

Body Fluids (Milk, CSF, Amniotic Fluid)

BODY FLUIDS

1. MILK

Milk is a complete biological nutrition fluid designed for neonatal survival.

Composition of Human Milk

Water: ~87%

Proteins: ~1–1.5%

Fat: ~3–5%

Lactose: ~7%

Minerals: ~0.2%

Major Components

1. Carbohydrate

- Lactose (major sugar)
- Provides energy
- Enhances calcium absorption

2. Proteins

- Casein

- Lactalbumin
- Lactoglobulin
- Immunoglobulins (IgA)

Human milk has:

More whey protein

Less casein compared to cow's milk

3. Fat

- Triglycerides
 - Essential fatty acids
 - DHA (brain development)
-

4. Minerals

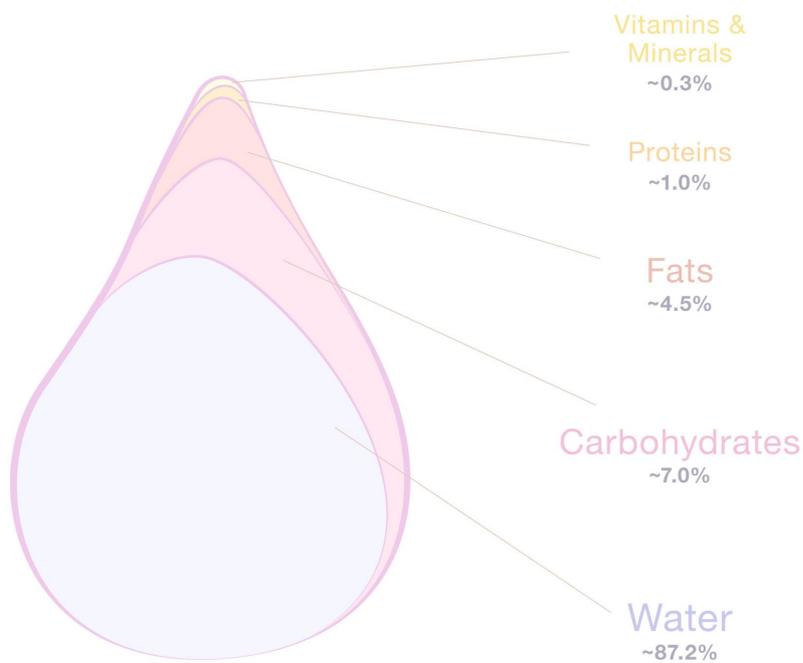
- Calcium
 - Phosphorus
 - Iron (low quantity but highly bioavailable)
-

Protective Factors

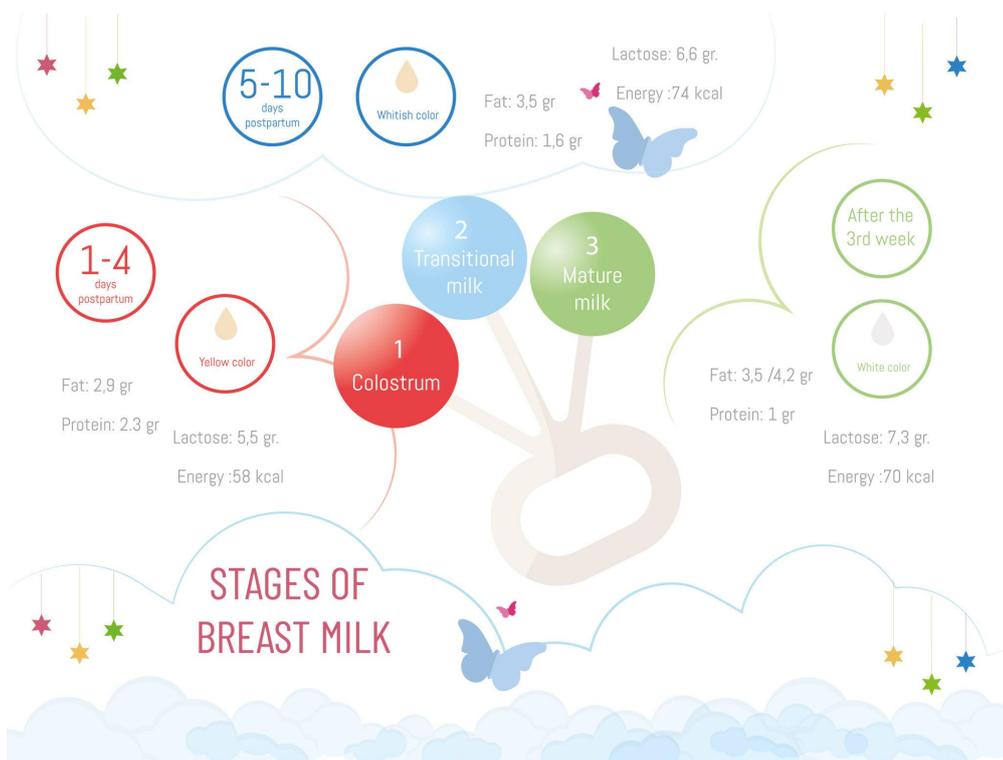
- IgA
- Lactoferrin
- Lysozyme

- Oligosaccharides (prevent bacterial adhesion)

Composition of Breast Milk



<https://www.researchgate.net/publication/346944144/figure/fig1/AS%3A967509645729793%401607683683798/The-structure-of-casein-mi>



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Clinical Significance

- Easily digestible
- Anti-infective
- Promotes gut microbiota
- Lower allergy risk

2. COLOSTRUM

Colostrum is the first milk produced after delivery (first 3–5 days).

Thick, yellowish fluid.

Composition Differences

Higher:

- Protein
- Immunoglobulin (especially IgA)
- Vitamin A

Lower:

- Fat
- Lactose

<https://www.researchgate.net/publication/265213594/figure/tbl6/AS%3A670479702577176%401536866226876/The-milk-maturity-effect-C>



https://www.mdpi.com/nutrients/nutrients-13-01810/article_deploy/html/images/nutrients-13-01810-g001.png

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Functions

- Passive immunity

- Laxative effect (meconium clearance)
- Prevents neonatal jaundice

3. CEREBROSPINAL FLUID (CSF)

Clear, colorless fluid around brain and spinal cord.

Formation

Produced by choroid plexus.

