Pathology of meningitis and its complications

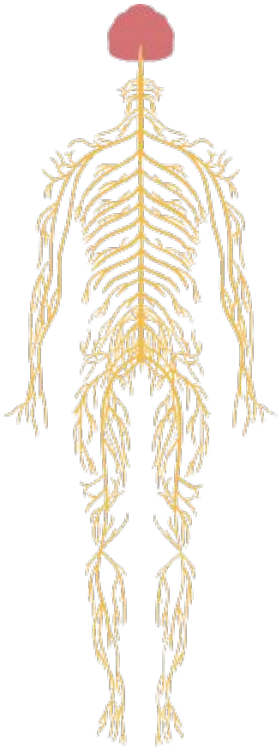
Editing File

Color index :
Main text (black)
Female Slides (Pink)
Male Slides (Blue)
Important (Red)
Dr's note (Green)
Extra Info (Grey)

Objectives

Osmosis Vid

- Revise the spectrum of organisms that can cause meningitis.
- Explain the terms used in the description of CNS infections patterns.
- Understand the pathology of acute bacterial and tuberculous meningitis and the information that can be obtained from investigation of cerebrospinal fluid in suspected meningitis.



If you want to read the lecture from Robbins click here

Meningitis

Osmosis Vid

Definition

Meningitis is an inflammatory process involving the leptomeninges and CSF within the subarachnoid space.

FEMALES SLIDES

If the infection spreads into the underlying brain, it is termed meningoencephalitis.

It can be:

- Infectious: acute pyogenic (usually bacterial), aseptic (usually viral), and chronic (usually tuberculous, spirochetal, or fungal).

- Non-infectious: chemical meningitis (a response to a nonbacterial irritant such as debris from a ruptured epidermoid cyst) and carcinomatous meningitis (the spread of metastatic cancer cells to the subarachnoid space).

FEMALES SLIDES

- Examination of the CSF is often useful in distinguishing among the various causes of meningitis.
- It is a medical emergency. Untreated pyogenic meningitis is often fatal, but with prompt diagnosis and administration of antibiotics, most patients can be saved.
- If treated early and effectively, resolved meningitis may leave little or no residuum.

Table 23.2 Common Central Nervous System Infections

Type of Infection	Clinical Syndrome	Common Causative Organisms
Bacterial Infections		
Meningitis	Acute pyogenic meningitis	*Escherichia coli* or group B streptococci (infants) *Neisseria meningitidis* (young adults) *Streptococcus. pneumoniae* or *Listeria monocytogenes* (older adults)
	Chronic meningitis	*Mycobacterium tuberculosis*
Localized infections	Abscess	Streptococci and staphylococci
	Empyema	Polymicrobial (staphylococci, anaerobic gram-negative)
Viral Infections		
Meningitis	Acute aseptic meningitis	Enteroviruses Measles (subacute sclerosing panencephalitis) Influenza species Lymphocytic choriomeningitis virus
Encephalitis	Encephalitic syndromes	Herpes simplex (HSV-1, HSV-2) Cytomegalovirus Human immunodeficiency virus JC polyomavirus (progressive multifocal leukoencephalopathy)
	Arthropod-borne encephalitis	West Nile virus, other arboviruses
Brain stem and spinal cord syndromes	Rhombencephalitis Spinal poliomyelitis	Rabies Polio West Nile virus
Rickettsia, Spirochetes, and Fungi		
Meningitic syndromes	Rocky Mountain spotted fever	*Rickettsia rickettsii*
	Neurosyphilis	*Treponema pallidum*
	Lyme disease (neuroborreliosis)	*Borrelia burgdorferi*
	Fungal meningitis	*Cryptococcus neoformans* *Candida albicans*
Protozoa and Metazoa		
Meningitic syndromes	Cerebral malaria Amebic encephalitis	*Plasmodium falciparum* *Naegleria species*
Localized infections	Toxoplasmosis Cysticercosis	*Toxoplasma gondii* *Taenia solium*

Meningitis

Route of entry

1

Hematogenous spread: the most common

Direct implantation: traumatic or in congenital CNS malformation

2

3

Local extension: occurs secondary to an established infection in a nearby organ (air sinus, an infected tooth or middle ear)

Through the **peripheral nervous system into the CNS:** certain viruses, such as **rabies** and **herpes** zoster.

4

Deep Focus Question

Which of the following statements about bacterial meningitis is TRUE?

A. It constitutes an infection of the meninges only.
B. It constitutes an infection of the subarachnoid space and the meninges.
C. It refers to the infection of the cerebral cortex.
D. Much like viral meningitis, it is a benign and self-limited disease.
E. In constitutes an infection of the subarachnoid space only.

