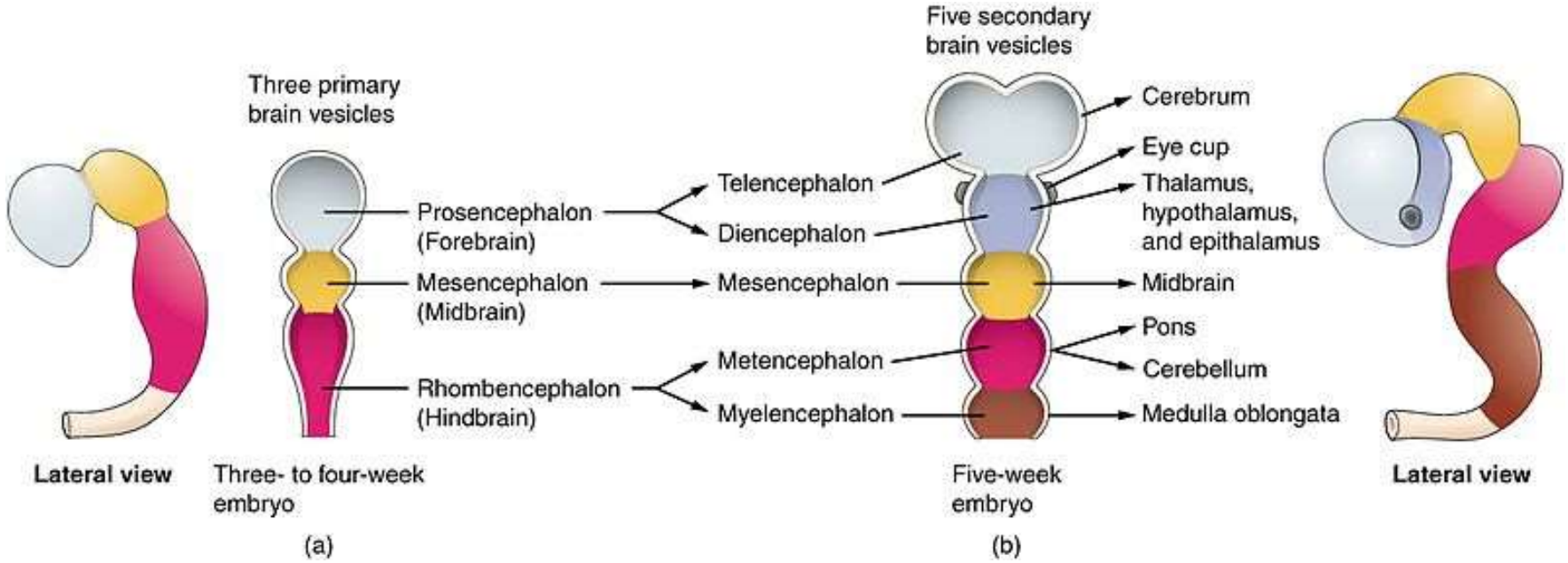
Central Nervous System Module - I

2nd Year MBBS(LGIS)

Early Development of Central Nervous System



Presenter: Prof. Dr. Ifra Saeed

Date: 00-00-25

First Ten Minutes

Prof. Umar's Model of Teaching Strategy

Self Directed Learning Assessment Program

Objectives :To cultivate critical thinking, analytical reasoning, and problem-solving competencies.

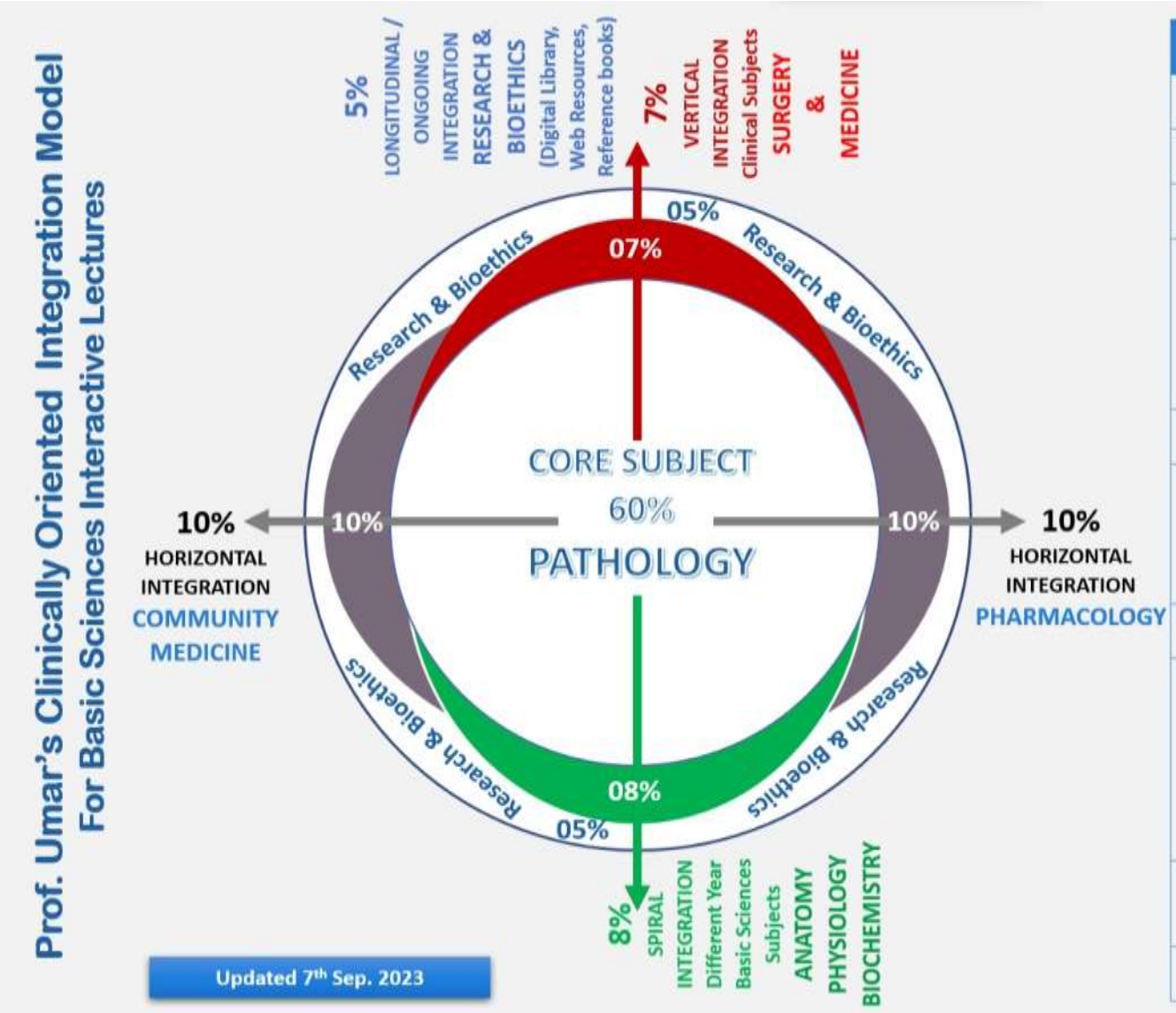
To instill a culture of self-directed learning, fostering lifelong learning habits and autonomy.

How to Assess?

- Ten randomly selected students will be evaluated within the **first 10 minutes of the lecture** through 10 multiple-choice questions (MCQs) based on the PowerPoint presentation shared on Students Official WhatsApp group, one day before the teaching session.
- The number of MCQs from the components of the lecture will follow the guidelines outlined in the **Prof. Umar model of Integrated Lecture**.

