KINESIOL 1Y03

8: Connective Tissue

Connective Tissue

structure: consists of very few cells and lots of extracellular matrix
functional differentiation: the content of the extracellular matrix determines the character of the connective tissue
location: one of the most abundant in the body; found in every organ
cell function: often create and support the extracellular matrix
vascular: most (not cartilage) have a direct blood supply; tendons have a minimal blood supply

Tissue Function

enclose organs: the outer layer of most organ systems is a connective tissue; can also separate tissues (e.g., PNS nerves)
connecting tissues: connecting bones to bones (ligaments) and muscles (tendons)
support and movement: bones give the muscles something to pull
storage: adipose tissue (fat) is the main form of energy storage; bones contain minerals (e.g., calcium, phosphorus)
cushion and insulate: subcutaneous fat helps insulate from temperature changes and cushion bones/organs from falls
transport: blood transports nutrients and oxygen to the body tissues; waste and carbon dioxide to the lungs; and hormones and immune cells
protect: white blood cells protect the body through immune response; bones protect the body (e.g., skull/brain, rib cage/thoracic cavity); adipose tissue insulates organs without bony protection

Cell Functions

-blasts: create the matrix (e.g., osteoblasts/bone); immature cells which often mature into -cytes
-cytes: maintain the matrix (e.g., chondrocytes/cartilage)
-clasts: break down the matrix for remodeling (e.g., osteoblasts/bone); less examples
macrophages: cells which engulf and digest any debris that shouldn't be in the tissue; arise from monocytes (type of white blood cell)
mast cells: secrete heparin (histamine involved in inflammation)

Extracellular Matrix

protein fibers: proportion of proteins varies dramatically between tissues
- ***collagen***: *collagen proteins make collagen fibrils which bundle into fibers; flexible; strong; inelastic*
- ***reticular***: *fine collagen strands lined with glycoprotein coating; creates branching networks which fill spaces between tissues and organs, providing supporting framework for soft organs*
- ***elastic***: *made from elastin protein surrounded by fibrillin glycoprotein; can be stretched, distended, and compressed, but will bounce back; strong but elastic; found in blood vessel walls, lungs, etc.; smaller fibers branching to form a network of cross-links*

ground substance: fluid, semi-fluid, gelatinous, or calcified filler substance
- ***hyaluronic acid***: *polysaccharide lubricant; found in joints and vitreous humor of the eye*
- ***proteoglycan***: *long protein core with many polysaccharides (often glycosaminoglycans) stuck onto the side; group together into a proteoglycan aggregate held together by hyaluronic acid; helps retain water (cartilage needs water for malleability, bone does not)*
- ***adhesion proteins***: *hold things like proteoglycan aggregates together and attach them to neighboring cells*

Connective Tissue Proper

loose: fewer fibers, more ground substance, scattered cells
dense: more fibers, less ground tissue, few cells

Supporting Connective

cartilage: semi-solid matrix
- ***hyaline***: *most common; found on articular surfaces of synovial joints; in larynx, trachea, and nose; chondrocytes in lacunae and collagen fibrils present in matrix; has perichondrium overlying cartilage*
- ***elastic***: *found in external ear and epiglottis; abundant elastic fibers form mesh around chondrocytes in lacunae; usually has perichondrium*
- ***fibrocartilage***: *found in intervertebral discs, pubic symphysis, and menisci of knee; irregular collage bundles; sparse ground substance; chondrocytes in parallel rows; no perichondrium*

bone: solid matrix
- ***compact***: *forms hard outer shell; concentric rings (lamellae) form cylindrical structures (osteon) with central canal forming branching canaliculi (contain blood vessels); lacunae contain osteocytes*
- ***spongy***: *cancellous inside of bones; does not contain osteons; slender plates (trabeculae) form a network, between which are bone marrow and blood vessels; osteocytes are scattered throughout trabeculae*

Fluid Connective Tissue

blood: contains erythrocytes (red blood cells), leukocytes (white blood cells), platelets, and watery ground substance with dissolved protein fibers

Loose Connective

areolar: fills in regions (packing material) and often mixes with other loose tissues
- ***location***: *found in subcutaneous layer (between dermis and muscle) and around organs*
- ***ground substance***: *gel-like ground substance,*
- ***cells***: *numerous blood vessels, scattered cells (fibroblasts, macrophages, white blood cells)*
- ***proteins***: *mostly collagen with some reticular and elastic*

adipose: densely packed adipocyte cells which store triglycerides for energy storage, support/protection, and insulation
- ***location***: *often mixed with areolar*
- ***cells***: *have organelles pushed to the side*

reticular: forms stroma of lymph nodes, spleen, thymus, and bone marrow; less common
- ***ground substance***: *gel-like ground substance*
- ***cells***: *scattered fibroblasts and leukocytes*
- ***proteins***: *network of branched reticular*