Rate:

? 500 mL/day

Total volume:

? 150 mL

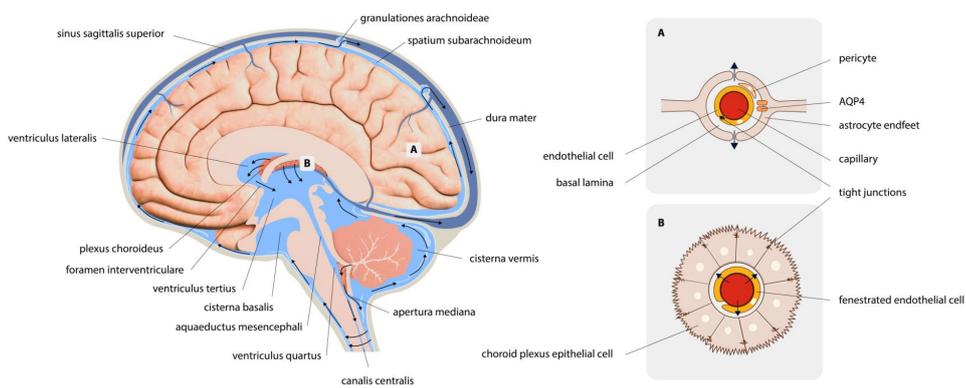
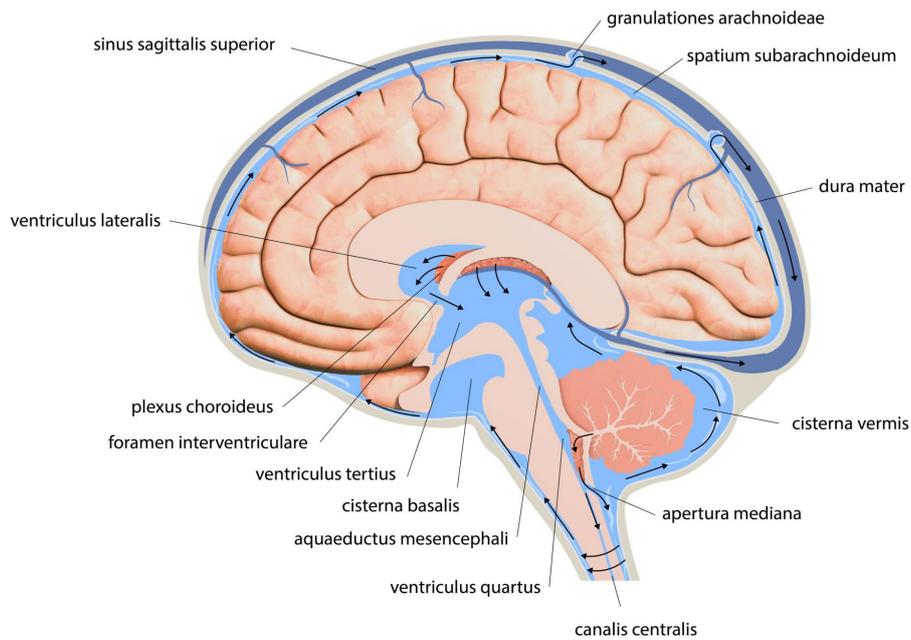
Composition Compared to Plasma

Lower:

- Protein
- Glucose (about 2/3 plasma)
- Potassium

Higher:

- Chloride



<https://www.researchgate.net/profile/Stephen-Hladky/publication/270794560/figure/tb1/AS%3A670324001611783%401536829104272/C>

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Normal Values

Protein: 15–45 mg/dL

Glucose: 45–80 mg/dL

Cells: 0–5 lymphocytes/mm³

Clinical Importance

Bacterial meningitis

- ? Protein
- ? Glucose
- Neutrophils

Viral meningitis

- Normal glucose
- Mild protein rise
- Lymphocytes

4. AMNIOTIC FLUID

Fluid surrounding fetus in amniotic sac.