Component of LGIS	Core Knowledge	Horizontal Integration	Vertical Integration	Spiral Integration
No of MCQs	6–7	1-2	1	1

Professor Umar Model of Integrated Lecture



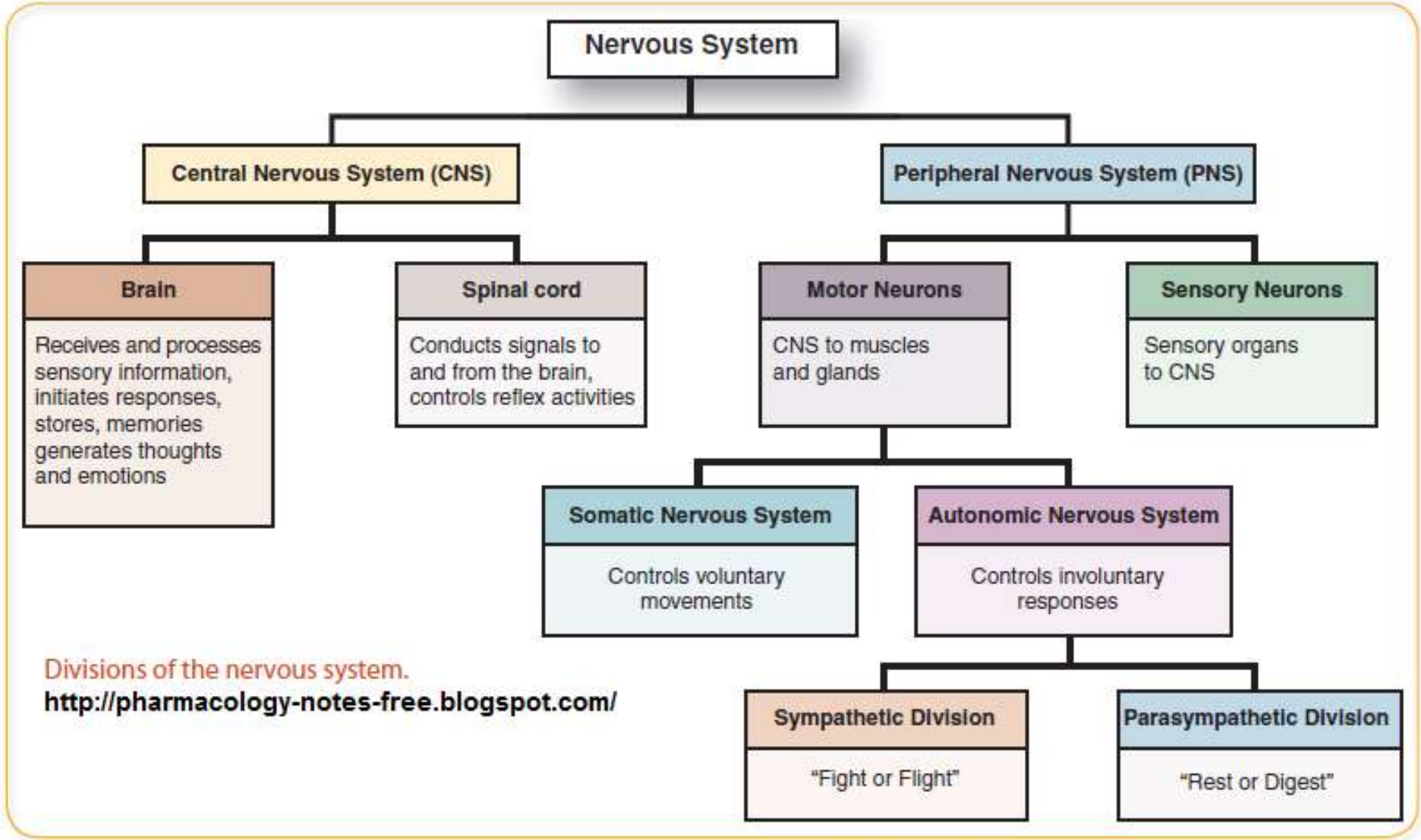
Model 3rd Year Pathology LGIS (≈30 slides)	
Core Subject – 60% (≈ 18-20 slides)	
Pathology (≈ 18-20 slides)	
Horizontal Integration – 20% (≈ 5-6 slides)	
Same Year Subjects	• Pharmacology (10%) (≈ 2-3 slides) • Community Medicine (10%) (≈ 2-3 slides)
Vertical Integration – 07% (≈ 2-3 slides)	
Clinical Subjects	• Medicine (3-5%) (≈ 1-2 slides) • Surgery (3-5%) (≈ 1-2 slides)
Spiral Integration – 08% (≈ 2-3 slides)	
Different Year Basic Sciences Subjects	• Anatomy (1-3%) (≈ 1-2 slides) • Physiology (1-3%) (≈ 1-2 slides) • Biochemistry (1-3%) (≈ 1-2 slides)
Longitudinal / Ongoing Integration – 05% (≈ 1-2 slides)	
Research & Bioethics (≈ 1-2 slides)	

Learning Objectives

At the end of the session, student will be able to

- Describe Early development of CNS
- Discuss process of neurulation
- Discuss congenital abnormalities
- Integrate physiological and biochemical aspects with development of CNS
- Approach towards patient of spina bifida
- Correlate and build core knowledge on the basis of latest research
- Role of artificial intelligence
- Bioethics related to patients of spina bifida

