function of nervous system

detects physical change that can affect the body	
works with endocrine system to respond to change	
excitable characteristics of nervous tissue aids these functions	
generation of nerve impulses - action potentials	

cells of nervous system

neurons	form processing networks "wiring" within brain and spinal cord, functional unit of the nervous system excitable cells that conduct nerve impulses. bring all regions of the body under the CNS control
glia	(protect, nutrients, insulating) smaller and more than neurons. the "glue" that maintains neuronal networks. ability to divide.

regions of neurons

dendrites (receiving end)	conduct nerve signals *toward* the cell body
cell body (aka soma)	contains organelles (lysosome, mitochondria, nissl bodies) respond to stimuli
axon	conducts nerve impulses *away* from cell body toward other neuron or effector cell.
axon hillock (axon)	axon joins cell body. determines if action potential happens (-55v)
synaptic knob/button (axon)	carry info of stimulus as electrical impulse

regions of neurons (cont)

cytos k-eleton	“railway” allowing rapid transport of small organelles to/from far ends of neuron. Motor molecules shuttle vesicles with NT between soma and terminal buttons. process= axonal transport

receiving and conducting nerve signals

input zone	dendrites, cell body
summation zone	axon hillock
conduction zone	axon
output zone	axon terminal, knobs

neuronal regeneration

in CNS	little to no regeneration possible
in PNS	repair possible if cell body not damaged and if shwann cells still capable of producing myelin

types of channels

leak channels	randomly open and close, there are more K+ leak channels than Na+. found in dendrites and cell bodies
ligand (gated)	open and close in response to binding with a ligand (specific chemical). found in dendrites and cell bodies.
voltage (gated)	opens in response to changes in membrane potential (voltage) charge in mVolts. found in initial segment of axon, a long axon and axon terminals

Repolarization channels 2 states

movement of K+ is responsible for repolarization	
voltage-gated potassium channels have 2 states	
resting state	channels closed; no K+ movement
activated state	channels open; K+ flows doen concentration gradients

local potential

excitation of a neuron	when a stimulus triggers opening of NA+ ligand-gated channels. Excess positive ions outside the plasma membrane decreases, the membrane potential becomes more positive (moves toward zero) depolarization
inhibition of a neuron	when a stimulus triggers opening of K+ ligand-gated channels as K+ diffuses out of cell, excess of positive ions outside plasma membrane increases membrane potential hyperpolarization

propagation of AP conduction speed

axons with larger diameter have faster conduction speeds	myelinated axons get signal to axon terminal faster
saltatory conduction	myelin sheath increases efficiency and speed of signal conduction; AP only depolarize nodes of Ranvier and "jump over" internodes

propagation of AP conduction speed (cont)

continuous conduction	every section of unmyelinated membrane from trigger zone to axon terminal must propagate AP; slow conduction speed

local anesthetic drugs

cause temporary numbness to a specific region of the body

block voltage gated Na+ channels of neurons in treated area; prohibits depolarization

causes APs relaying pain to not be transmitted to CNS

cause temporary paralysis

neurotransmitters (NT) classifications

function (post synaptic receptor)	2 main classifications: excitatory or EPSPs and inhibitory IPSPs; or whether receptor directly opens a channel, ionotropic or indirectly, metabotropic.
structure (mechanisms, NTs cause a change)	2 main classes: small and large-molecules transmitters; because the functions of specific NTs vary by location thayre usually classified by chemical structure.

3 fundamental steps

1. sensory function detects internal and external stimuli
2. interpretation is made (analysis)
3. motor response occurs (reaction)