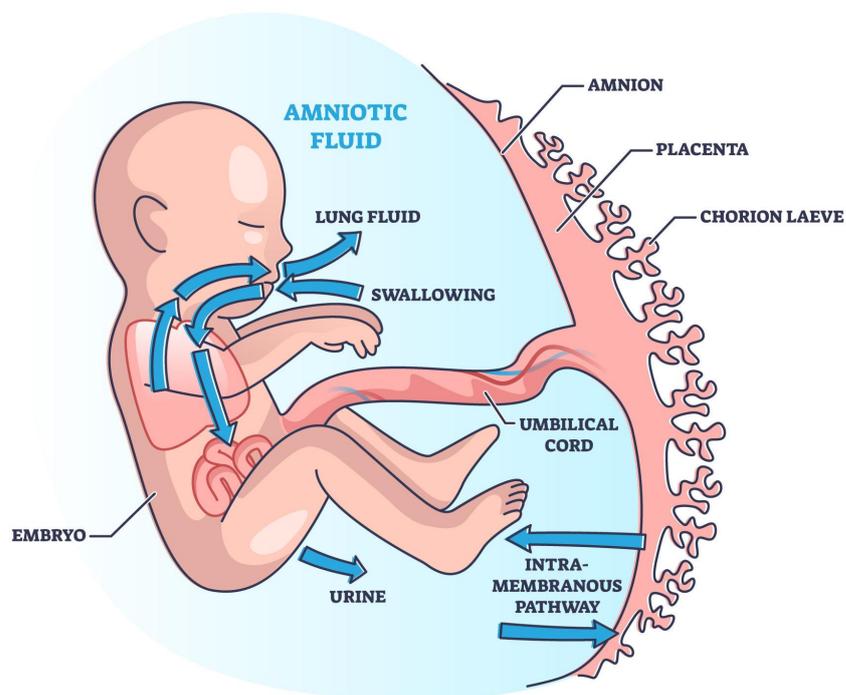
Sources

- Fetal urine
 - Fetal lung secretion
 - Maternal plasma
-

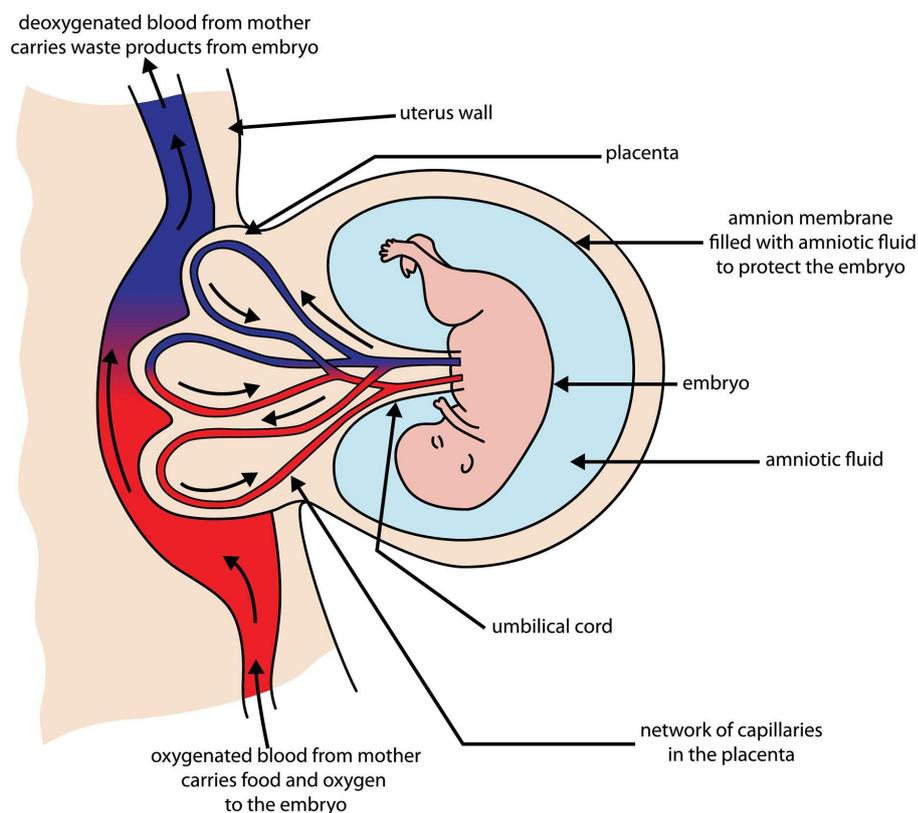
Functions

- Protects fetus
- Maintains temperature
- Allows movement
- Prevents adhesion

FETAL WATER FLOW



The developing embryo in the uterus



<https://www.researchgate.net/profile/Wellington-Martins-4/publication/259825842/figure/tbl2/AS%3A669295986085902%4015365840065>

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Clinical Importance

Oligohydramnios ? renal agenesis

Polyhydramnios ? GI obstruction

Amniocentesis:

- Genetic testing
- Fetal lung maturity (Lecithin/Sphingomyelin ratio)

5. AQUEOUS HUMOR

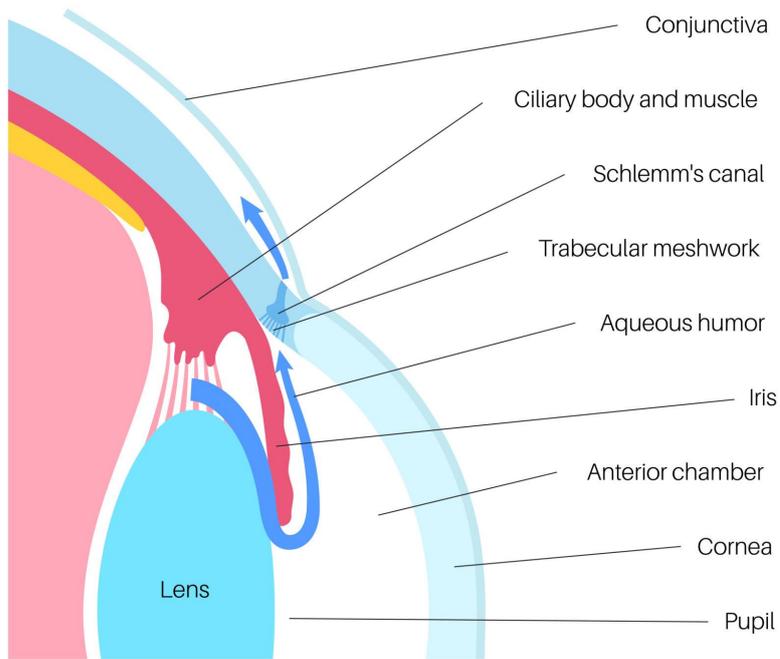
Clear fluid in anterior and posterior chambers of eye.

Formation

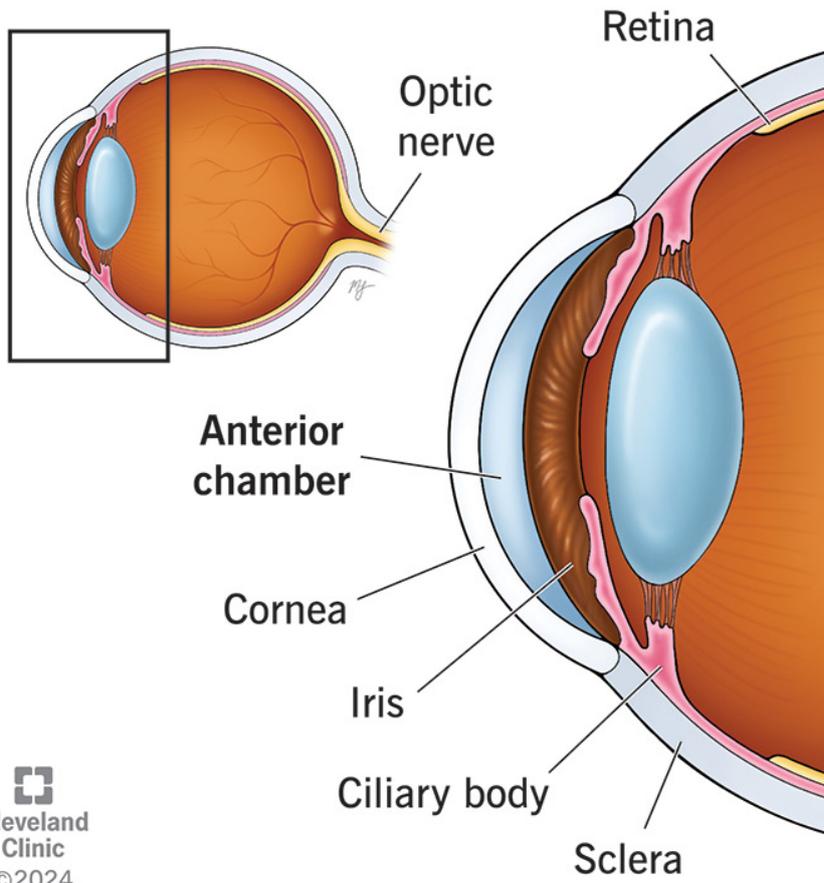
Produced by ciliary body.

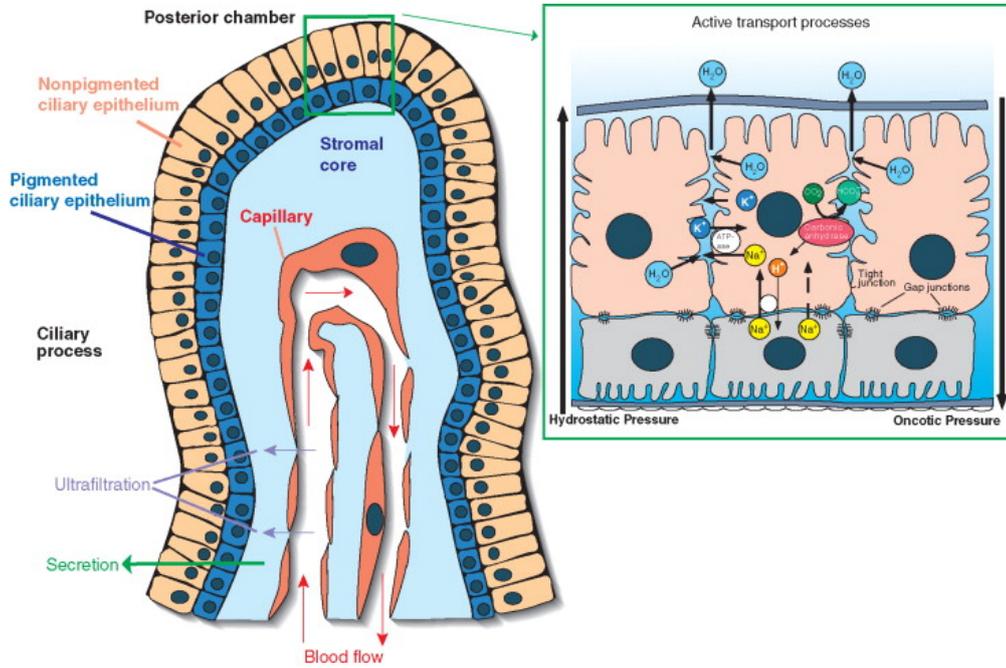
Functions

- Maintains intraocular pressure
- Provides nutrition to cornea & lens
- Removes waste