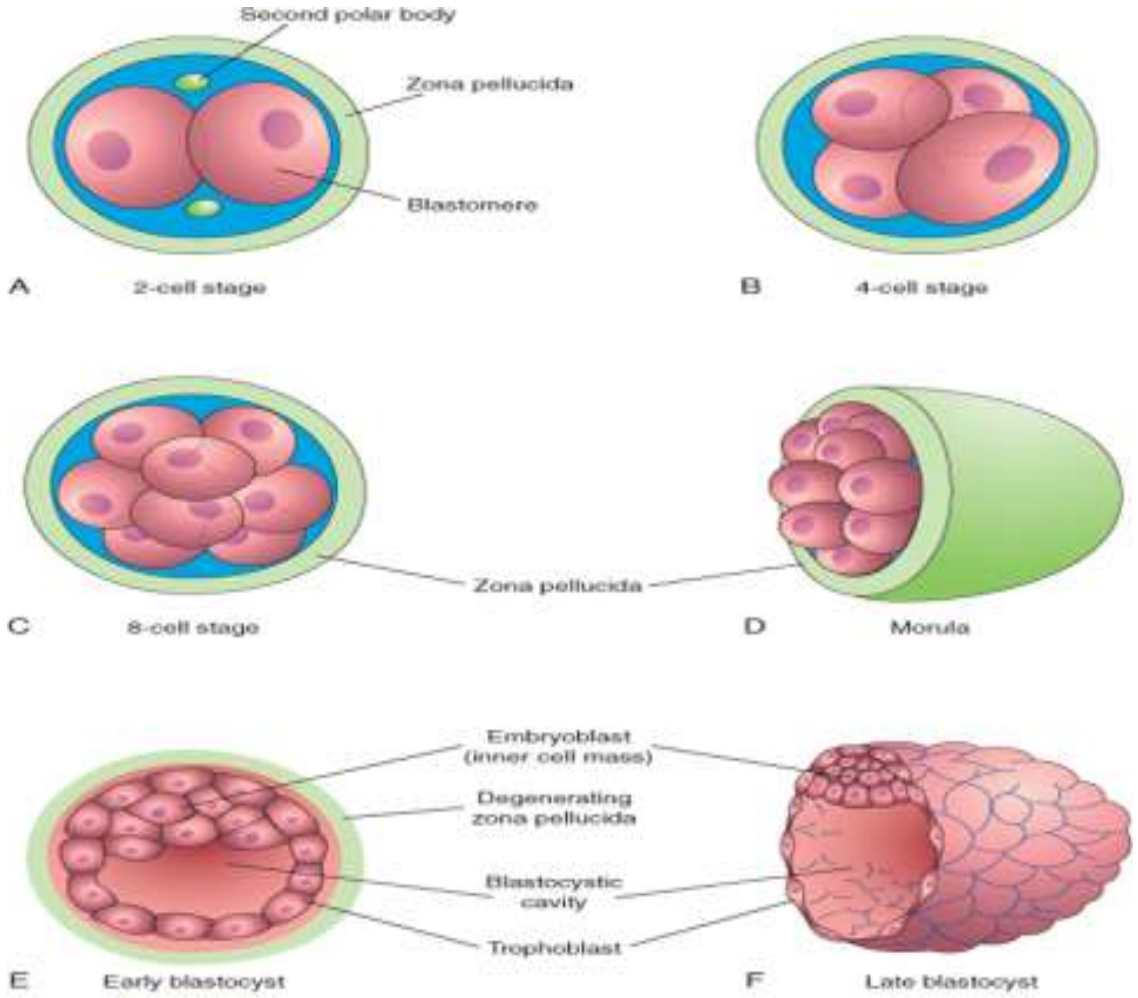
Central Nervous System

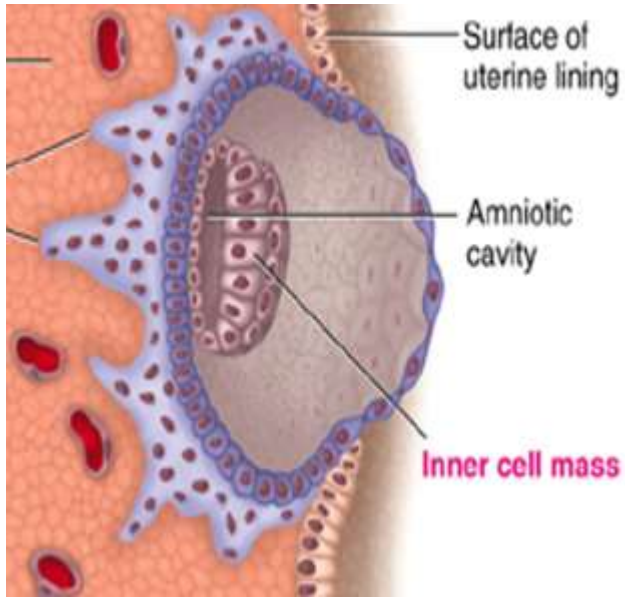


Divisions of the nervous system.
http://pharmacology-notes-free.blogspot.com/

Core Concept

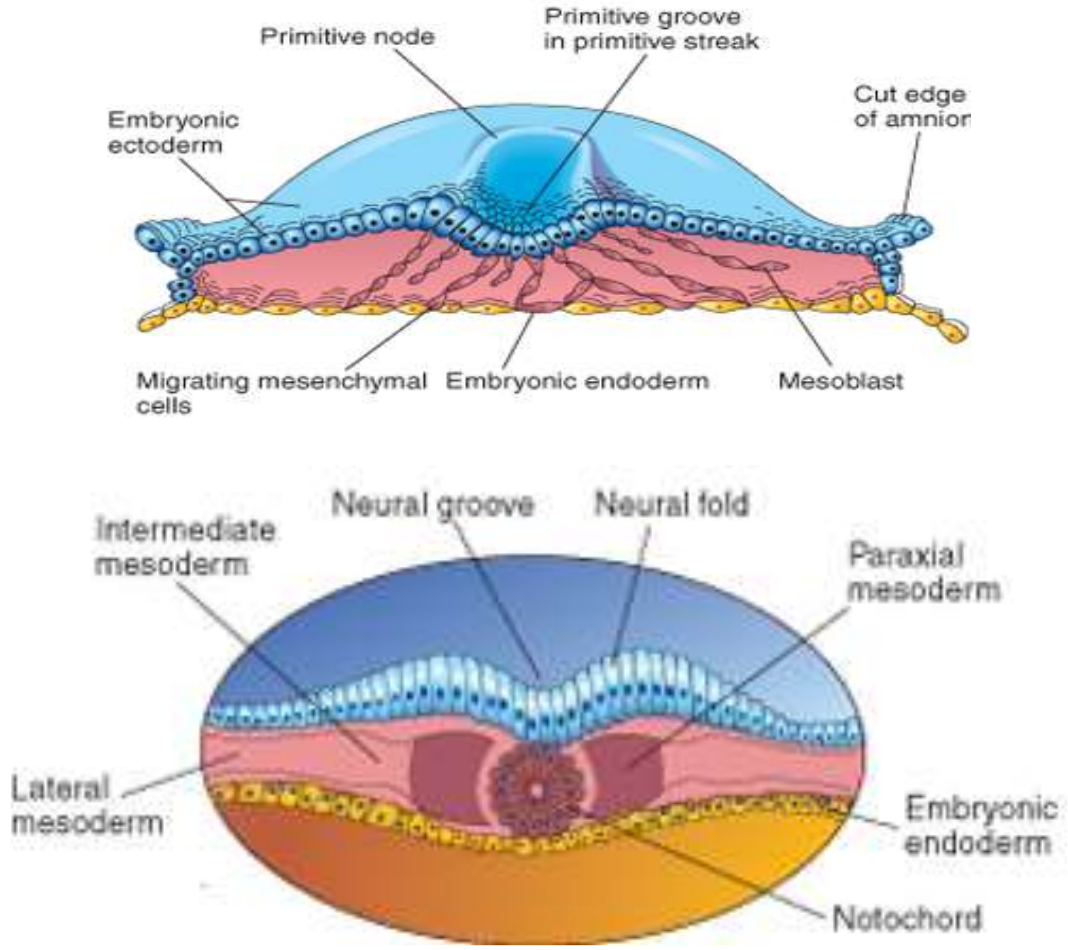
Early Development





Core Concept

Gastrulation and Formation of Three Germ Layers

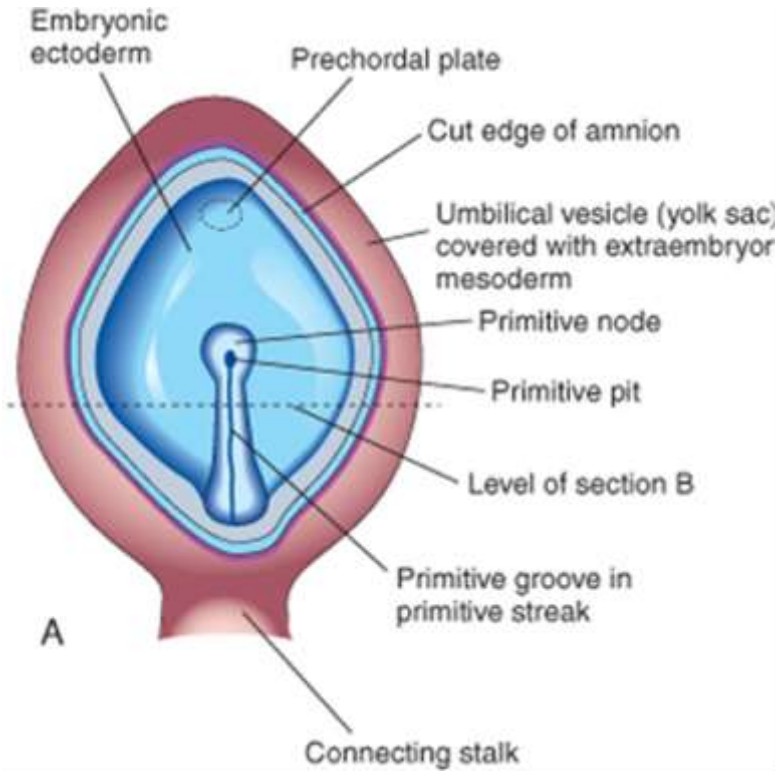


Core Concept

Early development of CNS

- At the beginning of the third week, an opacity formed by a thickened linear band of epiblast- the primitive streak-appears caudally in the median plane of the dorsal aspect of the embryonic disc