Dense Connective

dense regular collagenous: many parallel collagen fibers which resist stretching and are strong along length but not width
- ***composition***: *fibroblasts between layers and little ground substance*
- ***location***: *tendons and most ligaments*

dense irregular collagenous: many collagen fibers which point in various directions; stretchy and medium-strong in all directions
- ***composition***: *fibroblasts between layers and more ground substance*
- ***location***: *dermis, periosteum, perichondrium, capsule of organs (e.g., kidney, spleen), scars*

dense regular elastic: parallel-arranged elastic and collage fibers
- ***location***: *ligaments in vocal cords (collagen helps with shouting), nuchal ligament (attaches skull to back of neck to position head)*

dense irregular elastic: bundles and sheets of collagenous and elastic fibers oriented in multiple directions
- ***composition***: *mostly elastic fibers*
- ***location***: *walls of elastic arteries (leaving the heart) which need to accommodate changes in blood volume with each pump*

summary sheet by Jasmine Ah Yong for KINESIOL 1Y03 (2022)

KINESIOL 1Y03

9: Nervous Organization

Functions

sensory: gathering information from external and internal environments through specialized sensory receptors
integrative: analyze information and decide what needs to be done (store some, make decisions on actions); higher order functions
motor: response to stimuli; impacts muscles and glands

Neurons

neuron: specialized cell type in nervous tissue that can conduct signals from one part of the body to another
cell body (soma): hub of cell
axons: long projections which send out information
dendrites: short cytoplasmic projections which receive information from other neurons
synapse: connection between neurons or between neuron and target tissue

Subdivisions

central nervous system (CNS): brain and spinal cord
peripheral nervous system (PNS): sensory receptors and nerves

PNS Components

sensory receptors: ending of neurons or separate specialized cells that detect temperature, pain, light information, etc.
nerves: bundle of axons and sheaths that connects CNS to sensory receptors, muscles, and glands; categorized based on endpoints

- ***cranial nerves***: *originate/terminate in the brain; 12 bilateral nerves*
- ***spinal nerves***: *originate/terminate in the spinal cord; 31 pairs of spinal nerves; made up of a ventral (efferent) and dorsal (afferent)*

ganglion: collection of neuron cell bodies outside the CNS

- ***sensory information***: *information not going to the brain have their cell bodies in a ganglion*
- ***two-neuron systems***: *motor systems can have two-neuron systems which connect in a ganglion*

plexus: network of axons (and sometimes somas) located outside the CNS

PNS Divisions

sensory (afferent): transmits action potentials from receptors to CNS

- ***action potentials***: *electrical signals created by triggered receptors*
- ***general senses***: *receptors throughout the body, spread out over many body tissues*
- ***special senses***: *very specialized receptors in specific organs (e.g., vision)*
- ***dorsal root of spinal nerve***: *sensory information enters here*

integrative functions: go between
motor (efferent): transmits action potentials from CNS to effectors (muscles and glands)

- ***muscles***: *skeletal (move bones), cardiac (heart), smooth (involuntary)*
- ***glands***: *exocrine and endocrine*

Motor Nervous System

somatic: targets skeletal muscle (voluntary control, though it may coexist with reflex)

- ***single neuron system***: *soma is located inside the spinal cord; the axon exits and goes all the way to the target tissue*
- ***neuromuscular junction***: *synapse with skeletal muscle; goes through ventral root of the spine*

autonomic: targets cardiac muscle, smooth muscles, and certain glands (involuntary control)

- ***two neuron system***: *one goes from CNS to ganglion, then another goes from ganglion to effector*
- ***sympathetic***: *"fight or flight"; prepares for physical activity (increase heart rate and breathing)*
- ***parasympathetic***: *"rest and digest"; regulates resting and vegetative functions; can run at the same time as sympathetic, but not in the same target tissue*
- ***enteric***: *plexuses in the wall of the digestive tract; controls tract independently of CNS but still communicates with it via ANS; monitors chemical environment and stretching of walls; contracts smooth muscle and controls secretions of organs and endocrine cells*