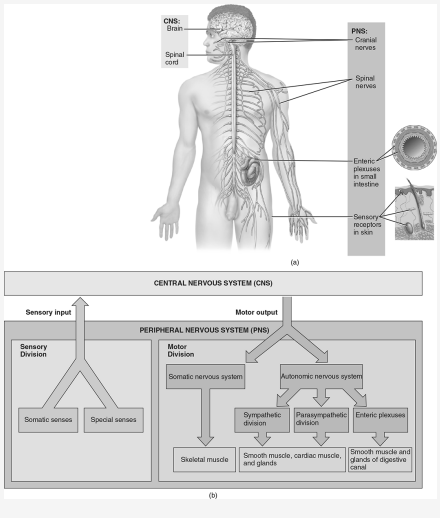
type of effector regulated

somatic nervous system (SNS)	info to the somatic effectors, skeletal muscles
autonomic nervous system (ANS)	info to autonomic or visceral effectors, smooth muscle, glands, adipose tissue, other involuntary tissue.
enteric nervous system (ENS)	info to digestive system effectors

efferent pathways of ANS

sympathetic division	pathways exiting the middle of the spinal cord, trigger fight or flight response
parasympathetic division	pathways exiting brain or lower portions of the spinal cord, triggers rest and repair response.

nervous system division



functional classification

Sensory or afferent neurons	conveys impulse *into* CNS through cranial or spinal nerves
Motor or efferent neurons	convey impulses *away* from CNS to effectors
Interneurons/Association neurons	located between sensory and motor neurons and process sensory info. elicit motor response

white vs gray matter

white matter	gray matter
	composed of cell bodies and unmyelinated fibres
CNS: myelinated tracts	CNS: referred to as nuclei (not nucleus)
PNS: myelinated nerves	PNS: referred to as ganglia

changes resting potential (RMP)

depolarization	Na+ channels open. Allows positively charged Na+ to flow into cell Membrane potential becomes **more positive**
repolarization	K+ channels open. Allows positively charged K+ to flow out of cell. Cell becomes **more negative**, returning to RMP
hyperpolarization	– cell becomes more negative than its normal RMP due to loss of K+

3 general phases AP

depolarization phase	membrane potential rises toward zero, then becomes positive briefly
repolarization phase	membrane potential returns to a negative value
hyperpolarization phase	membrane potential temporarily becomes more negative than resting membrane potential

mechanisms that produce AP

1. Stimulus applied to neuron, triggers ligand-gated Na+ channels to open; Na+ diffuses rapidly into cell = local depolarization

2. If magnitude of local depolarization surpasses a limit threshold potential (-55v) voltage-gated Na+ channels activated

3. More Na+ enters cell = further depolarization

4. Action potential is an ALL-OR-NONE response

5. Voltage-gated Na+ channels stay open for ~1 ms

6. More Na+ rushes into cell, membrane rapidly moves toward 0mV

7. continues in a positive direction to peak around +30v; an excess of positive ions inside the membrane

8. after action potential peaks, membrane potential begins to move back toward the resting membrane potential.

9. Na+ stop flowing into axon, K+ begins exiting axon as repolarization begins

10. as neuron's plasma membrane returns to RMP, there is a brief period of hyperpolarization; membrane potential more negative than RMP before K+ channels return to resting state

11. Na+ channels return to resting state

12. RMP is restored by Na+- K+ pumps

summation

summation	where all input from several postsynaptic potentials are added together (excitatory postsynaptic potential and inhibitory postsynaptic potential) to affect membrane potential at trigger zone
2 types	
temporal summation	NT releases repeatedly from axon terminal of a single presynaptic neuron
spatial summation	involves simultaneous release of NT's from axon terminals of many presynaptic neuron.

synaptic transmission sequence of events

1 AP reaches synaptic knob, causes Calcium Voltage gated channels to ope Ca $^{2+}$ diffuses into knob

2 increase Ca^{2+} triggers release of NT by exocytosis

3 neurotransmitters diffuse across synaptic cleft and bind to receptors, causing ion channels to open

4 opening of ion channels produces a local potential possibly an action potential is threshold is reached