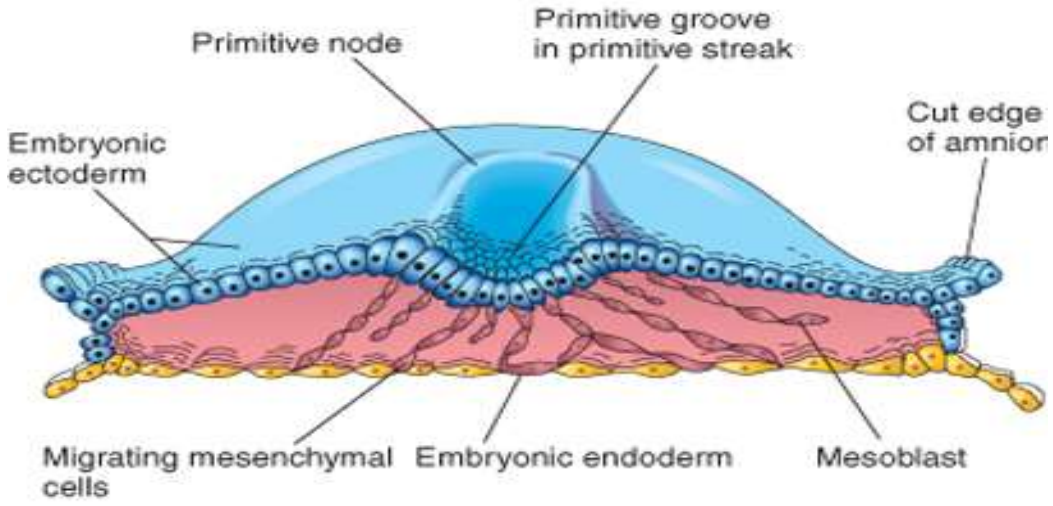
- As the streak elongates by addition of cells to its caudal end, its cranial end proliferates to form a primitive node



Core Concept

Primitive Streak

The primitive streak results from the proliferation and movement of cells of the epiblast to the median plane of the embryonic disc.

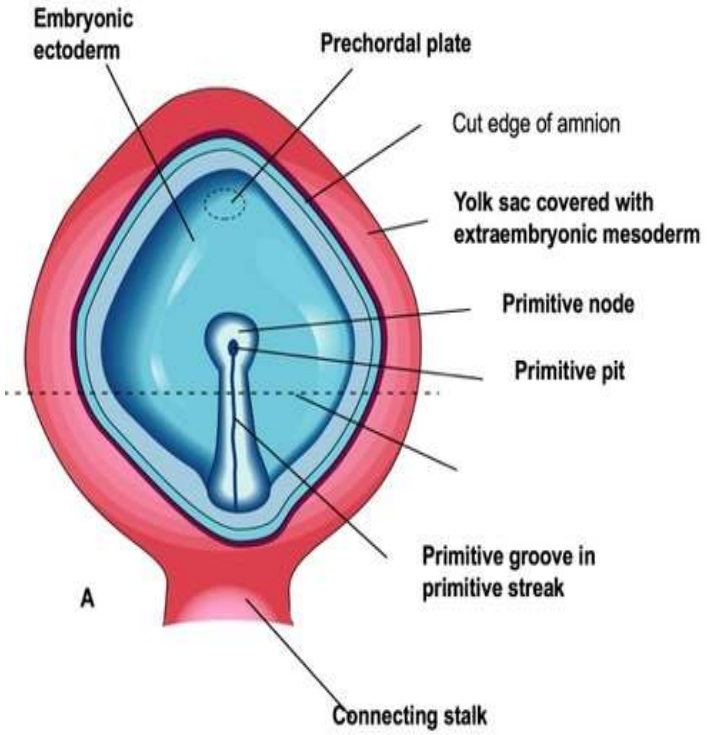


Core Concept

Primitive Groove

- A narrow groove-primitive groove- develops in the primitive streak that is continuous with a small depression in the primitive node-the primitive pit.

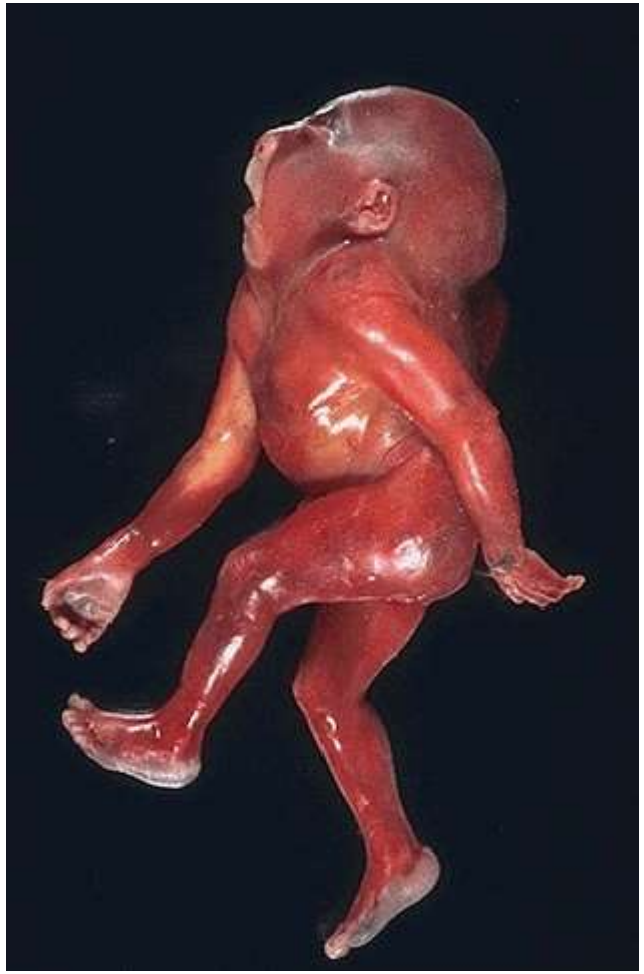
- The primitive groove and pit result from the invagination (inward movement) of epiblastic cells.



Core Concept

Iniencephaly

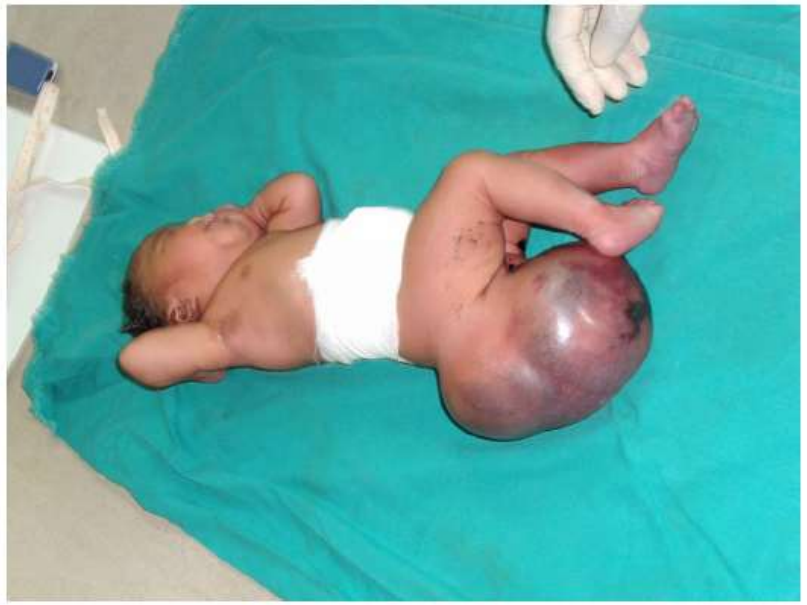
- Iniencephaly is a rare neural tube defect that results in extreme bending of the head to the spine.
- The diagnosis can usually be made on antenatal ultrasound scanning, but if not will undoubtedly be made immediately after birth because the head is bent backwards and the face looks upwards. Usually the neck is absent. The skin of the face connects directly to the chest and the scalp connects to the upper back. The infant will usually not survive more than a few hours.