Answer: B

Acute Pyogenic Meningitis (Bacterial Meningitis)

Organisms

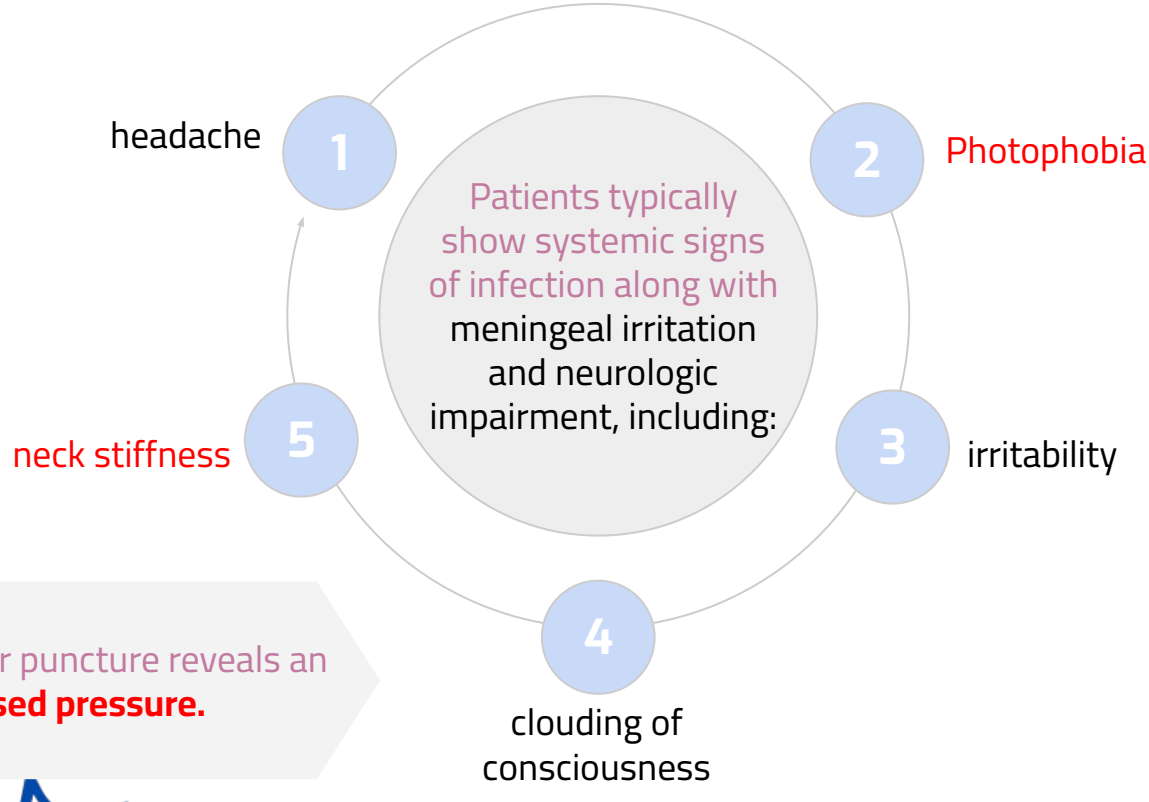
The most likely causes of bacterial meningitis vary with patient age:

neonates	adolescents and young adults	older adults
common organisms are **Escherichia coli and group B streptococci**	**Neisseria meningitidis (Meningococcal meningitis)** is the most common pathogen.	**Streptococcus pneumoniae and Listeria monocytogenes** are more common

Clinical Features

MALES SLIDES

- Systemic non-specific signs of infection
- Untreated, pyogenic meningitis can be fatal
- Effective antimicrobial agents markedly reduce mortality associated with meningitis



Lumbar puncture reveals an **increased pressure.**

Acute Pyogenic Meningitis (Bacterial Meningitis)

CSF findings in spinal tap

01 cloudy or frankly purulent CSF

02 as many as 90,000 neutrophils /mm

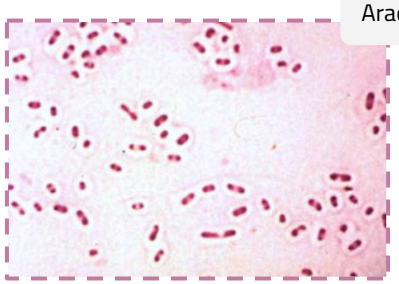
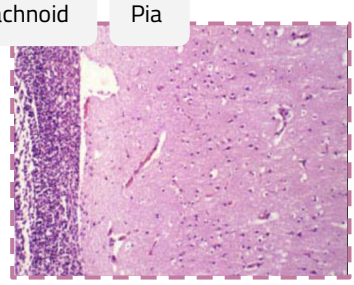
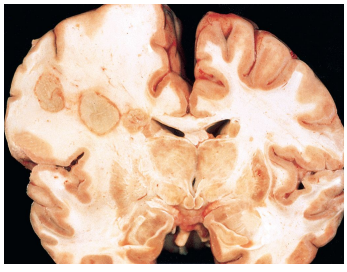
03 **raised protein level**

04 bacteria may be seen on a Gram stained smears or can be cultured, sometimes a few hours before the neutrophils appear.

