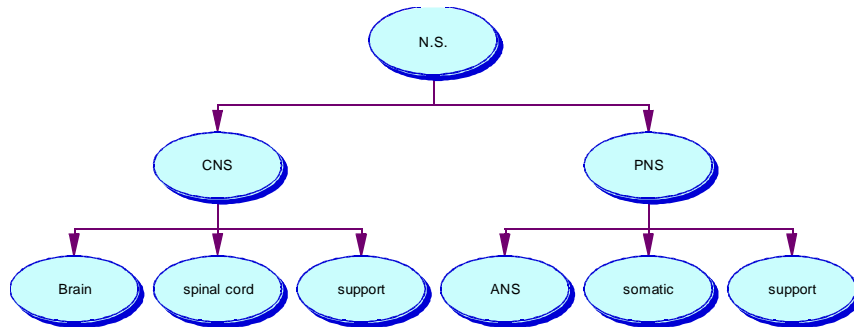


Ch. 11 Nervous System

Begins formation on 18th day of gestation (notochord)
Controls & coordinates entire body from that point on
Sensory input – integration - motor output

I. Parts

- a. CNS – central nervous system
 - i. Brain
 - ii. Spinal cord
 - iii. Support = neuroglia = brain glue
- b. PNS (peripheral nervous system)
 - i. Autonomic (ANS) = automatic
 1. sympathetic
 2. parasympathetic
 - ii. Somatic = voluntary
 - iii. Support = schwann cells = myelin – insulate & protect



c. Overall plan

- i. Sensory afferents = info in
- ii. Motor efferents = info out
- iii. Interneurons = connect the two
 1. especially in CNS
 2. 99% of all neurons

II. Neural anatomy

- a. Nerve = bundle of neurons
 - i. Neuron – neurilemma (if myelinated) – endoneurium – perineurium (around fascicle) – epineurium (Fig. 13-2 pg. 461)
 - ii. Neuron picture & parts (pg. 367)
 1. dendrites, cell body, axon hillock, axon, axon terminal
 - iii. Nerve tissue properties
 1. conduct impulses
 2. extreme longevity
 3. high metabolic rate
 4. amitotic???

III. Nerve transmission

- a. Pg. 373 basic principles of electricity
- b. Resting membrane potential (-70 mV inside:outside)
 - i. Na⁺ outside, K⁺ inside, neg proteins inside
 - ii. Na/K pump keeps potential by negating natural diffusion
 - iii. Depolarization = potential gets closer to zero
 - iv. Hyperpolarization = gets more negative (-90)
- c. 2 signals produce change in membrane potential
 - i. graded potentials
 1. depolarize over short distances
 - a. dendrites to cell body
 2. magnitude varies with strength of stimulus
 - ii. action potential
 1. depolarize down axon (long distances)
 2. harder to achieve
 3. start at axon hillock – after add up graded potentials
 4. Na channels opened & flows in
 - a. K starts out = repolarization
 - b. Na/K pump restores
 5. Fig. Pg. 379
 - a. Threshold & all-or-none phenomena
 - b. Graded potentials summate
 - i. Temporal summation
 - ii. Spatial summation
 - c. ~15mV above resting potential – AP will form
 - d. All AP are the same & travel whole neuron
 - e. How tell if stimulus is strong or weak?
 - i. Frequency of stimulation

d. Timing is everything in the nervous system

- e. Nerve velocities
 - i. 1 m/s to 150 m/s
 - ii. larger axon diameter = faster
 - iii. myelin sheath = faster
 1. *saltatory conduction* = signal leaps from node to node rather than depolarize whole neuron
- f. Synaptic continuation of nerve signal
 - i. Neurotransmitters (table 14-3, pg 505) – exocytosis
 1. 3 ways they are removed to stop signal
 - a. enzymes
 - b. reuptake proteins on presynaptic nerve
 - c. diffusion

IV. CNS (ch. 12)

- a. Brain
 - i. General Anatomy
 1. Cerebral hemispheres
 - a. Corpus callosum connects
 2. gyrus/gyri = ridges
 3. sulcus/sulci = shallow grooves
 - a. central – separates frontal from parietal