Core Concept

Fate Of Primitive Streak

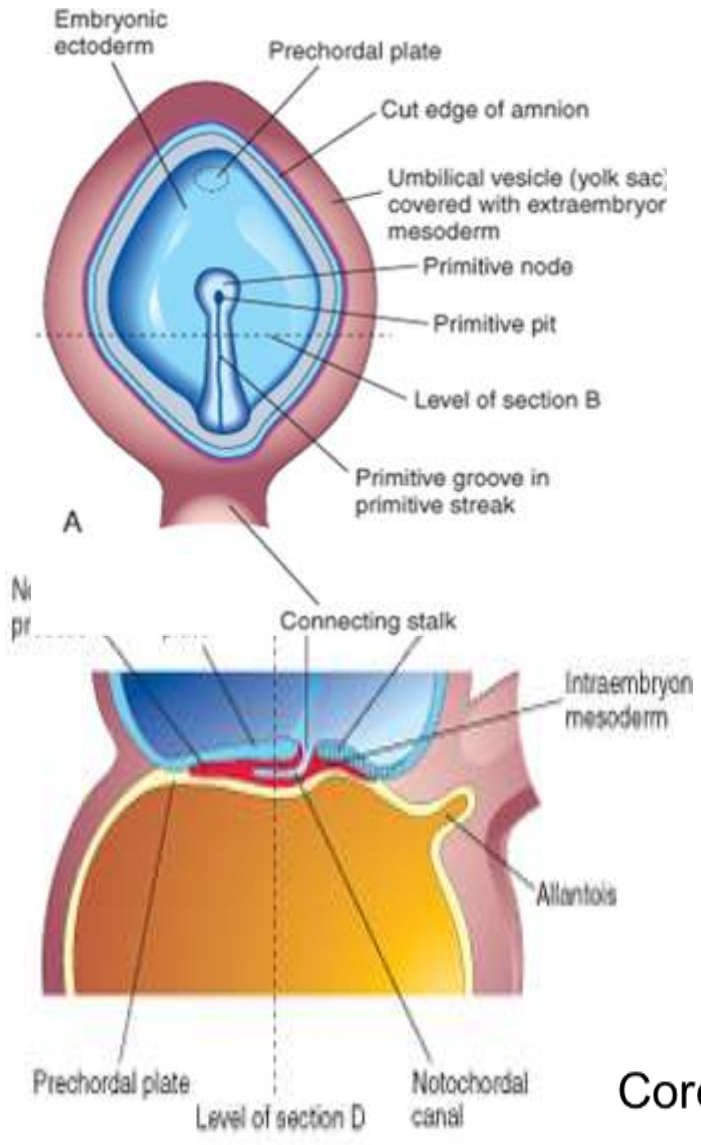
- Primitive streak actively form the mesoderm by the ingression of cells until the early part of 4th week thereafter production of mesoderm slows down.
- Primitive streak diminishes in size and become insignificant structure in sacrococcygeal region and **disappear by the end of fourth week**
- **Sacrococcygeal teratoma**: incidence is 1 in 35000
- 80% are females



Core Concept

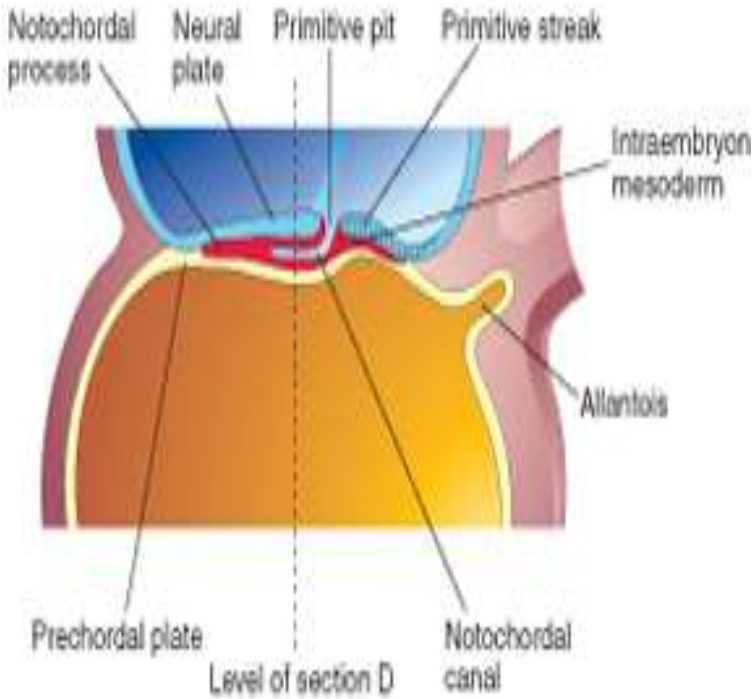
Formation Of Notochord

Some mesenchymal cells that have ingressed through the streak and, as a consequence, acquired mesodermal cell fates migrate cranially from the primitive node and pit, forming a median cellular cord, the **notochordal process**



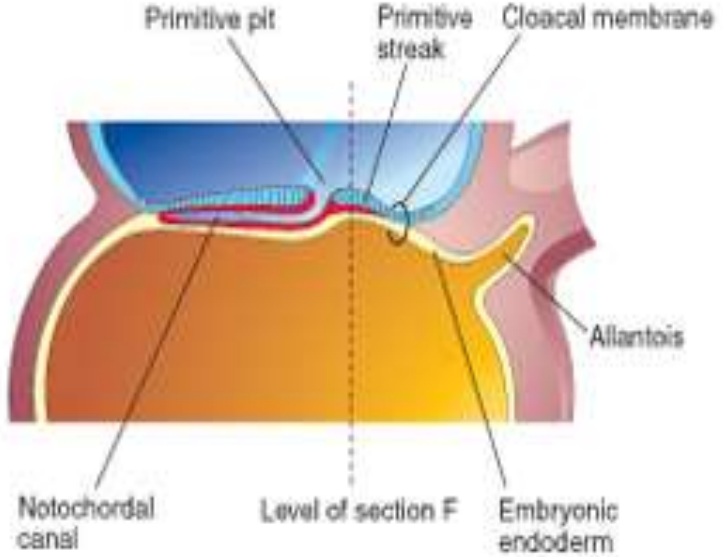
Core Concept

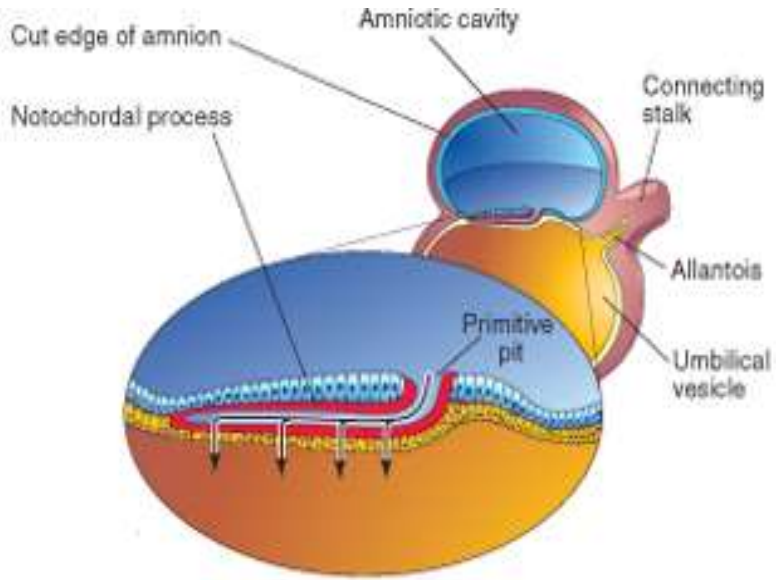
- Formation of notochordal canal
- Extent of notochordal process(from prechordal plate to pit)
- Significance of prechordal plate
- By the middle of the third month three sites without mesoderm



