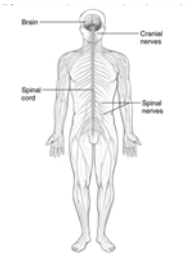


Infectious Diseases of the Nervous System

Nervous System



- CNS: brain and spinal cord
- PNS: peripheral nerves
- Cells are called neurons
- No normal flora

Natural Defenses of the Nervous System

- Skull and vertebrae
- Microglial cells and macrophages
- Restricted entry into brain (blood-brain barrier) for:
 - microorganisms
 - medications, including antibiotics
 - immune system

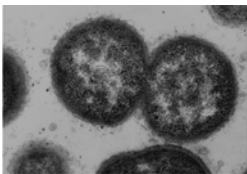
Nervous System Diseases

- Meningitis: inflammation of the meninges = membranes surrounding the brain and spinal cord
- Encephalitis: inflammation of the brain

Meningitis

- *Haemophilus influenzae* type b
 - Infants, newborn
 - (also, *E. coli*, *Streptococcus agalactiae*)
- *Streptococcus pneumoniae*
 - Children 1 month - 4 years
 - Elderly
- *Neisseria meningitidis*
 - College students

Streptococcal Meningitis



Subunit vaccine: induces opsonizing antibody to capsule

Streptococcus pneumoniae

- Gram + diplococci
- Virulent strains are encapsulated
- Children age 1 month – 4 years
- Elderly

Meningococcal Meningitis in College Students

Neisseria meningitidis

- Enters through nasal cavity (droplets)
- Incidence = 2,500 Americans/year
 - 10-15% die, up to 20% long-term disabilities
- Subunit vaccine: induces opsonizing antibody to capsule

Naegleria Meningoencephalitis

A rare infection



- *Naegleria fowleri*
- Small free-living amoebas
- Found in soil, fresh water, and sewage
- Can be normal flora
- Protozoan feeds on bacteria but if introduced into the CNS can feed on human tissue

Naegleria meningoencephalitis

- Acquired from hot tubs, warm ponds and ground water at high temperature
- Children and young adults
- Initially infects the nasal mucosa
- Abrupt onset of symptoms 3 to 10 days after exposure to water
- Severe headache, fever, stiff neck and coma

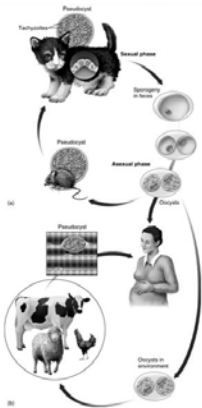
Naegleria meningoencephalitis

- Destroys brain and spinal tissue
- Death occurs within 10 days of the onset of clinical signs
- No treatment
- Chlorine kills the organism in spas and pools

Toxoplasmosis

- *Toxoplasma gondii*
- Flagellated protozoan parasite
- Infects over 200 species of birds and animals
- Primary reservoir is cats
- Infection usually handled by immune system



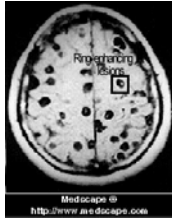


Toxoplasmosis

- Acquired from contaminated meat or ingestion of oocysts in cat feces

Toxoplasmosis

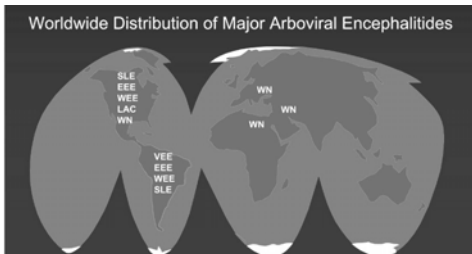
- Causes serious disease in developing fetus
 - Liver damage
 - Brain abnormalities
 - Blindness
- Serious disease in people with AIDS
- Prevention: no raw meat, no contact with cat litter box



Viral Infections of the CNS Acute Viral Encephalitis

- Arboviruses
 - West Nile Virus Encephalitis
 - Western or Eastern Equine Encephalitis
 - California Encephalitis
 - La Crosse Encephalitis
- Herpes simplex 1 or 2
- Rabies

Arboviral encephalitis is prevalent worldwide



EEE: Eastern equine encephalitis WEE: Western equine encephalitis
LAC: LaCrosse encephalitis WN: West Nile encephalitis
SLE: St. Louis encephalitis VEE: Venezuelan equine encephalitis

Arboviral encephalitis....