Anterior chamber





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Composition

Similar to plasma but:

- Low protein
- Low glucose
- Low cells

Clinical Relevance

Glaucoma:

? Intraocular pressure

Due to impaired drainage (trabecular meshwork).

HIGH-YIELD VIVA POINTS

- Colostrum rich in IgA
- CSF glucose ? 2/3 plasma
- Normal CSF protein low
- Amniotic fluid source: fetal urine
- Aqueous humor produced by ciliary body
- Glaucoma due to impaired aqueous drainage

CEREBROSPINAL FLUID (CSF)

Clear, colorless fluid surrounding brain and spinal cord.

Formation

Produced by **choroid plexus** in ventricles.

Rate of formation: ? 500 mL/day

Total volume in adults: ? 150 mL

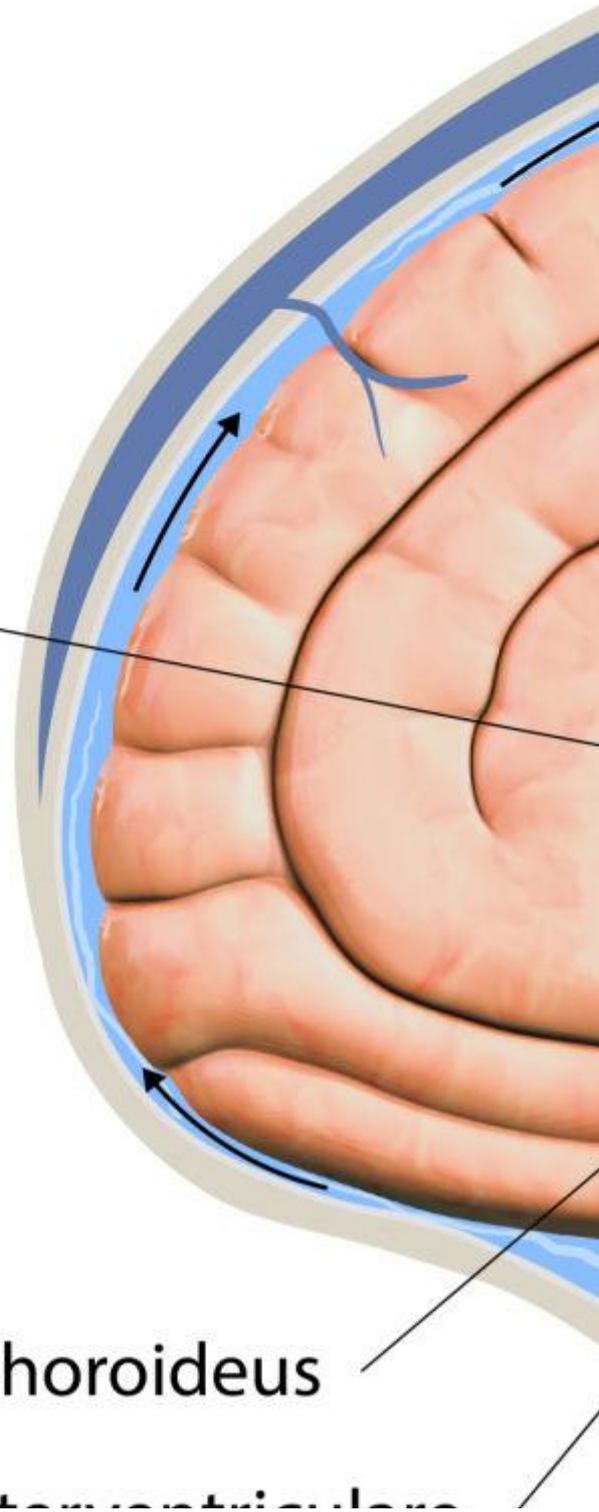
Turnover: ~3–4 times/day

sinus sagittalis superior

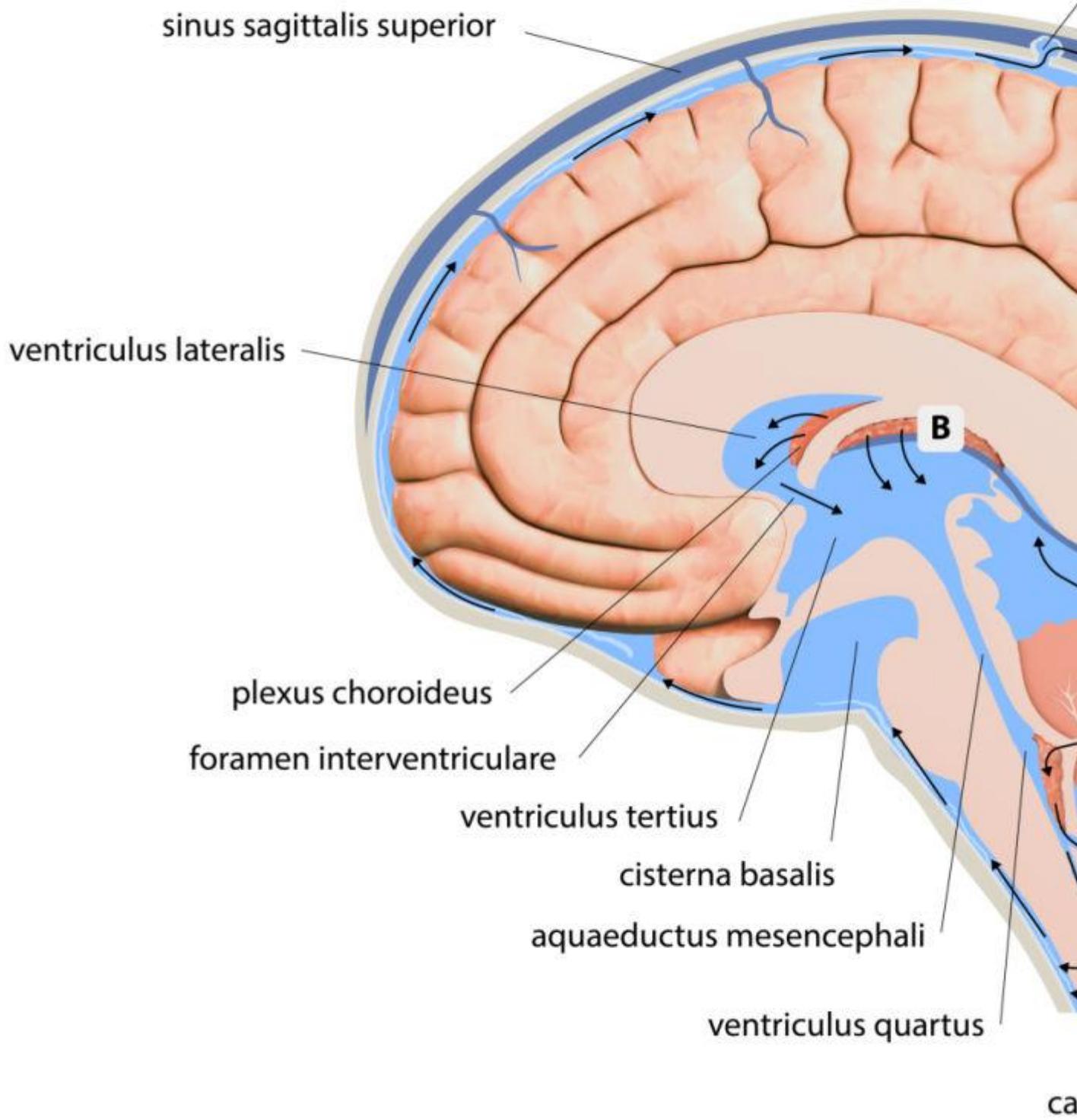
ventriculus lateralis

plexus choroideus

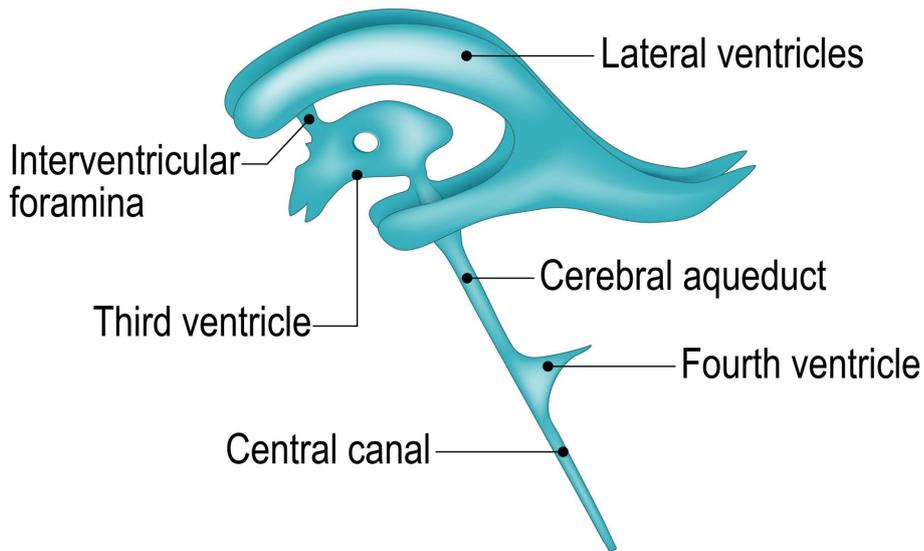
foramen interventriculare



ventriculus



Ventricular system