4. fissures = deeper grooves
 - a. longitudinal = R & L hemispheres
 - b. transverse = occiput & cerebellum
5. Lobes
 - a. Frontal (1), parietal (2), temporal (2), occipital (1), cerebellum (1)
6. Brain stem
 - a. Midbrain, Pons, Medulla Oblongata
7. Cortex
 - a. Top part
 - b. Gray matter (non-myelinated interneurons)
 - c. Controls consciousness, perception, understanding, voluntary movements
 - d. 3 general sections
 - i. motor
 - ii. sensory
 - iii. association
 - e. contralateral (opposite) body sensation & motor
 - f. lateralization of function
 - i. both sides not equal jobs
 - ii. areas do overlap and work together
 - g. HTM – hierarchical temporal memory
- ii. Motor areas (pg. 412 fig. 12-10)
 1. Primary motor cortex
 - a. Precentral gyrus
 - i. Before central sulcus
 1. in frontal lobe
 - ii. controls skeletal muscle
 - iii. homunculus pg. 414
 2. premotor cortex
 - a. skilled activities (play instrument)
 - i. coordinate multiple muscles
 - b. injury
 - i. loss of programmed skill but muscle still works and you can use it
 1. could physically type but not as fast until you relearn
 3. Broca's area
 - a. Speech
 - b. Probably in both hemispheres but classically in left
 4. Frontal eye field
 - a. Voluntary eye movement (not sight!!)
- iii. Sensory areas
 1. Primary somatosensory cortex
 - a. Post-central gyrus (parietal lobe)
 - b. Sensation
 - c. Proprioception
 - i. Spatial discrimination
2. Somatosensory associational area
 - a. Posterior to primary sensory area
 - b. Recalls from memory what the touched item is.
 - i. Ex. Keys in pocket
 - c. Damage = would have to see the object every time to know what it is.
3. Visual area
 - a. Occipital lobe
 - b. Sense of vision/sight
4. Visual associational area
 - a. Surrounds visual area
 - b. Recalls from memory
 - c. Damage = see it and can't recall what it is
5. Auditory area
 - a. Temporal lobes
6. Olfactory cortex
 - a. Smell
 - b. Temporal lobe (fig 12-8b)
7. Gustatory cortex
 - a. Taste
 - b. Parietal lobe
- iv. Associational areas
 1. Prefrontal cortex
 - a. Personality, abstract thought, reasoning
 - i. Biggest difference between man & animals
 - b. Prefrontal lobotomy
 - i. 1930s-1950s
 - ii. lose judgment, personality changes
 2. General interpretation area
 - a. Crosses temporal, parietal & occipital
 - b. Gathers info from all associational areas and creates memories associated with sensation
 - c. Gives overall understanding/single thought to situation – i.e. **danger**
 - d. Injury = Imbecile = lose ability to interpret entire situation
- v. Pg. 396 – Closer Look, cocaine addiction
 1. Answer following questions
 - a. How can the “wisdom of the body” and the way it responds to neurotransmitter like chemicals be related to antibiotic use/overuse?
 - b. Why is cocaine addictive? (how does it work?)
 - c. What is crack?
 - d. Can you see any problems with treating someone with Manzindol?
 - e. How does an overdose of Heroin kill?
 - f. Can you experience constant pleasure (for years), physiologically and psychologically? Why or why not?

vi. Hypothalamus

1. ANS control (homeostatic mechanisms)
 - a. HR, RR, BP, Pupils, digestion, etc...
 - b. Body temp regulation
 - i. Thermoreceptors
 - c. Food intake
 - i. Hunger & satiety
 - d. Water balance & thirst
 - i. Controls kidneys
 - e. Sleep/wake cycles
 - f. Endocrine system
 - i. Hormone release
2. Emotional response
 - a. Along with Limbic System (several parts of brain – picture pg. 429)
 - i. Fear, pleasure, rage, sex drive
 - ii. *Closer Look* pg. 511 – ***Learned Fear: How Scary Things get That Way***
 1. amygdala – links emotions to memories & situations (ex. Fear)
 2. prefrontal cortex – crucial for unlearning fear behaviors.
 - a. Interesting that ‘lower’ animals don’t have a large prefrontal cortex & always are skittish. (ex. Iguana)
 3. hypothalamus – stimulates cortisol release – preps body defenses (stimulates gluconeogenesis and enzyme making)
 4. Overall, fear increases cortisol, increases feeling of vulnerability and suppresses reasoning skills of prefrontal cortex - phobias
 5. People deal with fear various ways.
 - a. Anxiety disorder people may have brain problem causing excess cortisol secretion. (improper feedback mechanism)
 3. Tie all functions of hypothalamus together and infants deprived of love may not sleep or eat & may die.

vii. Thalamus

1. Gateway to cerebral cortex
 - a. Relay station that sorts information and sends to appropriate spot in cortex.
 - i. Like switchboard operator

viii. Brain stem (pg. 422)

1. Gives rise to most cranial nerves
2. More basic life functions & responses
3. Midbrain
 - a. Visual & auditory reflexes
 - i. Turn and look at something we see out of the corner of our eye
 - ii. Eyes and head coordinate to follow that object.
 - iii. “Startle reflex” – when hear sound
 1. test for baby’s hearing
 - b. Contains substantia nigra
 - i. Controls dopamine release
 - ii. Parkinson’s disease
4. Pons
 - a. Relay station between cerebrum & cerebellum
5. Medulla Oblongata
 - a. Blends into spinal cord
 - b. Area of most cross-over of motor neurons
 - i. ‘Decussation of pyramids’
 - c. Cardiovascular center
 - i. HR and BP
 - d. Respiratory center

ix. Cerebellum

1. Subconscious proprioception & coordination
 - a. read pg. 427 ‘Cerebellar Processing’
 - i. *Cerebrum* decides what it wants to do.
 - ii. Cerebellum figures out where body is in space & tells *cerebrum* which muscles to move to not hurt self and keep coordinated.
2. Balance
 - a. Ears, eyes and cerebellum keep balance
 - i. Cerebellum = postural control so you don’t fall over.
 - ii. Motion sickness = conflicting input from each
3. **summary on pg. 428, table 12.1**

x. Closer Look – “He-Brain” versus “She-Brain”