05 **markedly reduced glucose content**

Morphology

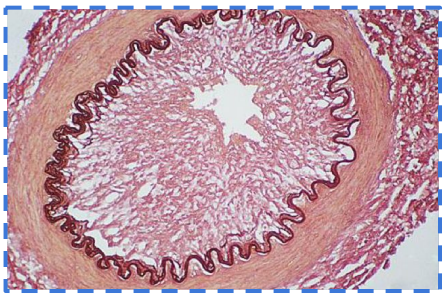
FEMALES SLIDES

Microscopic	Macroscopic
This gram stain shows multiple gram- positive diplococci, which is characteristic of Streptococcus pneumoniae. (1)	a Thick of suppurative exudate covers the brainstem and cerebellum and thickens the leptomeninges (1)
neutrophils may fill the entire subarachnoid space. Gram stain reveals varying numbers of the causative organisms	Cerebral abscesses in the frontal lobe white matter (2)
neutrophils may fill the entire subarachnoid space.	-
An exudate is evident within the leptomeninges on the surface of the brain	-
The exudate expands the meningeal space between the pia and arachnoid and may extend into the perivascular Virchow-Robin spaces. However, direct extension into the brain is rare. (2)	-
 (1)  (2)	 (1)  (2)

Acute Pyogenic Meningitis (Bacterial Meningitis)

Complication

1. Severe involvement of leptomeningeal veins (phlebitis) may lead to venous occlusion and hemorrhagic infarction of the underlying brain.
2. Leptomeningeal fibrosis → hydrocephalus.
3. Extension to the ventricles → ventriculitis.
4. Focal cerebritis → seizures and cerebral abscess
5. Cognitive deficit
6. Deafness
7. Septicemia → hemorrhagic infarction of the adrenal glands and cutaneous petechiae (known as Waterhouse-Friderichsen syndrome, particularly common with Neisseria meningitidis and pneumococcal meningitis)



Brain Abscess

Organisms

Causative agent:

- Brain abscesses are most often caused by bacterial infections.
- Streptococci and Staphylococci are the most common organisms identified in non-immunosuppressed populations.

Routes Of Entry

01

direct implantation of organisms

Deformities & Skull Fractures

02

local extension from adjacent foci

mastoiditis, paranasal sinusitis

03

hematogenous spread

usually from a primary site in the heart, lungs, or distal bones, or after tooth extraction

Predisposing conditions

01

Acute bacterial endocarditis(usually give multiple microabscesses) , from which septic emboli are released that may produce multiple abscesses

02

Cyanotic congenital heart disease, associated with a right-to-left shunt loss of pulmonary filtration of organisms

03

Chronic pulmonary infections, as in bronchiectasis which provide a source of microbes that spread hematogenously.

Brain Abscess

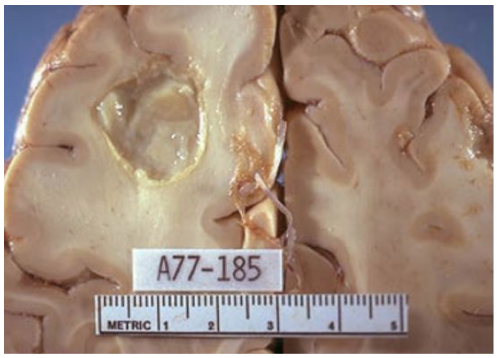
Morphology

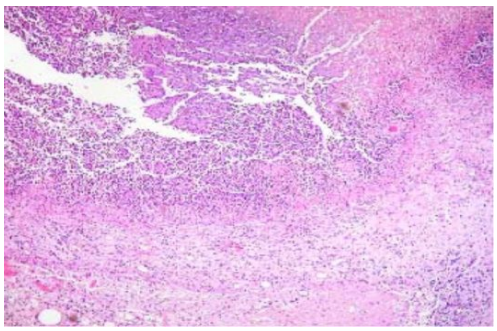
Abscesses are discrete destructive lesions with central **liquefactive necrosis** surrounded by a rim of vascularized granulation and fibrous tissue.

Outside the fibrous capsule is a zone of reactive gliosis.

The surrounding brain is edematous,congested & contains reactive astrocytes & perivascular inflammatory cells

Most common on cerebral hemispheres





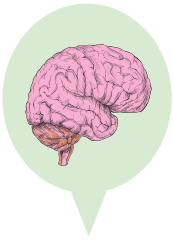
Clinical Features

Neurological

Patients present clinically with progressive focal neurologic deficits in addition to the general signs of raised intracranial pressure.