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Circulation Pathway

Lateral ventricles ? Third ventricle ? Aqueduct of Sylvius ? Fourth ventricle ? Subarachnoid space ? Absorbed via arachnoid villi into venous sinuses.

Functions

- Cushions brain (shock absorber)

- Maintains constant intracranial pressure
- Nutrient supply & waste removal
- Maintains ionic balance for neuronal function

Composition (Compared to Plasma)

PARAMETER	CSF	PLASMA
Protein	Low (15–45 mg/dL)	Higher
Glucose	45–80 mg/dL (~2/3 plasma)	Higher
Chloride	Slightly higher	Slightly lower
Cells	0–5 lymphocytes/mm ³	Many

Low protein due to blood-brain barrier.

Clinical Applications

1. Bacterial Meningitis

- ? Protein
- ? Glucose
- Neutrophils
- Turbid appearance

2. Viral Meningitis

- Mild ? Protein
- Normal glucose
- Lymphocytes

3. Subarachnoid Hemorrhage

- Xanthochromia

4. Guillain-Barré Syndrome

- Albuminocytologic dissociation
(? protein, normal cells)

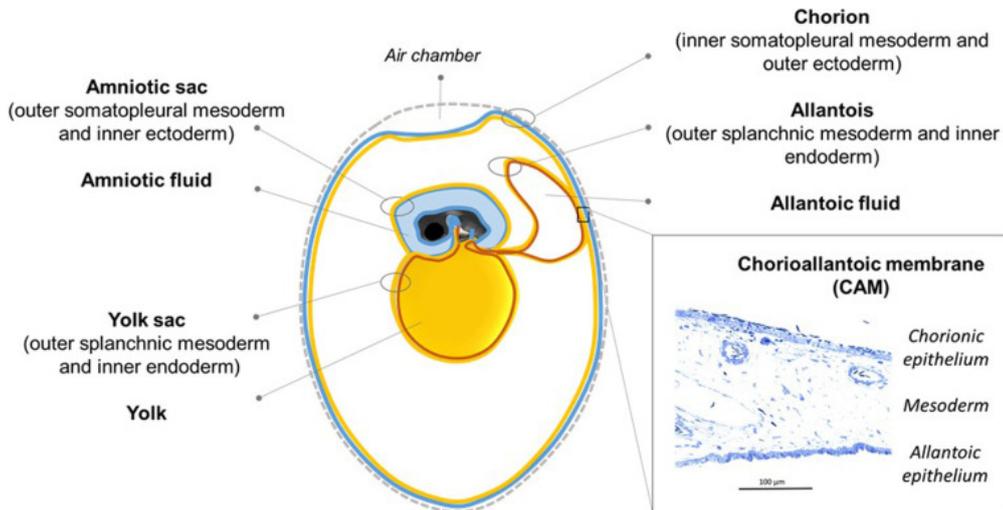
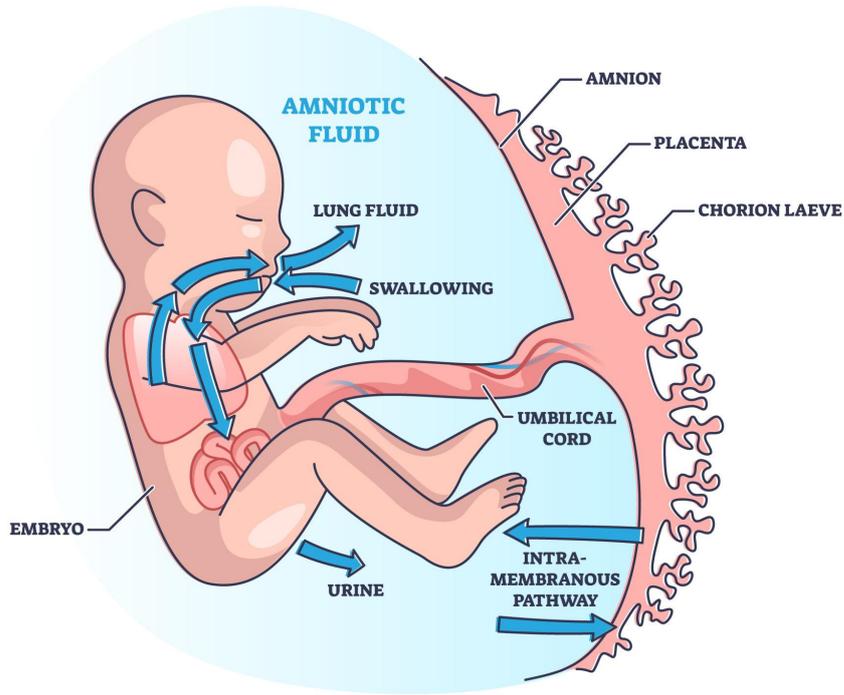
AMNIOTIC FLUID