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10: Nervous Cells

Neurons (Again)

neurons: nerve cells; create and propagate electric signals throughout the body; basic functional unit of the nervous system

characteristics: *high metabolic rate; non-mitotic (function through life); variable size*

cell body (soma): contains the nucleus

characteristics: *large nucleus, prominent nucleolus, many ribosomes (form Nissl bodies, which are chromatophilic and synthesize proteins)*

dendrites: short, tapered cytoplasmic projections where information and signals are collected; can interact with other neurons, typically their axon regions

dendritic spines: *small irregular projections*

axon: long projection which outputs information; has a constant diameter (depends on the neuron; impacts conduction rates); length of 1 mm to 1 m

trigger zone: where action potential is created

axon hillock: *cone shaped region coming off the soma and into the axon*

initial segment: *start of axon connecting to axon hillock*

synaptic end bulb (presynaptic terminal): end of the axon of off telodendria; contains synaptic vesicles which house neurotransmitters to be send to the target; can control response

axonal transport: *neurotransmitters are produced in the cell body and then transported; this is also how diseases (e.g., rabies, herpes) can be transmitted to the CNS as it bypasses the blood brain barrier*

axoplasm: cytoplasm of the axon

axolemma: cell membrane of the axon

collateral: branches off the axon (rare)

functional classification: based on direction of transport

sensory (afferent): *moves action potential towards CNS*

motor (efferent): *moves action potential away from CNS*

interneurons (association neurons): *exist within the CNS between neurons*

structural classification: based on the number of processes coming out

process: *projections from the soma*

multipolar: *many dendrites, 1 axon (most CNS neurons, all motor neurons)*

bipolar: *1 dendrite, 1 axon (specialized sensory organs; retina, inner ear, olfactory)*

(pseudo-)unipolar: *single process extending from cell body and dividing into 2 branches, with one extending to become dendrites; cell bodies are stuck off and grouped into ganglia (peripheral sensory receptors)*

Neuroglial Cells

neuroglial cells: "nerve glue"; non-neural cells that support and protect nerve cells

function: *hold things together, support, protection*

size and population: *smaller than neurons, but so numerous they account for most of the brain's weight (~60%)*

CNS Neuroglia

astrocytes: foot processes cover structures (e.g., blood vessels, neuron components, pia mater) and release chemicals

characteristics: *star-shaped; largest and most numerous in the CNS*

foot processes: *cytoplasmic projections*

blood brain barrier: *tight junctions between endothelial cells are created due to chemicals released near the capillaries by perivascular feet; regulates movement of substances in CNS; assists in the formation of synapses*

mitosis: *can reproduce to replace dying neurons with a glial scar*

ependymal: epithelium lining the ventricles and central canal; form the choroid plexus to produce cerebral spinal fluid (CSF)

shape: *range from cuboidal to columnar*

cilia/microvilli: *ciliated in patches to move CSF; microvilli facing the ventricles*

microglia: specialized macrophages to protect the CNS

phagocytic: *wraps around foreign object, engulfs and digests them (inflammation)*

shape: *small, star-shaped, few processes*

immunoregulatory secretions: *secrete substances (e.g. cytokines)*

oligodendrocytes: star-shaped with many processes wrapping around axon regions of neurons to form myelin sheaths; one oligodendrocyte can wrap multiple axons

processes: *have thin, flat processes that can wrap around*

PNS Neuroglia

satellite cells: flattened cells which protect the ganglia and provide nutrients

Schwann cells (neurolemmocytes): wrap around the axon region of the neuron to form the myelin sheath; one Schwann cell can wrap one axon

neurolemma: *outer membrane*

lipid-rich layer: *phospholipid bilayer is wrapped around many times, creating dense fat for insulation and protection (also makes it white)*

organelles: *cytoplasm and nucleus get pushed out towards the outside of the cell*

Myelin Sheaths

myelin: protects and insulates axons from one another, helping to conduct signals more quickly (easier to maintain proper chemical environment); most axons are myelinated

full myelination: *requires multiple oligodendrocytes or Schwann cells*

node of Ranvier: *space between myelin sheaths; allows for rapid conduction of nerve impulses*

unmyelinated axon: a Schwann cell is wrapping around multiple axons, only wrapping around once; cytoplasm and nucleus get pushed to the inside

CNS Tissue

tract: bundle of myelinated axons in the CNS

nucleus: collection of neuron cell bodies in the CNS

white matter: bunches of tracts; nerve tracts propagate action potentials from one area to another

grey matter: unmyelinated axons, cell bodies, dendrites, and neuroglia; where all the synapses and integrative functions are happening

spinal cord: white matter on outside, grey matter deeper (H/butterfly shape)

brain: grey matter on outside (cortex), white matter on inside, pockets of grey matter on inside (inner nuclei)