CSF

- **Contains only scanty cells**
- **↑ protein**
- **Normal level of glucose**



Complications of Brain abscess

- Herniation
- Rupture of abscess into subarachnoid space or ventricle

Epidural And Subdural Infections

Definition

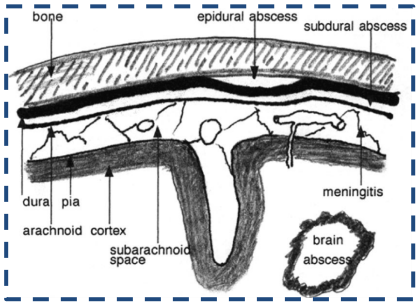
The epidural and subdural spaces can be involved by bacterial or fungal infections, usually as a consequence of direct local spread.

Epidural abscesses commonly associated with osteomyelitis arise from an adjacent focus of infection, such as sinusitis or osteomyelitis or a surgical procedure

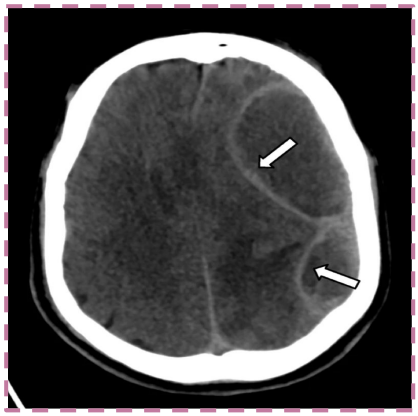
When abscesses occur in the spinal epidural space, they may cause spinal cord compression and constitute a neurosurgical emergency.

Empyema

Infections of the skull or air sinuses may also spread to the subdural space, producing subdural empyema.



The underlying arachnoid and subarachnoid spaces are usually unaffected, but a large subdural empyema may produce a mass effect.



In addition, **Thrombophlebitis** may develop in the **bridging veins** that cross the subdural space, resulting in venous occlusion and infarction of the brain.

Symptoms include those referable to the source of the infection. Most patients are febrile, with headache and neck stiffness, and if untreated may develop focal neurologic signs, lethargy, and coma

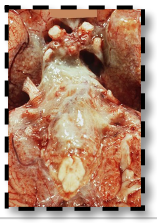
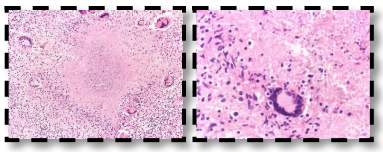
brain abscess in patient with sinusitis

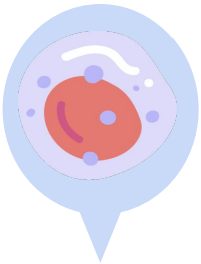
Prognosis:

- With treatment, including surgical drainage, resolution of the empyema occurs from the dural side; if resolution is complete, a thickened dura may be the only residual finding. With prompt treatment, complete recovery is usual

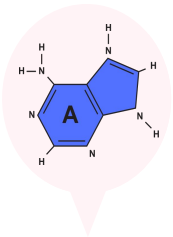
TUBERCULOUS MENINGITIS

IMPORTANT

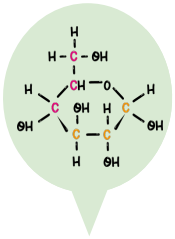
Symptoms	Macroscopic findings	Microscopic findings
• It usually manifests with generalized signs and symptoms of headache, malaise, mental confusion, and vomiting.	• The subarachnoid space contains a **fibrinous exudate**, most often at the **base** of the brain. 	• there is usually a central core of caseous necrosis surrounded by a typical tuberculous granulomatous reaction 



There is only a moderate increase in cellularity of the CSF (pleiocytosis) made up of mononuclear cells, or a mixture of polymorphonuclear and mononuclear cells.



The protein level is markedly elevated often strikingly so



The **glucose** content typically is **moderately reduced or normal**

Deep Focus Question

What is the test of choice for bacterial meningitis?

A. Computed tomography (CT) scan
B. Complete metabolic panel
C. Blood and urine cultures
D. Lumbar puncture

Answer: D

Deep Focus Question

What is a common cause of chronic bacterial meningitis?

A. Neisseria meningitides
B. Streptococcus agalactiae
C. Haemophilus influenzae
D. Mycobacterium tuberculosis

Answer: D

TUBERCULOMA

IMPORTANT

1. It is a well-circumscribed intraparenchymal mass by a Mycobacterium tuberculosis.

2. Rupture of tuberculoma into subarachnoid space results in tuberculous meningitis

3. Always occurs after hematogenous dissemination of organism from a primary pulmonary infection

Morphology

01

A tuberculoma is shown in the temporal lobe.
-It is a destructive lesion

02

A tuberculoma may be up to several centimeters in diameter,causing significant mass effect

03

It is seen as a well-circumscribed intraparenchymal mass that may have effects similar to those caused by any other intracranial mass, and may therefore mimic a tumor.