Core Concept

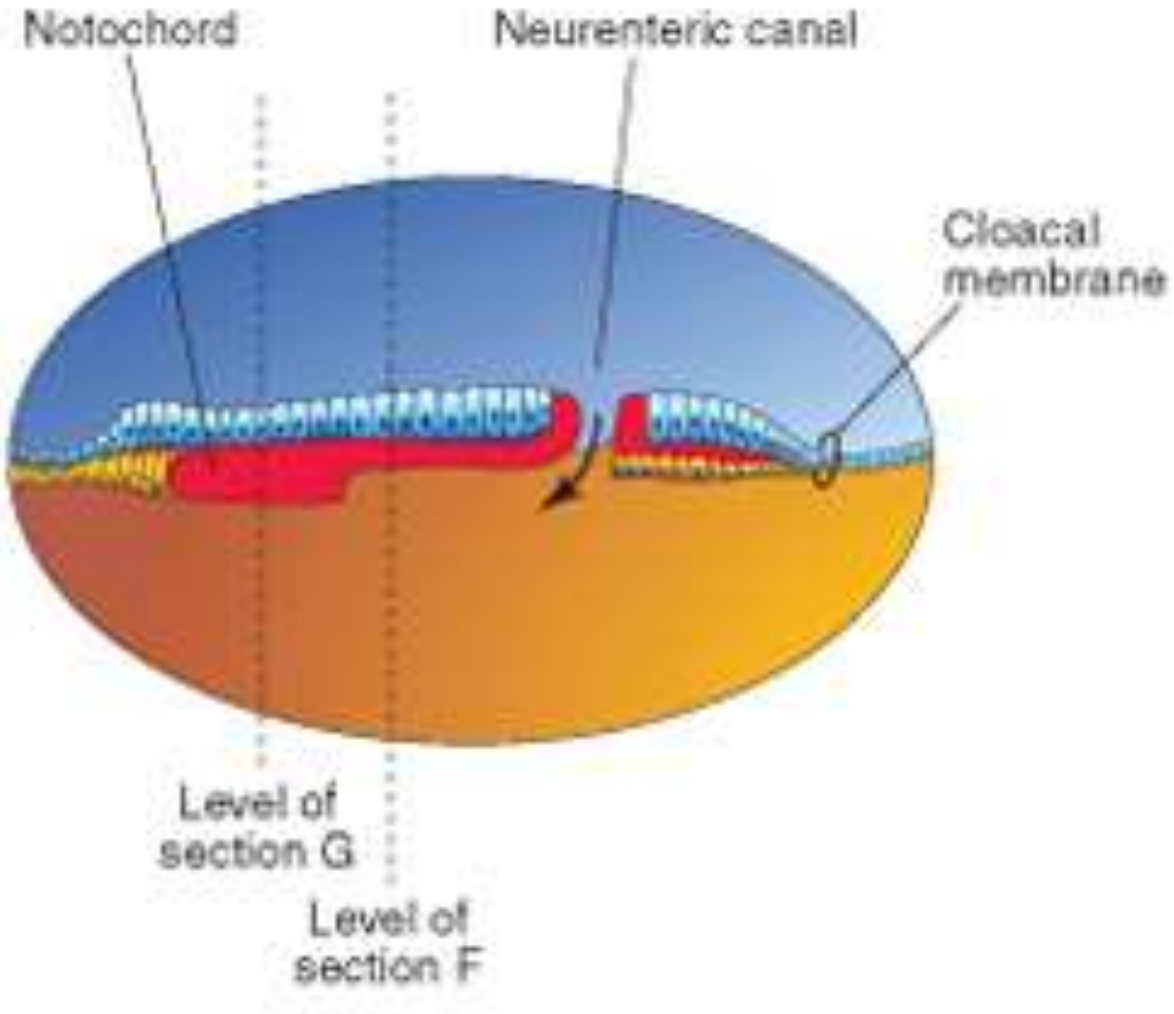
- The floor of the notochordal process **fuses** with the underlying embryonic endoderm
- The fused layers gradually undergo **degeneration**, resulting in the formation of **openings** in the floor of the notochordal process, which brings the notochordal canal into communication with the umbilical vesicle





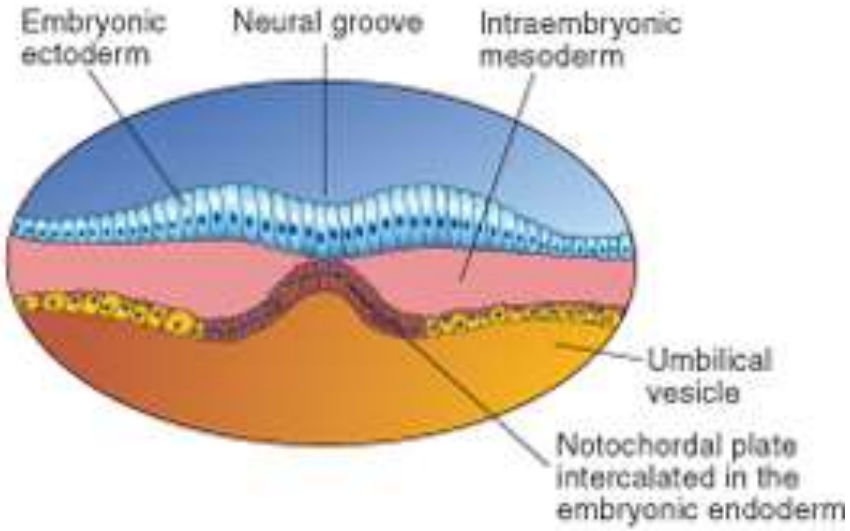
Core Concept

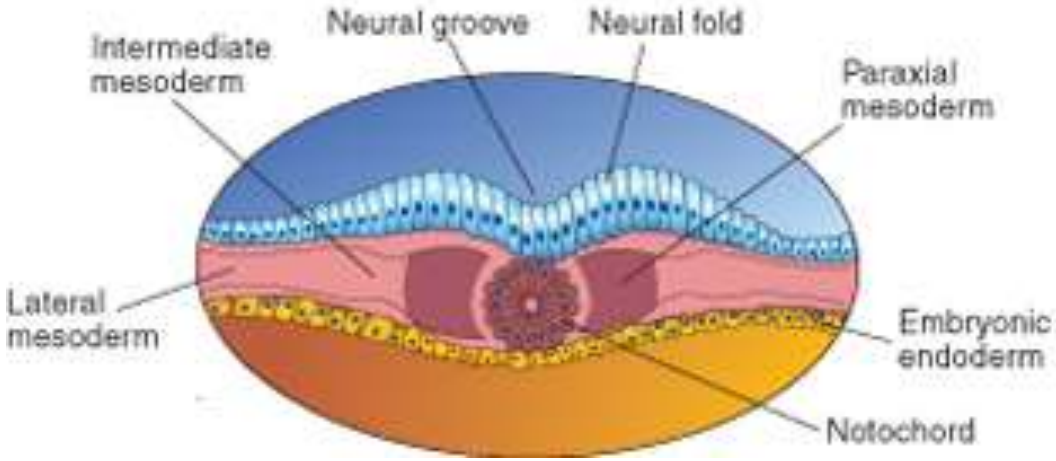
Neuroenteric Canal



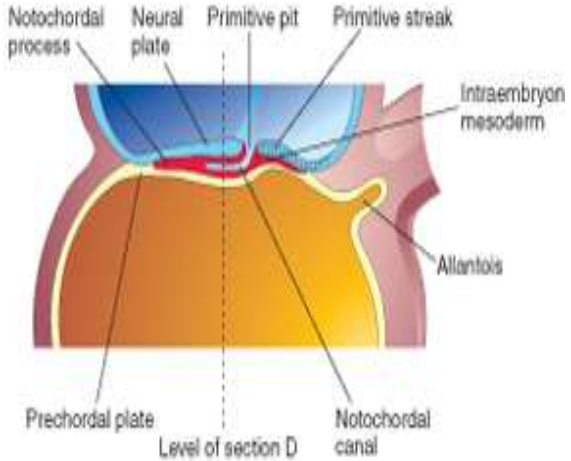
Core Concept

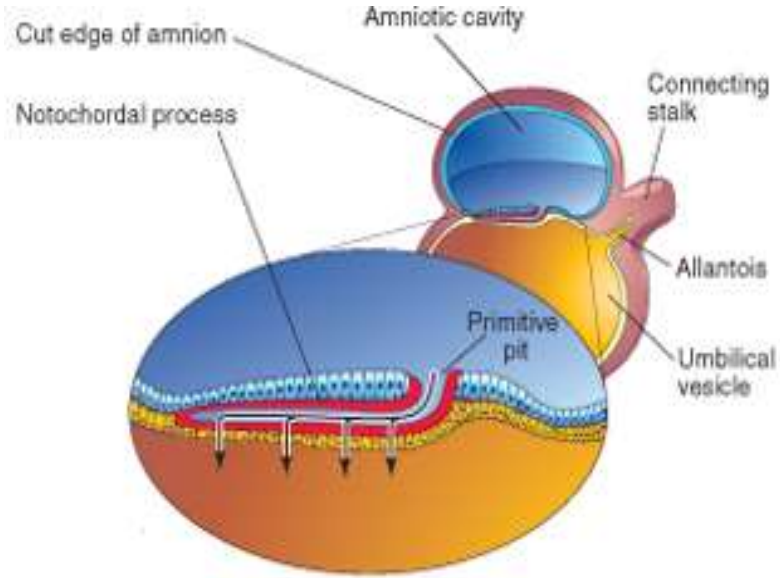
- The openings rapidly become confluent and the floor of the notochordal canal disappears; the remains of the notochordal process form a flattened, grooved **notochordal plate**
- Beginning at the cranial end of the embryo, the notochordal cells proliferate and the notochordal plate infolds to form the **notochord**

