22 slides

Wednesday, December 3, 2025 4:10 PM

Structure and Function of the Nervous System

- Nervous System
- Central Nervous System (CNS)
  - Brain and spinal cord
  - Picks up and interprets sensory info
  - Coordinates body's activities
- Peripheral Nervous System
  - All nerves that branch from CNS.

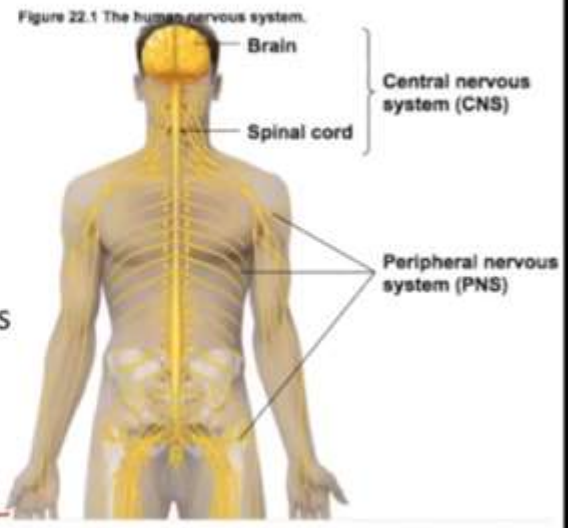
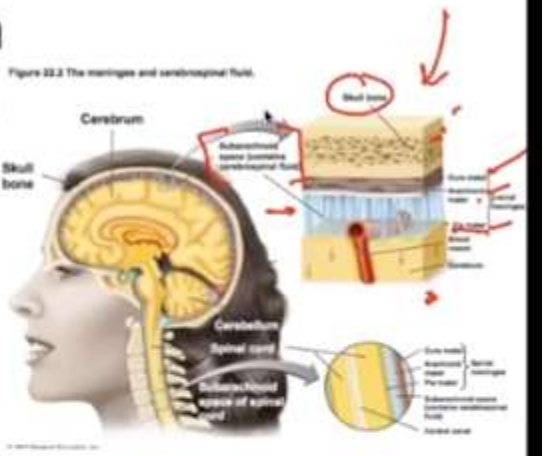


Figure 22.1 The human nervous system.

Structure and Function of the Nervous System

- Brain and spinal cord protected by 3 membranes: meninges
  - Dura mater
  - Arachnoid mater
  - Pia mater
- Subarachnoid space contains cerebrospinal fluid (CSF)
  - Low levels of Abs and phagocytes
  - Bacterial growth can be unregulated
- Meningitis
  - Inflammation of meninges
- Encephalitis
  - Inflammation of brain.



Bacterial Meningitis

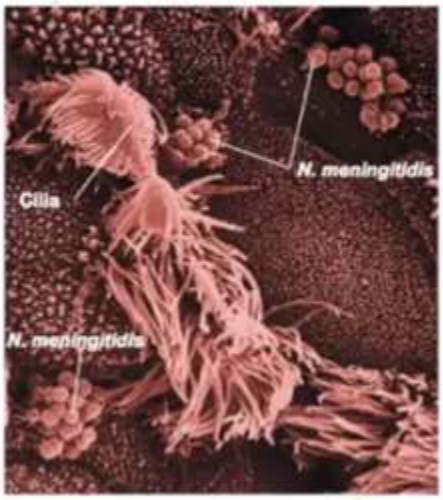
- *Meningitis can be caused by bacteria, viruses, fungi, and protozoans
- 3 bacteria cause the most common bacterial meningitis
  - *Haemophilus influenzae type B* (Hib)
  - *Neisseria meningitidis*
  - *Streptococcus pneumoniae*
  - All possess capsule; protects from phagocytosis
- Death from bacterial meningitis occurs quickly
  - Due to shock and inflammation
  - From release of endotoxins (gram neg)
  - Or release of cell wall fragments (teichoic acids; gram pos).

Haemophilus influenzae type B (Hib)

- Aerobic
- Gram negative
- Capsule
- Normal throat microbiota
- Erroneously thought to cause influenza (1889)
- Meningitis mostly in children under 4
- Other types: pneumonia, ear infections, bloodstream infections
- Hib vaccine 1988.

Neisseria meningitidis

- Causes meningococcal meningitis
- Aerobic
- Gram negative
- Normal microbiota of nose and throat
- 40% population is healthy carrier
- Symptoms caused by endotoxin
- Can lead to rapid death
- Outbreaks can occur in close quarters
- Vaccine available, recommended for preteens and teens (11 and 16 years).
- Many colleges require proof of vaccination.