Clinical Note

- Bacteria usually reach the meninges via the bloodstream from the nasal cavity, often following a viral upper respiratory tract infection.
- Both the meningococcus and the pneumococcus have capsules which render them resistant to phagocytosis and complement.
- The bacteria enter the subarachnoid space where the blood-brain barrier is weak, e.g. the choroid plexus.
- Once in the CSF, the bacteria multiply rapidly and stimulate an acute inflammatory response within the meninges.

Viral Meningitis

The nervous system is particularly susceptible to certain viruses such as rabies virus and poliovirus. Other viral infections could affect CNS such as HSV, Enteroviruses, Measles or Influenza virus

Intrauterine viral infection following transplacental spread of rubella and CMV may cause destructive lesions, and Zika virus causes developmental abnormalities of the brain.

CNS can be injured by immune mechanisms after systemic viral infections.

CNS viral infections could lead to meningitis, encephalitis or brain stem and spinal cord syndromes.

Deep Focus Question

How do you perform Kernig's test in a patient with suspected meningitis?

A. With the patient prone, extend their neck backward by one inch.
B. With the patient standing, flex their neck with the chin toward the chest.
C. With the patient supine, flex the leg at the hip and then extend the knee.

Answer: C

Viral Infections		
Meningitis	Acute aseptic meningitis	Enteroviruses
		Measles (subacute sclerosing panencephalitis)
		Influenza species
		Lymphocytic choriomeningitis virus
Encephalitis	Encephalitic syndromes	Herpes simplex (HSV-1, HSV-2)
		Cytomegalovirus
		Human immunodeficiency virus
		JC polyomavirus (progressive multifocal leukoencephalopathy)
	Arthropod-borne encephalitis	West Nile virus, other arboviruses
Brain stem and spinal cord syndromes	Rhombencephalitis	Rabies
	Spinal poliomyelitis	Polio
		West Nile virus

Aseptic meningitis

Definition

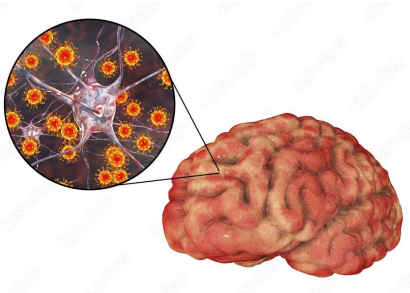
Misnomer, it is a clinical term for an illness comprising meningeal irritation, fever, and alterations of consciousness.The symptoms are usually of an **acute onset without recognizable organisms.**

Clinical course	Self-limiting & **less fulminant** than pyogenic & often treated symptomatically
Most Common Cause	A pathogen is identified in 70% of cases most commonly an **enterovirus.**
CSF	• Increased number of lymphocytes (pleiocytosis). • **Moderate protein elevation.** • **Glucose content is nearly always normal.**

Morphology

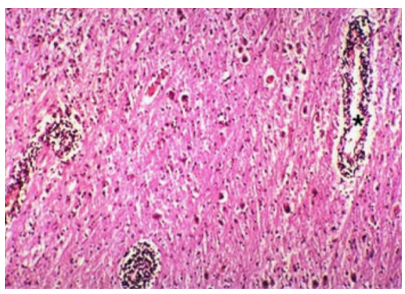
Macroscopic

There are no distinctive **macroscopic** characteristics except for brain swelling, only in some instances.



Microscopic

There is either no recognizable abnormality or a mild to moderate infiltration of the leptomeninges with lymphocytes.
In viral meningitis, clusters of lymphocytes surround cerebral blood vessels.



Herpes Simplex Virus (HSV)

HSV

HSV produces a hemorrhagic meningoencephalitis with inflammation in both the meninges and the brain parenchyma.

HSV-1

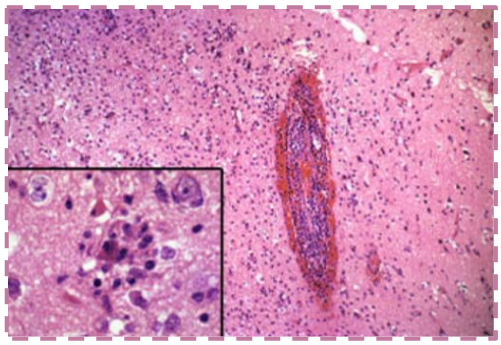
Cause encephalitis may occur in any age group but is most common in children and young adults

