muscle Attachments

Muscle's CT wrappings extend beyond muscle either as a ropelike tendon or a sheetlike aponeurosis which anchor muscle to CT covering bone/cartilage or fascia of other muscles; more common

Myofibrils

Rodlike contractile elements that occupy most of the muscle cell volume; composed of sarcomeres arranged end to end, striations and myofilaments

Striations

Repeating series of dark (A bands) and light (I bands) bands; each A band has a lighter region in its midsection (H zone); each H zone is bisected vertically by a dark line (M line); each I band has a midline interruption (Z disc)

Sarcomeres

Contractile/functional unit; composed of myofilaments; located between 2 Z discs, contain A band with half I bands at each end

Myofilaments - Thick Filaments

Contain myosin; extend entire length of A band; connected in the middle at M line; each myosin filament has a rodlike tail attached to 2 globular heads; heads link the thick and thin filaments

together during contraction to form cross bridges; titin (elastic filament) attaches thick filament to Z disc and M line (runs within filament), helps muscle resist excessive stretching

Myofilaments - Thin Filaments

Contain actin; extend across I band and partway into A band; anchored by Z disc; subunits of actin are G actin, they bind to the active sites of myosin during contraction; tropomyosin - rod-shaped protein, winds around actin core and stiffen it, block myosin binding sites in relaxed muscle fiber; troponin - binds to actin and tropomyosin, binds Ca^{2+} ions; dystrophin - links thin filaments to integral proteins of sarcolemma

Sarcoplasmic Reticulum

Elaborate web of ER around each myofibril; regulates intracellular Ca^{2+} , stores it and releases it when muscle stimulated to contract; most SR tubules run longitudinally; pairs of terminal cisternae across A-I junctions

T Tubules

At A-I junctions sarcolemma penetrates cytoplasm to form hollow elongated tubes; runs between the paired terminal cisterns of the SR forming triads; conduct nerve impulses from sarcolemma for muscle to contract

Sliding Filament Model of Contraction

During contraction, the thin filaments slide past the thick ones so that the actin and myosin filaments overlap to a greater degree; Z disc is pulled toward M line, I bands shorten, H zones disappear, A bands move closer together but do not change in length

Events at the Neuromuscular Junction

1. Action potential arrives at axon terminal of motor neuron
2. Voltage-gated Ca^{2+} channels open; Ca^{2+} enters the axon terminal, moving it down its electrochemical gradient
3. Ca^{2+} entry causes ACh (neurotransmitter) to be released by exocytosis
4. ACh diffuses across the cleft and binds to receptors on the sarcolemma
5. ACh binding opens ion channels that allow simultaneous passage of Na^{+} into the muscle and K^{+} out; more Na^{+} enters than K^{+} exits, which produces a local change in the membrane potential (end plate potential)
6. ACh effects are terminated by its breakdown in the synaptic cleft and diffusion away from the junction

Generation of an Action Potential across the Sarcolemma

1. Generation of an end plate potential - more Na^{+} in than K^{+} out; interior becomes less negative

2. Depolarization: generation and propagation of an action potential - end plate potential creates an AP which spreads along sarcolemma
3. Repolarization: restoring the sarcolemma to its initial polarized state - Na^+ channels close and K^+ open

Excitation-Contraction Coupling

Sequence of events by which transmission of an action potential along the sarcolemma leads to the sliding of myofilaments

1. The action potential propagates along the sarcolemma and down the T tubules
2. Calcium ions are released; Ca^{2+} channels in the SR are opened
3. Calcium binds to troponin and removes the blocking action of tropomyosin
4. Contraction begins - myosin binds to actin

Cross Bridge Cycling

1. Cross bridge formation - myosin head attaches to an actin myofilament, forming a cross bridge
2. The power (working) stroke - ADP and P are released and myosin head pivots, changing to its low-energy state, it pulls actin toward M line
3. Cross bridge detachment - ATP attaches to myosin and the link between myosin and actin weakens and head detaches
4. Cocking of the myosin head - ATP is hydrolyzed, the myosin head returns to its prestroke position

Muscle Twitch

Motor unit's response to a single action potential of its motor neuron

1. Latent period - excitation-contraction coupling occurs
2. Period of contraction - cross bridges are active
3. Period of relaxation - reentry of Ca^{2+} in SR, muscle tension decreases

Isotonic Contractions

On stimulation, muscle develops enough tension to lift the load; once the resistance is overcome the muscle shortens and the tension remains constant for the rest of the contraction

Pathways for Regenerating ATP During Muscle Activity

1. Direct Phosphorylation - Coupled use of creatine phosphate and ADP to produce ATP (lasts 15 seconds)
2. Anaerobic Pathway - glycolysis and lactic acid formation; no O_2 use (lasts 30-40 seconds)
3. Aerobic Pathway - aerobic cellular respiration; glucose, fatty acids, amino acids (lasts for hours)