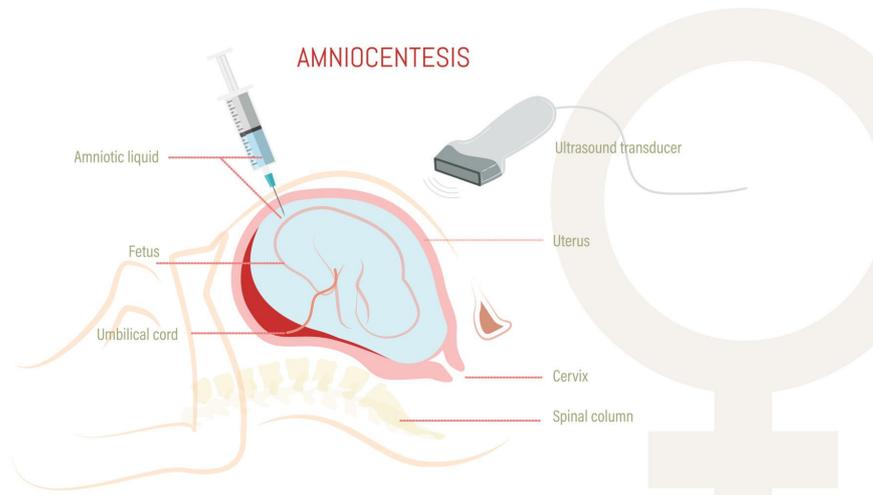
Fluid surrounding fetus within amniotic sac.

Volume:

- ~50 mL at 12 weeks
- ~800–1000 mL at term

FETAL WATER FLOW





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Sources

- Fetal urine (major source in late pregnancy)
- Fetal lung secretions
- Transudation from maternal plasma

Functions

- Protects from trauma
- Maintains temperature

- Allows fetal movement
 - Prevents cord compression
 - Helps lung development
-

Abnormalities

Oligohydramnios

Causes:

- Renal agenesis
- Placental insufficiency
- Post-term pregnancy

Risk:

Pulmonary hypoplasia

Polyhydramnios

Causes:

- GI obstruction (e.g., esophageal atresia)
 - Maternal diabetes
 - Neural tube defects
-

ASSESSMENT OF FETAL MATURITY

Most important clinical test:

Assessment of fetal lung maturity.

1. Lecithin–Sphingomyelin Ratio (L/S Ratio)

Lecithin increases with lung maturity.

Sphingomyelin remains constant.

L/S ratio:

- <1.5 ? Immature lungs
- ≥ 2 ? Mature lungs

Very high-yield exam point.

2. Phosphatidylglycerol

Appears late in pregnancy.

Presence indicates lung maturity.

3. Foam Stability Test (Shake Test)

Amniotic fluid + ethanol ? shake.

Persistent foam ring = adequate surfactant.

4. Lamellar Body Count

Lamellar bodies contain surfactant.

High count = mature lungs.

5. Bilirubin Measurement

Used in hemolytic disease of newborn.

Measured via spectrophotometry (?OD450).

Clinical Relevance

Immature lungs ? Respiratory Distress Syndrome (RDS).

Due to surfactant deficiency.

Surfactant reduces alveolar surface tension.

Main component:

Dipalmityl phosphatidylcholine (DPPC).

High-Yield Viva Points

- CSF glucose = 2/3 plasma
 - CSF protein low due to blood-brain barrier
 - Bacterial meningitis ? ? glucose, ? protein
 - Amniotic fluid major source late pregnancy ? fetal urine
 - L/S ratio ?2 indicates lung maturity
 - Surfactant deficiency ? neonatal RDS
-

CSF protects the brain.

Amniotic fluid protects the fetus.

Surfactant determines the first breath.

BODY FLUIDS – COMPLETE FAQ SET

MILK & COLOSTRUM

Q1. What is the major carbohydrate in human milk?

Lactose.

Q2. What is the main protein fraction in human milk?

Whey proteins (lactalbumin predominates over casein).

Q3. Why is human milk easily digestible?

Lower casein content and higher whey proteins.

Q4. What immunoglobulin is abundant in breast milk?

IgA.

Q5. What is the function of lactoferrin?

Binds iron and inhibits bacterial growth.

Q6. What is colostrum?

First milk secreted during initial 3–5 days after delivery.

Q7. How does colostrum differ from mature milk?

Higher protein and IgA; lower fat and lactose.

Q8. Why is colostrum important for neonate?

Provides passive immunity.

Q9. What is the laxative effect of colostrum useful for?

Expulsion of meconium and prevention of neonatal jaundice.

CEREBROSPINAL FLUID (CSF)

Q10. Where is CSF produced?

Choroid plexus.

Q11. Daily CSF production rate?

About 500 mL/day.

Q12. Total CSF volume in adults?

Approximately 150 mL.

Q13. What is normal CSF protein level?

15–45 mg/dL.

Q14. What is normal CSF glucose?

45–80 mg/dL (~2/3 plasma glucose).

Q15. Why is CSF protein low?

Blood-brain barrier restricts protein passage.

Q16. What is normal CSF cell count?

0–5 lymphocytes/mm³.

Q17. What happens to CSF glucose in bacterial meningitis?

Decreases.

Q18. What happens to CSF protein in meningitis?

Increases.

Q19. What is albuminocytologic dissociation?

High CSF protein with normal cell count (seen in Guillain–Barré syndrome).

Q20. What is xanthochromia?

Yellow discoloration of CSF due to hemoglobin breakdown (subarachnoid hemorrhage).

AMNIOTIC FLUID

Q21. What is the main source of amniotic fluid in late pregnancy?

Fetal urine.

Q22. What is normal amniotic fluid volume at term?