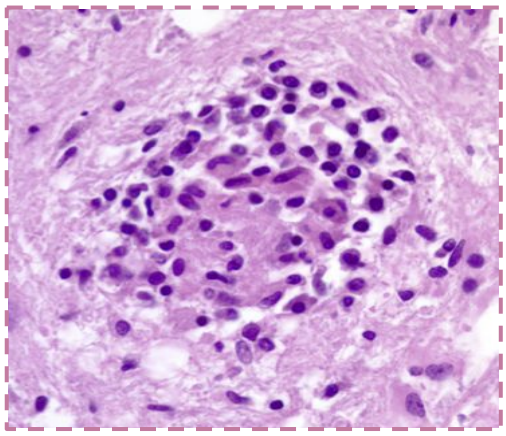
HSV-2

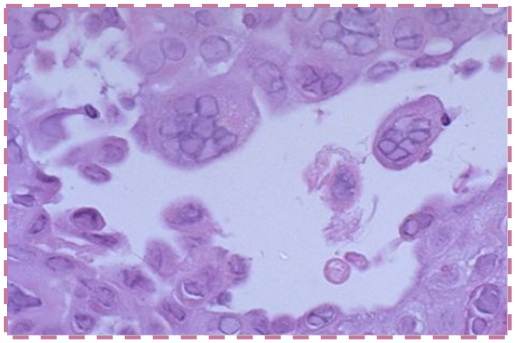
also affects the nervous system, usually in the form of meningitis in adults

Microscopic

- The infection is necrotizing and often hemorrhagic in severely affected regions.
- Perivascular inflammatory infiltrates usually are present.
- The virus directly infects cells in the cerebral cortex, causing necrosis and a glial reaction. This reaction produces a microglial nodule.
- Large eosinophilic intranuclear viral inclusions **(Cowdry type A bodies)** can be found in both neurons and glial cells.
- **Microglial nodule**: activated microglial cells encircle degenerating neurons (neuronophagia) and form clusters around small foci of necrotic brain tissue. Such nodules can be seen also in HIV encephalitis.
- The virus may be identified by H&E stain as viral inclusion, culture or polymerase chain reaction amplification.







Varicella-zoster virus (VZV) Meningitis

1. Varicella-zoster virus (VZV) causes chickenpox during primary infection, usually without any evidence of neurologic involvement.
2. The virus establishes latent infection in neurons of dorsal root ganglia.
3. Reactivation in adults manifests as a painful, vesicular skin eruption in the distribution of one or a few dermatomes (shingles).
4. This usually is a self-limited process, but there may be a persistent pain syndrome in the affected region (postherpetic neuralgia).

Extra INFO

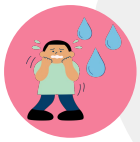
Chickenpox is usually a milder illness that affects children. Shingles results from a reactivation of the virus long after the chickenpox illness has disappeared.

CEREBROSPINAL FLUID	NORMAL	MENINGITIS			
		BACTERIAL	VIRAL	FUNGAL	TUBERCULOUS
OPENING PRESSURE (mm H_2O)	< 200	> 200	> 200	> 200	> 200
WBC COUNT (per mm^3) & DIFFERENTIAL	5 WBCs 70% lymphocyte 30% monocytes few neutrophils	1000s WBCs neutrophilic pleocytosis > 80%	100s WBCs lymphocytic pleocytosis > 50%	100s WBCs mononuclear pleocytosis > 50%	100s WBCs mononuclear pleocytosis > 50%
PROTEIN LEVEL (mg/dL)	15 - 20	100 - 500	15 - 200	15 - 200	100 - 500
GLUCOSE LEVEL (mg/dL)	45 - 100	< 40		< 40	< 40
	$^2/_3$ of serum		normal		
GLUCOSE CSF : SERUM	< 0.4		normal		

RABIES

Rabies is a fatal encephalitis infection transmitted to humans from rabid animals, usually by a bite.

The virus enters the CNS by ascending along the peripheral nerves.



Contracture of the pharyngeal musculature may create an aversion to swallowing even water (hydrophobia).

It progresses to coma and eventually death.

Take Home Messages

- Different pathogens may use distinct routes to reach the brain, and will cause different patterns of disease.
- Bacterial infections may cause meningitis, cerebral abscesses or a chronic meningoencephalitis. Viral infections can cause meningitis or meningoencephalitis.
- Lumbar puncture plays an important role in the diagnostic process of some CNS infections.

