Chapter 22
Microbial Diseases of the Nervous System

The Nervous System

The Human Nervous System

The Nervous System

- Meninges protect brain and spinal cord
- Dura mater: Outermost layer
- Arachnoid mater: Middle layer
  - Subarachnoid space contains cerebrospinal fluid (CSF)
- Pia mater: Innermost layer
- Blood-brain barrier

The Meninges and CSF

The Nervous System

- Meningitis: Inflammation of meninges
- Encephalitis: Inflammation of the brain
- Meningoencephalitis: Inflammation of both

Bacterial Diseases of the Nervous System

Bacterial Meningitis

- Initial symptoms of fever, headache, and stiff neck
- Followed by nausea and vomiting
- May progress to convulsions and coma
- Diagnosis by Gram stain and latex agglutination of CSF
- Treatment: Cephalosporins, vancomycin

Spinal Tap (Lumbar Puncture)

Haemophilus influenzae Meningitis

- Occurs mostly in children (6 months to 4 years)
- Gram-negative aerobic bacteria, normal throat microbiota
- Capsule antigen type b
- Prevented by Hib vaccine

Neisseria Meningitis

- Also called meningococcal meningitis
- Caused by N. meningitidis
  - Gram-negative, aerobic cocci with a capsule
  - 10% of people are healthy nasopharyngeal carriers
  - Begins as throat infection, rash
  - Serotypes B, C, Y, W-135 in U.S.
  - Serotype B in Europe
  - Serotype A in Africa, China, and Middle East
  - Vaccination (B, C, Y, W-135 capsule) recommended for college students

Neisseria Meningitis

Streptococcus pneumoniae Meningitis

- Also called pneumococcal meningitis
- Caused by S. pneumoniae (a gram-positive diplococcus)
• 70% of people are healthy nasopharyngeal carriers
• Most common in children (1 month to 4 years)
• Mortality: 30% in children, 80% in elderly
• Prevented by vaccination

14. **Listeriosis**
   - Caused by *Listeria monocytogenes*
   - Gram-negative aerobic rod
   - Usually foodborne; it can be transmitted to fetus
   - Reproduce in phagocytes

**Bacterial Diseases of the Nervous System**

15. **Tetanus**
   - Caused by *Clostridium tetani*
   - Gram-positive, endospore-forming, obligate anaerobe
   - Grows in deep wounds
   - Tetanospasmin released from dead cells blocks relaxation pathway in muscles
   - Prevention by vaccination with tetanus toxoid (DTP) and booster (dT)
   - Treatment with tetanus immune globulin

16. **An Advanced Case of Tetanus**

17. **Botulism**
   - Caused by *Clostridium botulinum*
   - Gram-positive, endospore-forming, obligate anaerobe
   - Intoxication comes from ingesting botulinal toxin
   - Botulinal toxin blocks release of neurotransmitter, causing flaccid paralysis
   - Prevention
     - Proper canning
     - Nitrites prevent endospore germination in sausages

18. **Botulism**
   - Treatment: Supportive care and antitoxin
   - Infant botulism results from *C. botulinum* growing in intestines
   - Wound botulism results from growth of *C. botulinum* in wounds

19. **Botulinal Types**
   - Type A toxin
     - 60–70% fatality
     - Found in CA, WA, CO, OR, NM
   - Type B toxin
     - 25% fatality
     - Europe and eastern United States
   - Type E toxin
     - 25% fatality
     - Found in marine and lake sediments
     - Pacific Northwest, Alaska, Great Lakes area

20. **Diagnosing Botulism by Toxin ID**

21. **Leprosy**
   - Also called Hansen's disease
   - Caused by *Mycobacterium leprae*
   - Acid-fast rod that grows best at 30°C.
   - Grows in peripheral nerves and skin cells
Transmission requires prolonged contact with an infected person

Leprosy
- Tuberculoid (neural) form: Loss of sensation in skin areas; positive lepromin test
- Lepromatous (progressive) form: Disfiguring nodules over body; negative lepromin test

Leprosy Lesions

Viral Diseases of the Nervous System

Polio (Poliomyelitis)
- Poliovirus
- Transmitted by ingestion
- Initial symptoms: Sore throat and nausea
- Viremia may occur; if persistent, virus can enter the CNS
- Destruction of motor cells and paralysis occurs in <1% of cases
- Prevention: vaccination (enhanced-inactivated polio vaccine)

Worldwide Annual Incidence of Poliomyelitis

Rabies
- Caused by the rabies virus
- Transmitted by animal bite
- Furious rabies: Animals are restless then highly excitable
- Paralytic rabies: Animals seem unaware of surroundings

Pathology of Rabies Infection

Reported Cases of Rabies in Animals

Rabies Virus
- Virus multiplies in skeletal muscles and then brain cells, causing encephalitis
- Initial symptoms may include muscle spasms of the mouth and pharynx and hydrophobia

Prevention of Rabies
- Preexposure prophylaxis: Injection of human diploid cells vaccine (HDCV)
- Postexposure treatment: Vaccine plus rabies immune globulin (RIG)

Arboviral Encephalitis
- Arboviruses
- Arthropod-borne viruses that belong to several families
- Prevention: controlling mosquitoes

California Serogroup Arbovirus Cases, 1964–2006

Fungal Diseases of the Nervous System

Cryptococcus neoformans Meningitis
- Also called cryptococcosis
Soil fungus associated with pigeon and chicken droppings
- Transmitted by the respiratory route; spreads through blood to the CNS
- Mortality up to 30%
- Treatment: Amphotericin B and flucytosine

**Cryptococcus neoformans**

**Protozoan Diseases of the Nervous System**

**African Trypanosomiasis**
- *Trypanosoma brucei gambiense*
  - Chronic (2 to 4 years)
- *T. b. rhodesiense* infection
  - Acute (few months)
- Transmitted from animals to humans by tsetse fly

**African Trypanosomiasis**
- Prevention: Elimination of the vector
- Treatment: Eflornithine blocks an enzyme necessary for the parasite
- Parasite evades the antibodies through antigenic variation

**How Trypanosomes Evade the Immune System**

**Naegleria fowleri**
- Protozoan infects nasal mucosa from swimming water

**Prion Diseases of the Nervous System**

**Transmissible Spongiform Encephalopathies**
- Caused by prions
- Typical diseases
  - Sheep scrapie
  - Creutzfeldt-Jakob disease
  - Kuru
  - Bovine spongiform encephalopathy
  - Chronic and fatal

**Prion Diseases of the Nervous System**
- Acquired by
  - Ingestion
  - Inherited
  - Transplant
  - Difficult to destroy

**Preventing Prion Diseases**
- Surgical instruments sterilized by
  - NaOH
  - + extended autoclaving at 134°C
Disease Caused by Unidentified Agents

Chronic Fatigue Syndrome
- Also called myalgic encephalomyelitis (ME)
- Unexplained fatigue that lasts at least 6 months + 4 of these symptoms:
  - Sore throat
  - Tender lymph nodes
  - Muscle pain
  - Pain in multiple joints
  - Headaches
  - Unrefreshing sleep
  - Malaise after exercise
  - Impaired short-term memory or concentration

Chronic Fatigue Syndrome
- Experimental treatment promotes antiviral interferons