1. Pg. 437 – Write down differences between male & female brains.

b. Spinal cord

- i. Anatomy (figure 12.29 pg. 442)
 1. Anterior horn – motor
 - a. Ventral root
 2. Posterior horn – sensory
 - a. Dorsal root & ganglion
 3. Spinal nerve
 - a. Ventral & dorsal root come together

4. White matter
 - a. Tracts
 - i. Carry common information
 1. touch or pain or temp.
 - b. Myelinated
 - i. Ant. & post. Horn – gray
 1. cell bodies & interneurons
5. Meninges – 3 layers of covering
 - a. Dura mater
 - i. Outermost
 - ii. 'hard mother'
 - iii. strongest, leathery
 - b. Arachnoid mater
 - i. 'spider'
 - ii. web-like extensions to pia mater
 - c. Pia mater
 - i. innermost
 - ii. 'gentle mother'
 - iii. clings tightly to brain
 - d. Subarachnoid space – between pia & arachnoid
 - i. Area of CSF flow (cerebrospinal fluid)
 1. protects brain & spinal cord
 2. reduces brain weight by 99% so doesn't crush itself
 3. removes waste products
 4. 150ml (½ cup) total – replaced every 3-4 hours.
 5. Hydrocephalus = drainage obstructed
 - a. Adult = pressure damage
 - b. Infant = head swells
 - c. Tx = shunt into neck veins
 - d. Fig. 12.25 pg. 433
 - e. Meningitis = inflammation of Meninges
 - i. Bacterial or viral
 - ii. Can spread into CNS
 1. encephalitis – infl. of brain
 - a. die due to pressure
 - iii. Spinal tap
 - iv. Myelomeningocele
 1. Pg. 450 picture
6. Spinal reflexes (pg. 487 & 489)
 - a. Stretch reflex
 - i. Stimulate muscle & inhibit antagonist
 - b. Crossed extensor reflex
 - i. Same on one side as stretch
 - ii. Opposite side, stimulate extensor and inhibit flexor
 - iii. Ex. someone pulls on your arm and you jerk one arm back and push away with the other.

7. Terminology
 - a. Paraesthesia = sensory loss
 - b. Paralysis = motor loss
 - i. Flaccid paralysis (LMNL)
 - ii. Spastic paralysis (UMNL)
 - c. Paraplegia = 2 limbs affected
 - i. Spinal cord severed below T-1 and both legs
 - d. Quadriplegia = 4 limbs affected
 - i. Cervical cord transection
 - e. Hemiplegia = one side of body
 - i. Usually brain injury (precentral gyrus)
- c. Homeostatic Imbalances
 - i. Cerebral Palsy
 1. Lack of O₂ to the brain
 - a. Bad delivery, pregnant mother - smoking/alcohol
 - b. UMNL – spastic paralysis, loss of voluntary motor control, vision, deafness, seizures, mental retardation (½ the cases)
 - i. Does not get worse with time but irreversible
 - c. #1crippler of children – 6/1000 births.
 - ii. Anencephaly
 1. 'Without a brain'
 - a. Cerebrum & brainstem don't fully develop
 2. Death occurs soon after birth
 - a. Some have strangely survived
 - iii. Spina bifida
 1. Incomplete formation of vertebral arches
 - a. Usually lumbar spine
 2. Occulta – less serious (hidden)
 - a. Small dimple and tuft of hair (fawn's beard)
 3. Cystica – more serious
 - a. Sac-like cyst protrudes from spine
 - i. Meningocele or myelomeningocele
 - b. 90% of the time accompanied by hydrocephalus
- d. Developmental aspects
 - i. Premature babies
 1. Hypothalamus is one of last areas to mature
 - a. Must keep them warm with incubator
 - ii. 5 days old & thalamus & primary somatosensory cortex are active but visual cortex is not.
 1. Respond to touch but not sight.
 - iii. 11 weeks – more cortex and can reach for a rattle
 - iv. 8 months – can think about what he/she sees
 - v. Neuromuscular coordination & myelination continue throughout childhood.
 - vi. Then neurons continue to die
 1. Other neurons can make new synaptic connections and learning can continue
 - vii. Less than 5% over 65 have true senility
 1. Most senility is reversible (poor nutrition, drug effects etc...)
 - viii. Boxing & alcohol cause brain atrophy