KINESIOL 1Y03

I: Epithelium + Embryos

Lab Orientation

contact: kinap@mcmaster.ca (CC: kozlowb@mcmaster.ca)
accessing IAHS: be 5-10 minutes early if possible and wait outside; entry closes once the pre-lab talk begins
attendance: tracked via QR code and MS form (there's a physical option as well)
prelab: to be completed before the lab proper; opens Thursday before lab at noon and closes Monday at noon
safety training: you will not be able to do labs if you don't have WHMIS 1A00 and Routine Lab Practices completed
lab goals: nothing in lab is being marked; lab is for interaction with peers and integrating theory with practice
testability: lab content is testable material on the Friday quizzes and final exam
safety: you have the right to refuse to participate if you feel unsafe

first aid kit: *found by the corner office*
fire extinguisher: *found at each of the exists*
eyewash stations: *found at each of the sinks*
personal belongings: *leave at the coat racks; you cannot have any personal electronics on you in the lab*
stools: *push stools in to avoid tripping*
food/drink: *not allowed in the lab, but there is a chair outside for if you need to leave a drink there*
attire: *you must wear closed toe shoes and long pants; hair should be away from the face*
PPE: *lab coats and gloves are mandatory for dissection labs; if needed, gloves and goggles will be provided*
hand-washing: *wash hands after each lab, even if you were wearing gloves*
exits: *one main entrance, one emergency exit at each wing (2); total of 3 exits*
fire attendance: *if case of fire, attendance will be taken in the field outside; you are not excused from class*
chemicals: *low concentrations of formaldehyde, phenol, and thymol will be present; wear PPE*
sickness: *if at any point you are feeling unwell (including a physiological reaction to seeing cadavers), sit on the floor and get help*
disposal: *regular garbage (gloves, paper towels); yellow sharps container (glass, needles, scalpels); red biohazard bin (animal bits, blood-soiled items)*
animal dissections: *from food processing industry; have all been screened for disease*
cadavers: *respect the cadaveric models; they are only for lab use, so no visitors or pictures should be taken*
health history: *let your TA know if you are immunocompromised, pregnant, epileptic, or have any known heart conditions*

Online Resources

lab resources: lab images will be posted to A2L under "Lab Images"
anatomy act: do not distribute or download the lab images

Epithelial Tissue

simple squamous + alveoli: allows easy diffusion for quick gas exchange (simple squamous is good for passive transport)
simple cuboidal + lining of kidney collecting ducts: allows absorption, secretion, and filtration for creating urine (simple cuboidal is good for active transport)
simple columnar + gut lining: allows for secretion and transport of mucus; allows nutrient absorption (simple columnar is more selective; it doesn't let everything pass back and forth)
non-keratinized stratified squamous + vagina: fluid helps with lubrication; strata allow for protection against abrasion and infection
transitional + inner lining of ureter: can stretch to hold urine (cuboidal --> squamous) and protects the ureter from urine

Cheek Swab

visible cell structures: nucleus, cell membrane, cytoplasm
cheek cells: non-keratinous stratified squamous epithelium
microscope samples: trachea, cerebrum, jejunum, spinal cord, cardiac muscle, bone, cheek swab

Fertilization

ovaries: where the oocyte develops and matures
ampulla (fallopian tube): where fertilization takes place
zygote: the product of fertilization
totipotent: days 1-4; can specialize into every type of cell in embryo; can develop into twins; creates tissue for development
pluripotent: days 5+; can specialize into many but not all cells post-embryo; used for embryonic stem cell research (supplementing damaged tissue)
trophoblast: single layer of cells around the blastocele; eventually forms the placenta and membranes (chorion and amnion)
inner cell mass: also known as the embryoblast; thickened area of cells in the blastocyst that develops into the embryo proper

Post-Fertilization

24 hours: zygote
30 hours: 2 cells
40 hours: 4 cells
60 hours: 8 cells
80 hours: morula
100 hours: blastocyst

Structures to Know

blastocyst invading uterine wall: trophoblast, endoderm, ectoderm (epiblast), amniotic cavity, syncytiotrophoblast, endometrium, uterine endothelium
gastrulation: epiblast, amniotic cavity, hypoblast, yolk sac, connecting stalk, extraembryonic mesoderm, chorionic villi, lacunae, uterine vein, spiral uterine artery

Fetal Circulation

ductus venosus: the first major landmark of the umbilical vein; bypasses the liver since the placenta has already filtered the blood; enters into the inferior vena cava
lung bypass: the fetus uses the foramen ovale and ductus arteriosus to bypass the lungs since they are deflated and the placenta can act as the fetal "lungs"
umbilical arteries: wrap around the umbilical vein
atrial septal defect: in 25% of people, the foramen ovale doesn't close properly, causing a heart murmur (this is a random fun fact from the TA)

IVF Case Study

dizygotic: fraternal twins; have 2 amnions and 2 placentas
dichorionic diamniotic: identical twins; has 2 amnions and 2 placentas; splits as morula
monochorionic diamniotic: identical twins; has 2 amnions and 1 placenta; splits as blastocyst
monochorionic monoamniotic: identical twins; has 1 amnion and 1 placenta; splits after implantation
in vitro fertilization: egg and sperm are removed from parents, fertilized, and then implanted into mom; because the mechanism for killing sperm doesn't occur, twins are more likely