Streptococcus pneumoniae

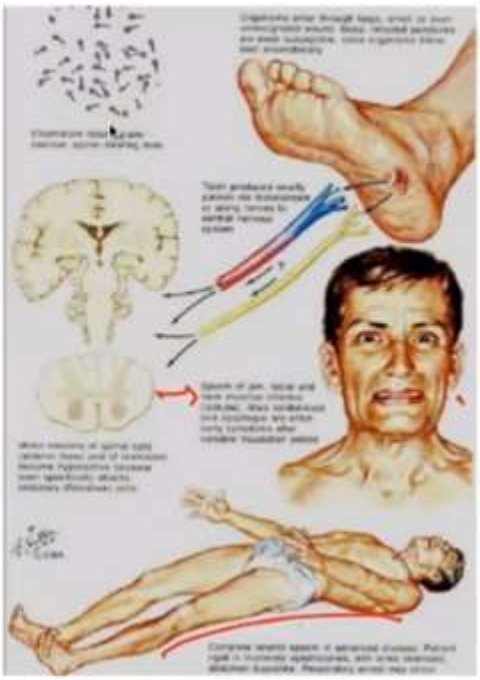
- Causes pneumococcal meningitis
- Also causes pneumonia, otitis media
- Normal nose/throat microbiota
- 70% of population is healthy carrier
- Gram positive
- The leading cause of bacterial meningitis
- Most cases occur among children 1 month – 4yrs
- Vaccine (Prevnar13) available, recommended for infants.

Tetanus

- *Clostridium tetani*
- Endospore forming
- Gram positive
- Common in soil with animal waste
- Obligate anaerobe
  - Wound by which it enters must provide anaerobic growth conditions.

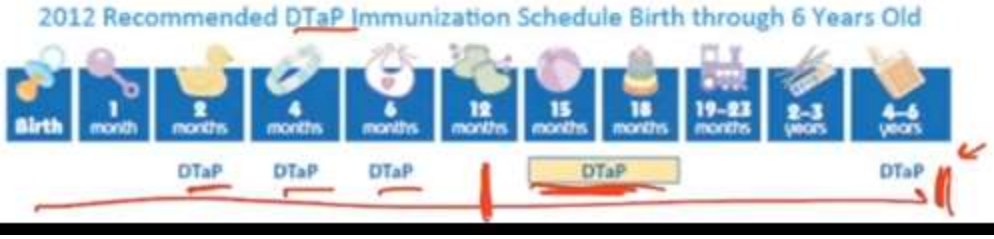
Tetanus

- A-B neurotoxin: tetanospasmin
- Released upon death and lysis of cells
- Absorbed in peripheral axons
- Carried to target neurons in spinal column
- Attaches to junctions of regulatory neurons that inhibit muscle contraction
- Blocks inhibitory neurotransmitter (GABA, glycine) release
- Opposing sets of muscles contract uncontrollably
- Muscles of jaw affected early: lockjaw
- Then arching of back and extension of arms/legs
- Death from spasm of respiratory muscles.



Tetanus

- Vaccine
- DTaP
  - Diphtheria
    - *Corynebacterium diphtheriae*
    - Causes upper respiratory infection
  - Tetanus
  - Acellular pertussis
    - *Bortadella pertussis*
    - Causes acute respiratory syndrome: whooping cough
- Booster required every 10 years.

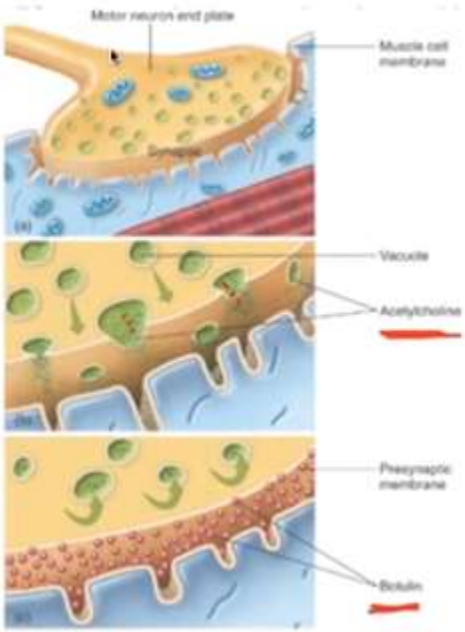


Botulism

- Food poisoning caused by *Clostridium botulinum*
  - From poorly preserved foods
- Obligate anerobe
- Endospore forming
- Soil and water bacterium.

Botulism

- Produces exotoxin under anaerobic conditions: botulinum toxin
- Works at neuromuscular junction
- Prevents release of acetylcholine
- Preventing muscle contraction
- Initial symptoms
  - Dizziness, double vision
- Progresses to muscle paralysis
  - Respiratory and cardiac failure
- Toxin destroyed by ordinary cooking methods.