Keywords

Acute Pyogenic meningitis	• neonates : E.coli , group B streptococci • Adults : Neisseria meningitidis • older adults: Streptococcus pneumoniae , Listeria monocytogenes • Neck stiffness • Headache • Fever • Increase protein level • reduced glucose levels • exudate
Brain Abscesses	• Streptococci , Staphylococci • bacterial endocarditis • Cyanotic congenital heart disease • Increased ICP • scanty cells • Increase proteins level • Normal glucose • central liquefactive necrosis
Epidural and Subdural infections	• direct local spread. • Epidural abscesses : sinusitis or osteomyelitis. • empyema • Thrombophlebitis : in bridging veins • Headache • Fever • neck stiffness
Tuberculous meningitis	• Malaise • fibrinous exudate • central core of caseous necrosis • Increase mononuclear • elevated protein level • Normal glucose • Tuberculoma • Negative gram stain

Keywords

<table>
<tr><td rowspan="4">Aseptic meningitis</td><td colspan="2">• without recognizable organisms.
• Self-limiting
• enterovirus
• brain swelling
• lymphocytes infiltration
• Elevated protein
• Normal glucose</td></tr>
<tr><td>Herpes Simplex Virus (HSV)</td><td>• Hemorrhagic meningoencephalitis
• Necrosis
• HSV-1 encephalitis : children
• HSV-2 meniginits : adult
• Perivascular inflammatory
• Microglial nodule
• Cowdry type A bodies</td></tr>
<tr><td>Varicella-zoster virus Meningitis (VZV) “HSV”</td><td>• chickenpox
• Dorsal root ganglia
• shingles
• postherpetic neuralgia</td></tr>
<tr><td>Rabies</td><td>• encephalitis infection
• Animal bite
• coma & death</td></tr>
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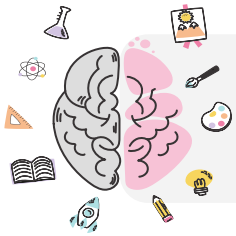


Need a SUMMARY ? Click here

MCQ

Encephalitis with intranuclear Cowdry bodies type A?

A- Arbovirus

B- Arthropod-induced

C- Herpes simplex 1

D- Spirochaetes

What is the main cause of aseptic meningitis?

A- fungi

B- viruses

C- bacteria

D- parasite

Apatientwith TB meningitis a had a well circumscribed intraparenchymal mass,a biopsy was taken from this mess. Which Of the following is most likely to be seen?

A- Lymphocyte & plasma cell

B- Fibrinoid exudate

C- Neutrophils & microglial cell

D- Astrogliosis

A patient died from a stroke. His autopsy showed lymphocytic infiltrate and microglial nodules, what is the diagnosis?

A- VZV meningitis

B- HIV encephalitis

C- Rabies encephalitis

D- Acute Pyogenic meningitis

1-C / 2-B / 3-B / 4-B

MCQ

A Person presented with tuberculous meningitis, what CSF results are expected to show up?

A- High protein low glucose

B- High glucose low protein

C- High protein high glucose

D- Low protein low glucose

A patient with AIDS came to the ER showing symptoms of stiff neck vomiting and fever. He recently travelled to Africa. CSF sample showed normal levels of glucose and protein. microscopy there was microglial nodules with inclusions.CT scan was normal. he was expected to have meninges. What is the possible diagnosis?

A- Aseptic meningitis

B- Rabies encephalitis

C- Herpes encephalitis

D- Paralytic poliomyelitis

What is the morphology of brain abscess?

A- central liquefactive necrosis

B- Fibrinoid necrosis

C- Caseous necrosis

D- Coagulative necrosis

1-A/ 2-C / 3-A

Cases

1.A 32-year-old woman presents with a 2-day history of headache, vomiting, and fever. Physical examination reveals cervical rigidity and knee pain with hip flexion. Lumbar puncture demonstrates an abundance of neutrophils and decreased levels of glucose. Which of the following diseases is most likely associated with these clinical laboratory findings?			
A.Meningococcal meningitis	B.Staphylococcal meningitis	C.Tuberculous meningitis	D.Viral meningitis
2.A 3-day-old infant presents with a fever of 38.7°C (103°F) and convulsions. The infant is started on broad-spectrum antibiotics and antiviral medications but slips into a coma and died. At autopsy, the brain shows a purulent exudate in the subarachnoid space at the base of the brain (shown in the image). What was the most likely cause of suppurative meningitis in this neonate? 			
A.Candida albicans	B.Cryptococcus neoformans	C.Escherichia coli	D.Neisseria meningitidis
3.A 59-year-old woman presents with headache and mild fever of 3 days in duration. On physical examination, the patient appears confused and inattentive. On the following day, she is rushed to the emergency room after suffering a generalized seizure. Lumbar puncture shows increased levels of CSF protein, but cultures are negative, and the white cell count is not elevated. PCR analysis of the CSF fluid shows evidence of herpes simplex type 1. This infection most likely involves which of the following anatomic regions of the patient's brain?			
A.Basal ganglia	B.Brainstem nuclei	C.Temporal lobes	D. None
4.The patient described in Question 3 is started on antiviral medication but becomes increasingly unresponsive and expires. Examination of affected brain tissue at autopsy would most likely reveal which of the following pathologic findings?			
A.Charcot-Bouchard aneurysms	B.Focal plaques of demyelination	C.Neurofibrillary tangles	D.Perivascular cuffs of lymphocytes