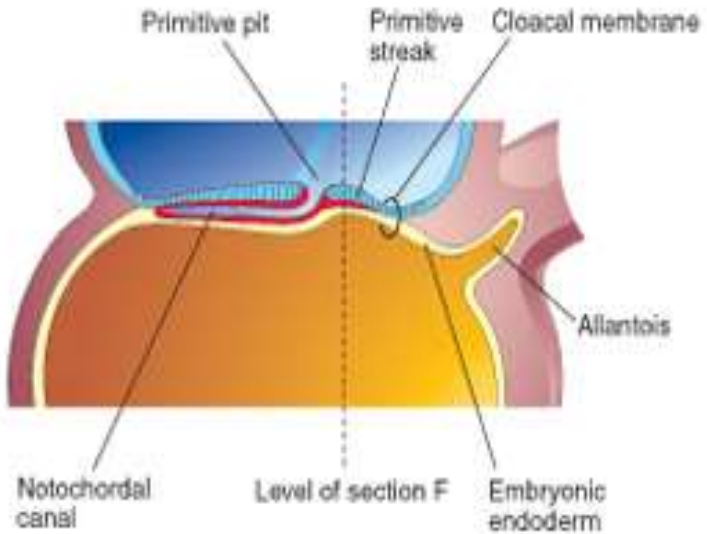


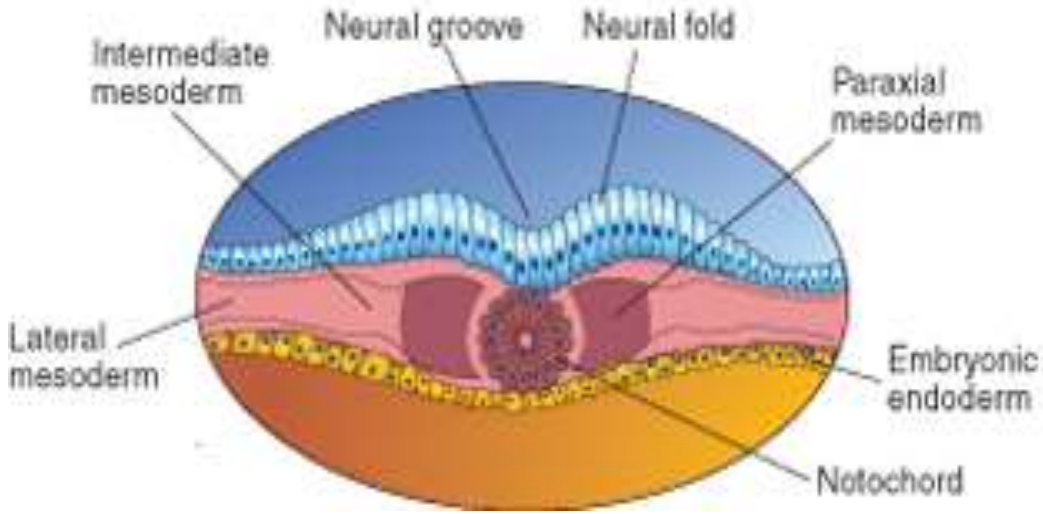


Core Concept





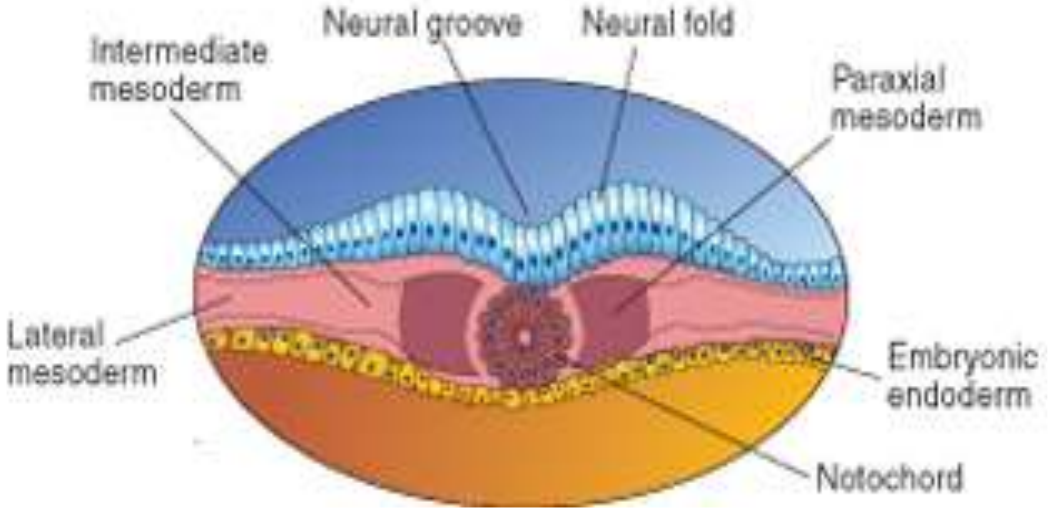




Core Concept

The Notochord :

- Defines the primordial longitudinal axis of the embryo and gives it some rigidity
- Provides signals that are necessary for the development of axial musculoskeletal structures and the central nervous system
- Contributes to the intervertebral discs
- Remnants forms the chordomas



Core Concept

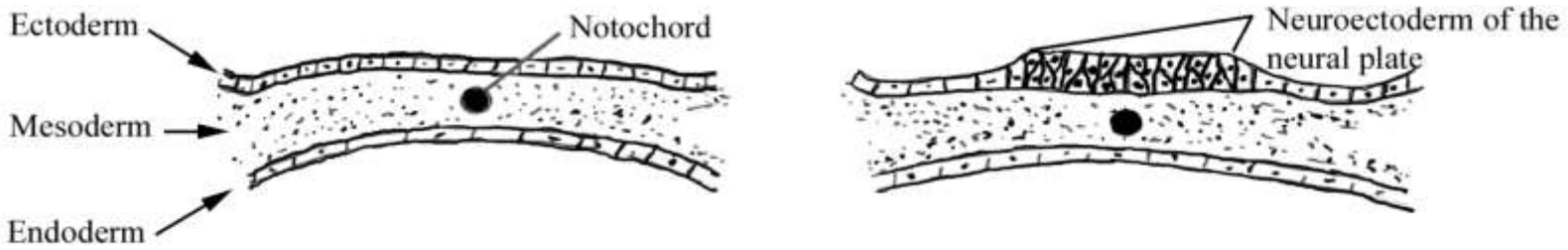
Neurulation (Formation Of Neural Tube)

- The processes involved in the formation of neural plate, neural folds and closure of folds to form neural tube constitute neurulation.
- These process are completed by the end of fourth week when closure of caudal neuropore occurs