800–1000 mL.

Q23. Functions of amniotic fluid?

Protection, temperature regulation, movement, lung development.

Q24. What is oligohydramnios?

Decreased amniotic fluid.

Q25. Major cause of oligohydramnios?

Renal agenesis.

Q26. What is polyhydramnios?

Increased amniotic fluid.

Q27. Causes of polyhydramnios?

GI obstruction, maternal diabetes, neural tube defects.

ASSESSMENT OF FETAL MATURITY

Q28. Most important indicator of fetal lung maturity?

Lecithin–sphingomyelin (L/S) ratio.

Q29. What L/S ratio indicates maturity?

? 2.

Q30. Why does lecithin increase in late pregnancy?

Increased surfactant production.

Q31. What is the main component of surfactant?

Dipalmityl phosphatidylcholine (DPPC).

Q32. What disease results from surfactant deficiency?

Neonatal respiratory distress syndrome.

Q33. What is phosphatidylglycerol significance?

Presence indicates lung maturity.

Q34. What is foam stability (shake) test?

Test for surfactant presence using ethanol.

Q35. What is lamellar body count?

Measurement of surfactant-containing particles in amniotic fluid.

Q36. What is ?OD450 used for?

Assessment of fetal hemolysis via bilirubin measurement.

AQUEOUS HUMOR

Q37. Where is aqueous humor produced?

Ciliary body.

Q38. Main function of aqueous humor?

Maintains intraocular pressure.

Q39. Why is aqueous humor protein low?

Blood-aqueous barrier restricts protein entry.

Q40. What condition results from impaired drainage?

Glaucoma.

Q41. Through which structure does aqueous humor drain?

Trabecular meshwork into canal of Schlemm.

INTEGRATED QUESTIONS

Q42. Which body fluid has lowest protein concentration?

CSF (among major fluids discussed).

Q43. Which fluid contains high IgA?

Colostrum.

Q44. Which fluid is analyzed for fetal lung maturity?

Amniotic fluid.

Q45. Which fluid maintains brain buoyancy?

CSF.

Q46. Which fluid maintains intraocular pressure?

Aqueous humor.

Q47. Why is CSF glucose measured in meningitis?

Bacteria consume glucose, lowering its level.

Q48. Why is human milk preferred over cow milk?

Better digestibility and immune protection.

Q49. What prevents protein entry into CSF?

Blood-brain barrier.

Q50. What biochemical factor allows neonate's first breath?

Surfactant production.

Ultra-Short Rapid Recall

- CSF glucose = $\frac{2}{3}$ plasma
- CSF protein low
- L/S ratio > 2 = mature lungs
- Colostrum rich in IgA
- Aqueous humor from ciliary body

- Surfactant = DPPC

Body fluids are chemically specialized environments.

Each one is tuned to its purpose — brain protection, fetal development, neonatal immunity, or optical clarity.

BODY FLUIDS – MCQs

1. Total CSF volume in adults is approximately:

- A. 50 mL
 - B. 100 mL
 - C. 150 mL
 - D. 500 mL
-

2. Daily CSF production is about:

- A. 100 mL
 - B. 250 mL
 - C. 500 mL
 - D. 1000 mL
-

3. CSF is mainly produced by:

- A. Pia mater
 - B. Arachnoid villi
 - C. Choroid plexus
 - D. Hypothalamus
-

4. CSF glucose level is approximately:

- A. Equal to plasma
 - B. Half plasma
 - C. Two-thirds plasma
 - D. One-third plasma
-

5. Normal CSF protein:

- A. 1–5 mg/dL
 - B. 15–45 mg/dL
 - C. 60–100 mg/dL
 - D. 150 mg/dL
-

6. CSF protein is low due to:

- A. High metabolism
 - B. Dilution
 - C. Blood-brain barrier
 - D. Low synthesis
-

7. Decreased CSF glucose is seen in:

- A. Viral meningitis
 - B. Bacterial meningitis
 - C. Multiple sclerosis
 - D. Guillain–Barré syndrome
-

8. Albuminocytologic dissociation is seen in:

- A. Bacterial meningitis
 - B. Viral meningitis
 - C. Guillain–Barré syndrome
 - D. Tuberculosis
-

9. Xanthochromia indicates:

- A. Viral infection
 - B. Subarachnoid hemorrhage
 - C. Hypoglycemia
 - D. Tumor
-

10. Major source of amniotic fluid in late pregnancy:

- A. Maternal sweat
 - B. Fetal urine
 - C. Placenta
 - D. Liver
-

11. Normal amniotic fluid volume at term:

- A. 200 mL
 - B. 400 mL
 - C. 800–1000 mL
 - D. 2000 mL
-

12. Oligohydramnios is commonly due to:

- A. Esophageal atresia
 - B. Renal agenesis
 - C. Maternal diabetes
 - D. Neural tube defect
-

13. Polyhydramnios may occur in:

- A. Renal agenesis
 - B. GI obstruction
 - C. Dehydration
 - D. Hypothyroidism
-

14. The most reliable indicator of fetal lung maturity:

- A. Bilirubin level
 - B. Protein content
 - C. L/S ratio
 - D. Glucose
-

15. L/S ratio indicating lung maturity:

- A. 1
 - B. 1.5
 - C. 2 or more
 - D. 3
-

16. Major component of pulmonary surfactant:

- A. Cholesterol
 - B. Phosphatidylcholine
 - C. Triglyceride
 - D. Glycogen
-

17. Respiratory distress syndrome occurs due to deficiency of:

- A. Albumin
 - B. Lecithin
 - C. Cholesterol
 - D. Hemoglobin
-

18. Foam stability test assesses:

- A. Bilirubin
 - B. Surfactant
 - C. Glucose
 - D. Protein
-

19. Presence of phosphatidylglycerol indicates:

- A. Infection
 - B. Hemolysis
 - C. Lung maturity
 - D. Placental failure
-

20. ?OD450 measurement is used to detect:

- A. Glucose
 - B. Protein
 - C. Bilirubin
 - D. Lecithin
-

21. Major carbohydrate in human milk:

- A. Sucrose
 - B. Maltose
 - C. Lactose
 - D. Fructose
-

22. Immunoglobulin abundant in colostrum:

- A. IgG
 - B. IgM
 - C. IgA
 - D. IgE
-

23. Colostrum differs from mature milk by:

- A. Lower protein
 - B. Higher fat
 - C. Higher immunoglobulins
 - D. Lower vitamins
-

24. Whey proteins are more abundant in:

- A. Cow milk
 - B. Human milk
 - C. Plasma
 - D. CSF
-

25. Lactoferrin function:

- A. Digest lactose
 - B. Bind iron
 - C. Bind glucose
 - D. Bind sodium
-

26. Aqueous humor is produced by:

- A. Retina
 - B. Lens
 - C. Ciliary body
 - D. Iris
-

27. Aqueous humor maintains:

- A. Brain pressure
 - B. Intraocular pressure
 - C. Plasma osmolality
 - D. Blood pressure
-