Infant Botulism

- Botulism organisms don't compete well with intestinal flora
  - So toxin of ingested bacteria not produced
- Infant botulism
  - Most common type of botulism in US
  - Honey can contain endospores
  - Should not be given to children under 1.

Wound Botulism

- Endospores enter via wound or puncture
- Drug users are at increased risk.

Botox

- Botulinum toxin
  - Migraines
  - Relieving painful muscle contractions
  - Cerebral Palsy, MS
  - Excessive sweating
  - Eye twitching
  - Cosmetic.

Leprosy

- Caused by *Mycobacterium leprae*
- Optimum growth at 30°C
- Long generation time (12-14 days)
- Shows preference for outer, cooler parts of body (skin, superficial nerves)
- Invades cells of myelin sheath of PNS
- Nerve damage.

Leprosy

- Lepromatous (progressive) form
- Skins cells infected
- Disfiguring nodules all over body
- Necrosis of tissue
- Transmission
  - Prolong contact with patients
  - Cells are discharged in nasal secretions, skin lesions
- Death usually from complications (tuberculosis).

(b)

Leprosy

- Treatment
  - Dapsone, rifampin
  - 2 years, until lesions free of organisms
- No vaccine.

Polio

- Caused by poliovirus (RNA virus)
- Transmitted fecal-orally
- Replicates in pharynx and small intestine
- Enters blood (viremia)
- Penetrates capillary walls, enters CNS
- Affinity for motor nerve cells in upper spinal cord
- Multiplies, cells die
- Paralysis
- Death results from respiratory failure.

Polio

- 99% of infected show no symptoms
- But they can still excrete virus

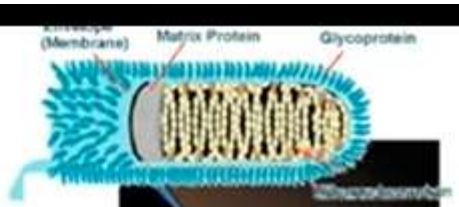
Two types of vaccine protect against polio: oral poliovirus vaccine (OPV) and inactivated poliovirus vaccine (IPV) (given as an injection in the leg or arm, depending on the patient's age).

- Vaccine
- Salk vaccine, IPV (1955)
  - Inactivated virus
  - Injected
- Sabin vaccine, OPV (1963)
  - Live, attenuated virus
  - Oral

- Next eradicated disease?
- Aug 2020, Africa is wild polio virus FREE!.

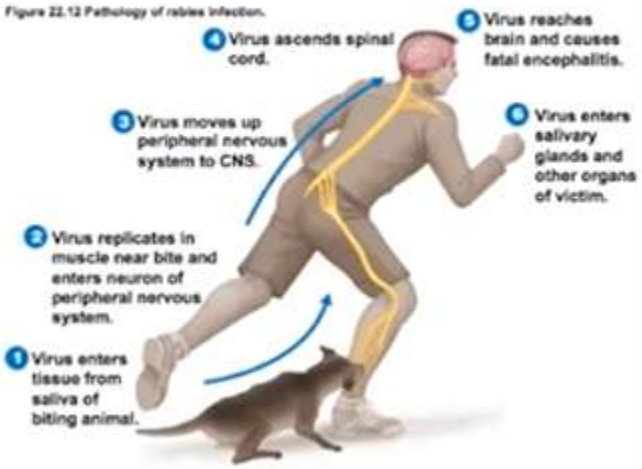
Rabies

- Bullet shaped rabies virus (RNA)
- Slow, progressive zoonotic disease
- Main reservoirs are skunks, bats, raccoons
  - But any mammal
- Transmission
  - Direct contact
    - Bite from infected animal
  - Indirect contact
    - Aerosol transmission.



Rabies

- Virus multiplies at bite site
- Can remain local for months
- Enters motor neuron
  - Within nerve, sheltered from immune system
- Travels to CNS, causes encephalitis, death of neurons
- Travels to salivary glands to be transmitted
- Fatal.



Rabies

- Incubation period: 1-2 months
- Begins with fever, nausea, vomiting
- Furious Phase
  - First neurological signs
    - Agitation, disorientation, seizures
  - Spasms in muscles of throat, pain in swallowing
    - Hydrophobia
- Dumb phase
  - Paralysis, disorientation, coma, death.

Rabies

- Treatment
- Vaccines given to high risk individuals
- HRIG (Human Rabies Immune Globulin)
  - Administered once, at beginning of anti-rabies prophylaxis
  - And if never vaccinated
  - Provides immediate Abs.