... Results after the bite of a blood sucking insect, commonly mosquitoes

The virus is inoculated directly into the blood stream and grows in monocytes and/or lymphocytes

Virus is released into the blood and can enter the brain infecting neurons.

EEE: Eastern equine encephalitis WEE: Western equine encephalitis
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Arboviral encephalitis is prevalent worldwide

... But each virus has its own locality, due to its host insect **vector species** (e.g. *Culex species*, *WNV*)

... Most disease in the USA is mild with symptoms of fever and malaise, and only occasionally leads to infection of the brain

... Most disease localities are known and controlled by via virus monitoring, disease monitoring and mosquito control

EEE: Eastern equine encephalitis WEE: Western equine encephalitis
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Rabies

- Viral infection from bite of a "furious" rabid animal:

Animal rabies: Wandering, aggression, biting, salivating

- Virus travels from the bite to the brain, via nerves
- Thus, variable latent period
- A fatal zoonotic disease

Human "dumb" rabies: fever, confusion, anxiety, encephalitis, death

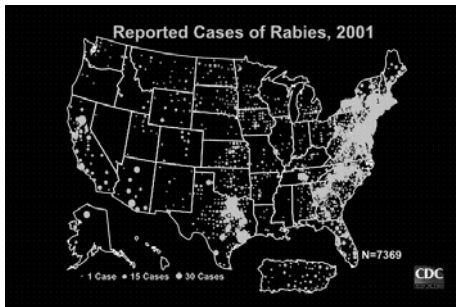


Rabies

- Bite
- Virus grows in muscle
 - Virus enters sensory nerve ending
 - Virus travels to cord, brain
 - Virus grows in brain, changes behavior
 - Virus travels to salivary gland and is secreted



Where is Rabies?

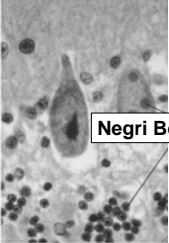


Animal Reservoirs of Rabies




Diagnosis of Rabies:

- Performed via a Post-mortem autopsy on animals
- Observing neuronal brain cells with intracytoplasmic inclusions (Negri bodies)
- Identification of Rabies Strain (Bat, Skunk, etc....)



Negri Bodies



Rabid brain stained with
Fluorescent anti-rabies antibody

Rabid brain stained with Hematoxylin and eosin

Prevention of Rabies

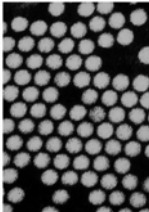
CHECKPOINT 19.6 Rabies	
Causative Organism(s)	Rabies virus
Prevention	HDCV—inactivated vaccine Pet Animal vaccines Wildlife edible bait vaccines
Treatment	Postexposure passive and active immunization Euthanize (kill) all rabid animals Quarantine biting, aggressive unvaccinated pets or pet animals bitten by wildlife

Paralytic Poliomyelitis

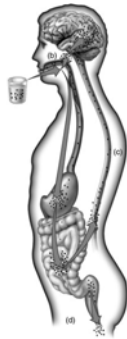
- Neurotropic viral infection acquired by ingestion
- Paralytic spinal cord infection
- Effective vaccine (PV-1,2,3)
- Unvaccinated children are at risk in parts of the world like India, Africa

The unique stages of infection and pathogenesis of poliomyelitis.

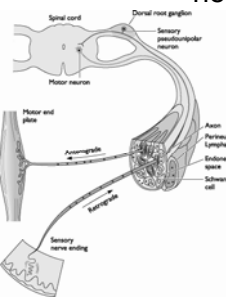
Poliovirus, an "Enterovirus" has an icosahedral capsid shell that protects it from digestion.



GI Tract
 → Blood
 → Cord
 → CNS
 Paralysis of motor neurons



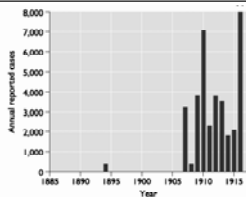
Virus travels through blood and the nerves



... And each place in the **cord** that nerve cells are destroyed causes **paralysis** of that part of the body controlled by those motor neurons.

Summer epidemics in the early 1900s in the USA caused panic

ACUTE ANTERIOR POLIOMYELITIS
 (A COMMUNICABLE DISEASE)
Keep Out of this House
 By Order of BOARD OF HEALTH
 HEALTH OFFICER
 Any person removing this card without authority is liable to prosecution.



Polio in the USA in spurred the first human vaccines:
 - Salk Killed Vaccine
 - Sabin Modified Live Vaccine

Poliomyelitis – World Wide