1-A / 2-C / 3-C / 4-D

NEED EXPLANATION ? CLICK HERE

Cases

EXTRA CASES REQUIRE EXTRA INFO

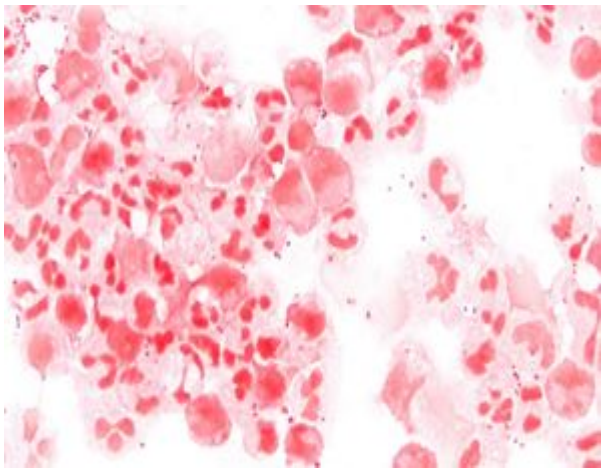
1.An 18-day-old boy is brought to the emergency department due to fever and irritability. The boy was healthy at birth; however, 2-days ago, he developed a fever and decreased appetite. In addition, the patient has become increasingly irritable. Blood testing reveals leukopenia and cerebrospinal fluid (CSF) analysis reveals low glucose concentration and elevated proteins. Gram culture of the blood and CSF is positive for Streptococcus agalactiae. Which of the following is true regarding this pathogen?			
A.Demonstrates sensitivity to bacitracin	B.Produces a factor that enhances Staphylococcus aureus hemolysis on blood agar	C.Produces α-hemolysis on blood agar	D.Produces an enzyme that converts hydrogen peroxide to oxygen and water
2.A 45-year-old man presents to the emergency department due to intense headaches and difficulty with bright lights. The patient developed new genital lesions about a week ago. Brain imaging shows no abnormalities. Lumbar puncture is performed, and the CSF profile shows pleocytosis with a predominance of lymphocytes and a normal CSF glucose concentration. Which is the most likely cause of this patient's condition?			
A.Herpes simplex virus-2	B.Herpes simplex virus-1	C.Cytomegalovirus	D.Cryptococcus
3.A 20-year-old man is brought to the emergency department due to altered mental status and headaches for the past day. His roommate states that he was in his usual state until yesterday, when he started complaining of headaches, fever, and abnormal behavior. Temperature is 38.5°C (101.3°F), pulse is 100/min, and blood pressure is 124/80 mmHg. On physical examination, the patient is lethargic but arousable. The neck is supple with full range of motion. The patient responds to questions, but the speech is incomprehensible. Hyperreflexia is present. MRI of the head shows edema and hyperintensities in the temporal lobes. Which of the following is the most likely explanation for these findings?			
A.Encephalitis	B.Myelitis	C.Aseptic meningitis	D.Meningitis

1-B / 2-A / 3-A

Cases

EXTRA CASES REQUIRE EXTRA INFO

3.A 19-year-old man comes to the emergency department with a severe headache, vomiting, and fever. The patient is a military recruit who is three weeks into bootcamp. His friend states that he appeared normal 12 hours ago. Temperature is 39.5 °C (103.1 °F), pulse is 120/min, respirations are 19/min, and blood pressure is 110/75 mmHg. The patient is markedly disoriented and unable to answer questions. Physical examination shows positive Kernig and Brudzinski signs. Serum glucose concentration is 90 mg/dL. A lumbar puncture is performed, and the cerebrospinal fluid gram stain is shown below:



Cerebrospinal Fluid	Reference Range
Cell count	0-5/mm³
Chloride	118-132 mEq/L
Gamma globulin	3%-12% of total proteins
Glucose	40-70 mg/dL
Pressure	70-180 mm H_2O
Proteins, total	<40 mg/dL

Cerebrospinal fluid analysis is most likely to reveal which of the following sets of findings?

A.

Cell count/mm3	Protein level (mg/dL)	Glucose level (mg/dL)
50	500	20

B.

Cell count/mm3	Protein level (mg/dL)	Glucose level (mg/dL)
1100	300	15

C.

Cell count/mm3	Protein level (mg/dL)	Glucose level (mg/dL)
4	30	50

D.

Cell count/mm3	Protein level (mg/dL)	Glucose level (mg/dL)
70	40	65

The difference between A & B that A CSF analysis is consistent with tuberculosis (TB) meningitis, as characterized by slightly elevated lymphocyte count, markedly elevated protein level, and usually low glucose. Routine bacterial cultures would be negative.

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