5 the NT's action is quickly terminated

large molecule NTs

neuropeptides	act as neuromodulator: released with other NTs and modifies their effects
example	Endorphins, substance P

peripheral nervous system

nervous tissue in outer regions of the body

cranial nerves- originate in brain communicate with peripheral nerve

spinal nerves - originate in spinal cord

central nervous system

structural and functional centre

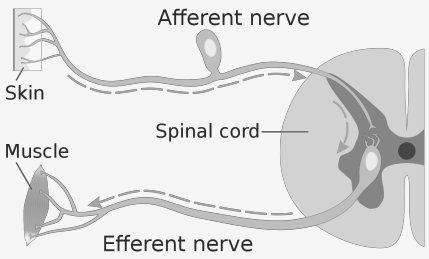
brain and spinal cord

brings in incoming sensory info then evaluates info, creates outgoing response

pathways divisions

afferent division	carry toward, all incomoing sensory and afferent pathways.
efferent	carry away, all outgoing motor or efferent pathways

afferent vs efferent



Glia

astrocyte (CNS)	(tight junctions =blood-brain barrier) Connect neurons and capillaries of the brain. transfers nutrients
microglia (CNS)	(macrophages) In inflamed brain tissue, they enlarge, move and carry on phagocytosis
Ependymal cells (CNS)	Produce or aid in circulation of fluid (help make CSF)

Glia (cont)

oligo dendro-cytes (CNS)	Hold nerve fibers together and produce myelin sheath (wraps itself around neuron)
shwann cells (PNS)	Hold nerve fibers together and produce myelin sheath (wraps itself around neuron)

nerves and tracts

NERVES layers of nerves	bundles of peripheral neurons held together by layers of C.T
epineurium	surrounds complete nerve (superficial)
perine-urium	surrounds bundles of nerve fibres (fascicles)
endone-urium	surrounds each neuron (deep)
in CNS	bundles of neurons are called tracts or fasciculi not nerves

remember

(-) inside cells k+, (+) outside cells Na+

2 types of electrical signals

local potentials	*short* distance, shift away from RMP in a specific region of the plasma membrane. (strength of potential decreases with distance)
action potentials	*long* distance (axon length), only travel from axon hillock to axon terminal only generated in trigger zone (axon hillock, initial segment of axon)

depolarization channels 3 states AP

Na+ movement is responsible for depolariz-ation

voltage gated Na+ channels have an activation gate and inactivation gate with 3 states

resting state	inactivation gate open and activation gate closed; no Na+ movement
activated state	activation and inactivation gates open when an action potential is initiated; due to voltage change
inacti-vation state	inactivation gate closed and activation gate open; no Na+ movement; once action potential is over channel returns to resting state

refractory period

period after AP when a neurons cannot be stimulated to generate another AP

propagation of AP sequence

1 the plasma membrane depolarizes to threshold at trigger zone due to local potential

2 as Na+ channels activate, an AP is triggered and spreads down the axon

3 the next section of plasma membrane depolarizes to threshold and fires an AP as the previous section of plasma membrane repolarizes

4 the current continues to move down the axon, and the process repeats

neuronal synapses

synapses	where signals are transmitted one neuron (sender presyn-aptic) to another neuron/muscle (receiver-postsynaptic)

two kinds

neuronal synapses (cont)

1 electrical synapses	cells joined end to end (gap junctions); cardiac muscles cells, smooth muscle cells, parts of brain
2 chemical synapses	presynaptic cells release chemical transmitters across a tiny gap to postsynaptic cell, possibly including an AP there
synaptic knob	tiny bulge at end of a terminal branch of presynaptic neuron's axon that contains vesicles housing NTs
synaptic cleft	space between a synaptic knob and the plasma membrane of a postsynaptic neuron

PLasma membrane of presynaptic neuron has protein molecules that work as receptors fpr neurotransmitters (NTs)

Ionotropic receptors	direct; ion channels
Metabo-tropic receptors	indirect; proteins that bind NT and signals ion flow elsewhere.

small molecule NTs

acetyl-choline	Excitatory and Inhibitory roles; deactivated by acetylcholinest-erase
amines	Monoamines and catecholamines ; ex dopamine, epinephrine, norepinephrine

small molecule NTs (cont)	
amino acids	Common neurotransmitters in CNS; ex Glutamate, Glycine, Aspartate, Gabba aminobutyric acid
other small molecule transm-itters	Nitric Oxide, Carbon monoxide

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