28. Glaucoma is due to:

- A. Increased CSF
 - B. Decreased protein
 - C. Impaired aqueous drainage
 - D. Retinal damage
-

29. Aqueous humor drains via:

- A. Optic nerve
 - B. Canal of Schlemm
 - C. Retina
 - D. Lens
-

30. CSF chloride is:

- A. Lower than plasma
 - B. Equal to plasma
 - C. Slightly higher than plasma
 - D. Absent
-

31. Main function of CSF:

- A. Nutrient storage
 - B. Oxygen transport
 - C. Shock absorption
 - D. Fat digestion
-

32. CSF cell count normally:

- A. 50–100
 - B. 10–20
 - C. 0–5
 - D. 100–200
-

33. Human milk fat provides:

- A. Antibody
 - B. Immunity
 - C. Energy
 - D. Sodium
-

34. In bacterial meningitis CSF is:

- A. Clear
 - B. Turbid
 - C. Colorless
 - D. Yellow
-

35. In viral meningitis CSF glucose is:

- A. Very low
 - B. Normal
 - C. Absent
 - D. High
-

36. Amniocentesis is used for:

- A. CSF removal
 - B. Lung maturity assessment
 - C. Eye pressure
 - D. Milk analysis
-

37. Main function of amniotic fluid:

- A. Digestion
 - B. Brain nutrition
 - C. Protection of fetus
 - D. Immunity
-

38. Blood-brain barrier mainly restricts:

- A. Sodium
 - B. Chloride
 - C. Protein
 - D. Water
-

39. Surfactant reduces:

- A. Osmotic pressure
 - B. Surface tension
 - C. Blood pressure
 - D. Sodium
-

40. Neonatal jaundice prevention by colostrum is due to:

- A. High fat
 - B. Laxative effect
 - C. Sodium
 - D. Protein
-

ANSWER KEY

1. C

2. C

3. C

4. C

5. B

6. C

7. B

8. C

9. B

10. B

11. C

12. B

13. B

14. C

15. C

16. B

17. B

- 18. B
- 19. C
- 20. C
- 21. C
- 22. C
- 23. C
- 24. B
- 25. B
- 26. C
- 27. B
- 28. C
- 29. B
- 30. C
- 31. C
- 32. C
- 33. C
- 34. B
- 35. B
- 36. B

37. C

38. C

39. B

40. B

These fluids are small-volume, high-importance systems.
Miss one biochemical parameter, and diagnosis shifts entirely.

BODY FLUIDS – VIVA VOCE

(CSF, Amniotic Fluid, Fetal Maturity, Milk, Colostrum, Aqueous Humor)

CEREBROSPINAL FLUID (CSF)

Q1. Where is CSF produced?

Choroid plexus of ventricles.

Q2. Daily CSF production?

About 500 mL per day.

Q3. Total CSF volume in adults?

Approximately 150 mL.

Q4. Normal CSF protein level?

15–45 mg/dL.

Q5. Why is CSF protein low?

Due to blood-brain barrier restriction.

Q6. CSF glucose level compared to plasma?

About two-thirds of plasma glucose.

Q7. Normal CSF cell count?

0–5 lymphocytes/mm³.

Q8. What happens to CSF glucose in bacterial meningitis?

It decreases.

Q9. What happens to CSF protein in meningitis?

It increases.

Q10. What is albuminocytologic dissociation?

High protein with normal cell count (seen in Guillain–Barré syndrome).

Q11. What is xanthochromia?

Yellow discoloration of CSF due to hemoglobin breakdown.

Q12. Why is chloride slightly higher in CSF?

Due to active transport and ionic regulation across blood-brain barrier.

AMNIOTIC FLUID

Q13. Main source of amniotic fluid in late pregnancy?

Fetal urine.

Q14. Normal volume at term?

800–1000 mL.

Q15. Main functions of amniotic fluid?

Protection, movement, lung development, temperature control.

Q16. What is oligohydramnios?

Decreased amniotic fluid.

Q17. Common cause of oligohydramnios?

Renal agenesis.

Q18. What is polyhydramnios?

Excess amniotic fluid.

Q19. Cause of polyhydramnios in fetal GI obstruction?

Failure of fetus to swallow amniotic fluid.

Q20. What is amniocentesis?

Sampling of amniotic fluid for diagnostic purposes.

ASSESSMENT OF FETAL MATURITY

Q21. Most important test for lung maturity?

Lecithin–sphingomyelin (L/S) ratio.

Q22. What L/S ratio indicates maturity?

Two or more.

Q23. Why does lecithin increase near term?

Due to increased surfactant synthesis.

Q24. Main component of pulmonary surfactant?

Dipalmityl phosphatidylcholine.

Q25. Disease due to surfactant deficiency?

Neonatal respiratory distress syndrome.

Q26. What does presence of phosphatidylglycerol indicate?

Lung maturity.

Q27. What is the foam stability (shake) test?

A test for surfactant presence using ethanol.

Q28. What does ?OD450 measure?

Bilirubin in amniotic fluid (hemolytic disease).

MILK & COLOSTRUM

Q29. Major carbohydrate in human milk?

Lactose.

Q30. Major immunoglobulin in colostrum?

IgA.

Q31. Why is colostrum yellow?

High protein and beta-carotene content.

Q32. How does colostrum differ from mature milk?

Higher protein and antibodies, lower fat and lactose.

Q33. What is the function of lactoferrin?

Binds iron and inhibits bacterial growth.

Q34. Why is human milk preferred over cow's milk?

Better digestibility and immune protection.

Q35. What type of protein predominates in human milk?

Whey proteins.

AQUEOUS HUMOR

Q36. Where is aqueous humor produced?

Ciliary body.

Q37. Function of aqueous humor?

Maintains intraocular pressure and nourishes cornea and lens.

Q38. Why is protein low in aqueous humor?

Due to blood-aqueous barrier.

Q39. Through which structure does aqueous humor drain?

Trabecular meshwork into canal of Schlemm.

Q40. What happens if drainage is impaired?

Glaucoma.

INTEGRATED EXAMINER QUESTIONS

Q41. Which fluid has lowest protein concentration?

CSF.

Q42. Which fluid protects brain from mechanical injury?

CSF.

Q43. Which fluid helps fetal lung development?

Amniotic fluid.

Q44. Which test predicts neonatal respiratory function?

L/S ratio.

Q45. Why does bacterial meningitis lower CSF glucose?

Bacteria consume glucose.

Q46. Why is colostrum important immediately after birth?

Provides passive immunity.

Q47. What prevents large proteins from entering CSF?

Blood-brain barrier.

Q48. Why does surfactant prevent alveolar collapse?

Reduces surface tension.

Q49. Which fluid maintains optical clarity of anterior chamber?

Aqueous humor.

Q50. Which fluid change suggests hemolytic disease of fetus?

Raised bilirubin in amniotic fluid.