- **Important terms:**
  - **Meningitis:** it is inflammation of meninges (coverings of the central nervous system) caused by infection. They are classified to:
    - Pachymeningitis: involving the dura matter.
    - Leptomeningitis: involving the pia matter + arachnoid matter.
  - **Encephalitis or myelitis:** these are infections of cerebral and spinal parenchyma
  - **Meningoencephalitis:** infection of both meninges and brain parenchyma.

- **Causes and routes of infection in meningitis:**
  - **Direct:** this happens when there is otitis media or infection of the mastoid sinus.
  - **Indirect:** bloodborne infections and septicemia from infections elsewhere.
  - **Neurosurgical settings:** shunt infection, head injury, CSF leak and postoperative.
  - **Meningeal carcinomatosis/lymphomatosis.**
  - **Ruptured dermoid/teratoma-chemical irritants.**

- **Infectious meningitis can be:**
  - **Acute (pyogenic: producing pus):** bacterial.
  - **Acute (aseptic):** viral.
  - **Chronic:** TB, cryptococcal and spirochetal infections.
    Note: infectious causes can be bacterial, viral, fungal or protozoal.

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- **Acute bacterial/pyogenic meningitis:**
  - It is the commonest type of meningitis.
  - **Organism which are causing pyogenic meningitis in relation to age:**

<table>
<thead>
<tr>
<th>ORGANISM</th>
<th>PEAK AGE INCIDENT</th>
<th>GRAM STAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>Neonates</td>
<td>Gram negative rods</td>
</tr>
<tr>
<td>Hemophilus influenzae</td>
<td>Infants and Children</td>
<td>Gram negative coccobacilli</td>
</tr>
<tr>
<td>Neisseria meningitidis</td>
<td>Adolescents and Young adults</td>
<td>Gram negative diplococci</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>Older adults or Children</td>
<td>Gram positive cocci in chains</td>
</tr>
</tbody>
</table>

- **Morphology:**
  - **Gross:**
    - Engorged vessels.
    - **Exudates in:**
      - Parasagittal areas.
      - Sylvian fissure (lateral fissure).
      - Between peduncles.
      - Cisterns.
    
      **Note:** this exudates is producing yellow-tan clouding of meninges.
    
      Location of exudates differs:
      - **H.influenzae:** basal exudates.
      - **S.pneumoniae:** in cerebral convexities.
      - Fulminant cases: ventricles+adjacent brain parenchyma.
      - Untreated cases: leptomeningeal fibrosis & hydrocephalus.
  - Inflammation usually does not extend to the brain.
The results of inflammation are:
- **Tissue and vascular injury (vasculitis):** caused by lysosomal enzymes and free radicals released by granulocytes and monocytes.
  - Vasculitis will cause → infarcts.
- **Increased intracranial pressure:** due to increased vascular permeability + leakage of CSF and proteins in the interstitial space (cerebral edema).
  - Increased intracranial pressure causes → hypoxic-ischemic encephalopathy.

- **Tuberculous menigitis:**
  - Spread: hematogenous.
  - **Tuberculoma.**
  - Pott’s disease of spine.
  - Hydrocephalus is the common complication.
  - **Morphology:**
    - Gross:
      - *Thick exudate (see the image below):* it is difficult to see the vessels at the base of the brain because of overlying meningeal inflammation and fibrosis.
      - *Tuberculoma (see the image below):* it is close to the ventricles causing pressure which will increase intracranial pressure and result in hydrocephalus.
      - *Images below:* granuloma causing increased pressure on the spinal cord (left) complete dilatation of ventricles as a result of hydrocephalus.
- **Fungal meningitis:**
  - **Mostly occurring in:** immunocompromised hosts.
  - **Causative organisms are:**
    - Aspergillosis.
    - Mucormycosis.
    - Cryptococcosis: encapsulated spheres (5-15 micrometers in diameter) seen in CSF in india ink stain.
  - **What happens in this disease?**
    - Granulomatous meningitis: with caseous necrosis and black discoloration due to fungal infection.
    - Blood vessels develop endarteritis obliterans leading to infarction in parenchyma: there will be branching fungal hyphae invading arteries.
  - **Morphology:**
    - Gross:

- **Protozoal meningitis (amoebic meningoencephalitis):**
  - Naegleria.
  - Acanthamoeba (see the image).
  - Entry through cribriform plate from water.
- **Viral meningitis** (also known as aseptic meningitis because bacteria are not present):
  - Viruses reach the central nervous system through:
    - Bloodstream.
    - Along nerves.
  - Common viruses which might lead to viral meningitis are:
    - HIV
    - Polio
    - Herpes
    - Rabies
    - Cytomegalovirus (CMV).
  - **Morphology:**
    - Microscopically:
      - Lymphocytes + macrophages: especially around blood vessels.
      - Formation of microglial nodules.
      - Individual cells necrosis to diffuse brain necrosis.
      - Certain viruses cause intranuclear and intracytoplasmic inclusions.

- **Complications of meningitis:**
  - **Acute:**
    - Papilledema: due to hydrocephalus.
    - Involvement of cranial nerves (especially optic and ventilocochlear).
    - Raised intracranial pressure.
    - Inappropriate ADH secretion.
    - Seizures.
  - **Subacute:**
    - Cerebral abcess:
      - Localized area of suppurative inflammation in the brain substance.
      - The cavity contains thick pus formed from necrotic, liquefied brain tissue and large numbers of neutrophils and is surrounded by a fibrogliotic wall.
      - The location of the abcess corresponds to its source.
    - Subdural hygroma.
    - Seizures.
  - **Long-term:**
    - Deafness.
    - Blindness.
    - Hydrocephalus.
    - Epilepsy.
    - Cognitive impairment.
    - Physical handicap.