Core Concept

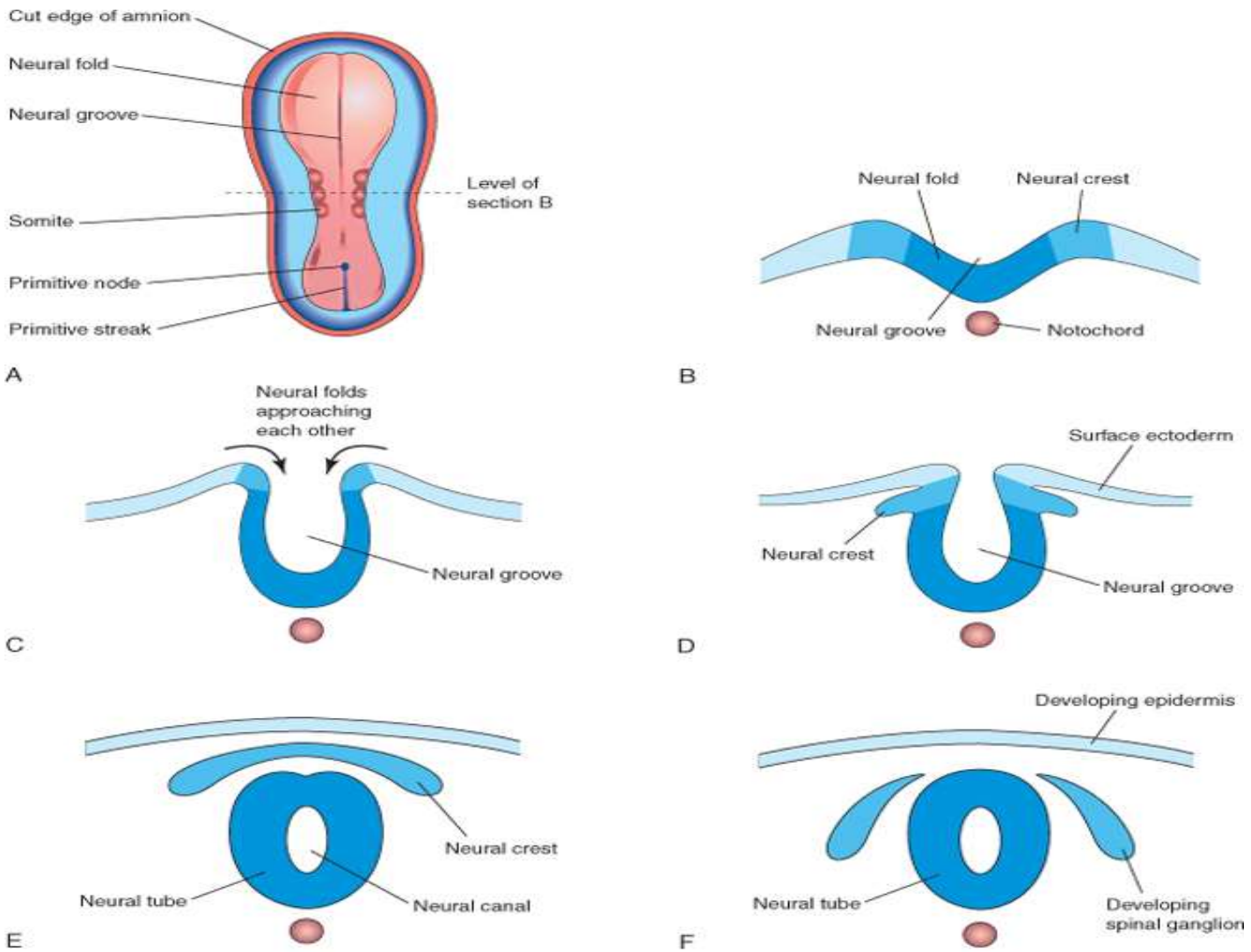
Neurulation

- Induction of the neuroectoderm
- Organized by the notochord
- Creation of a neural plate
- Position of neural plate
- Extension of neural plate



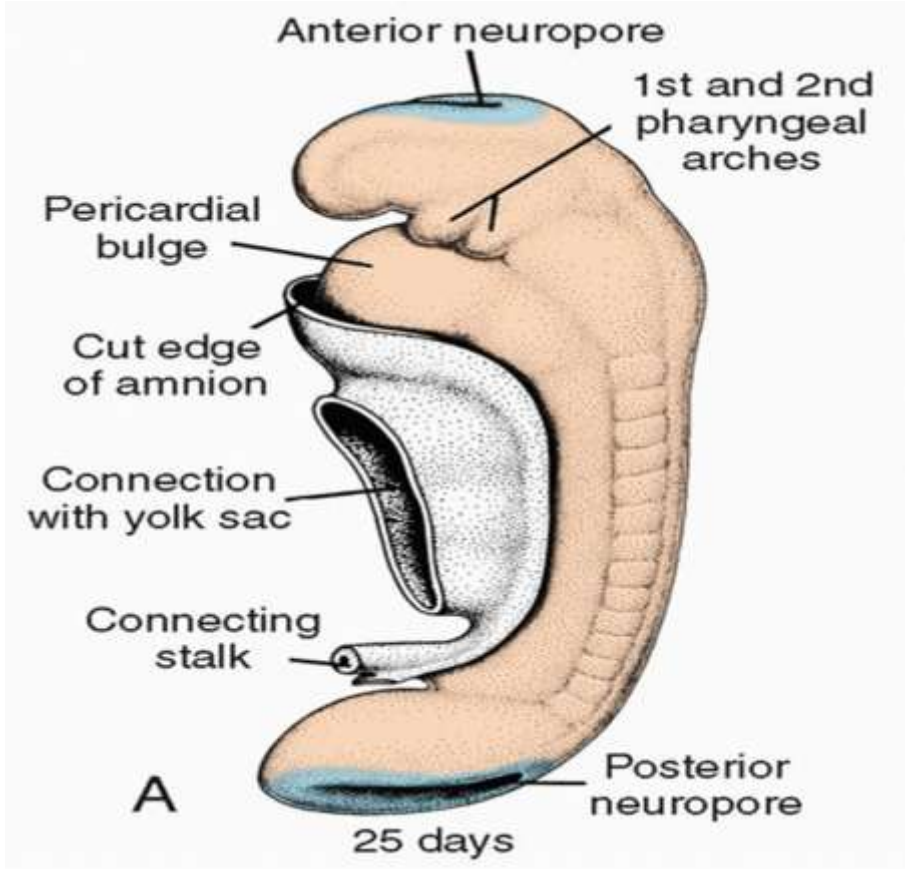
Core Concept

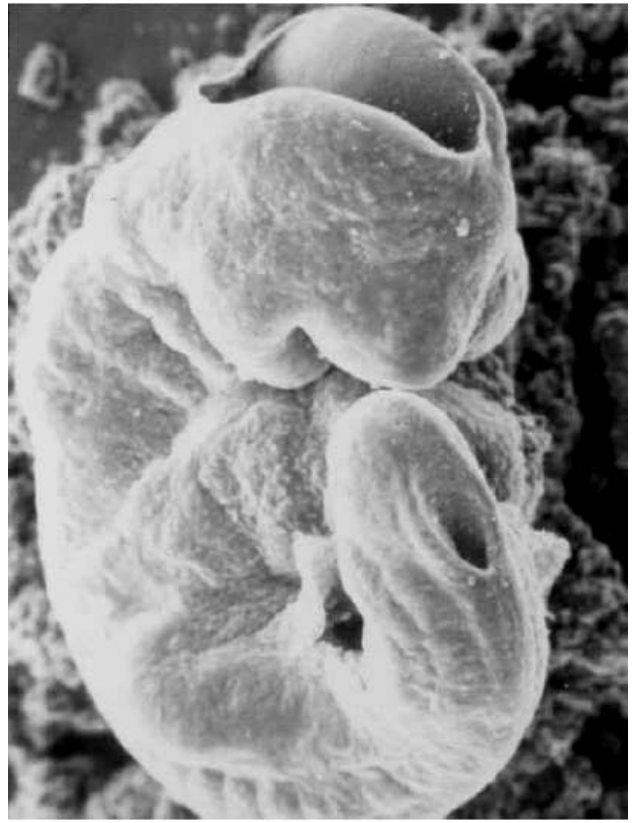
Neural Tube Formation



Closure of Neural Tube

- Day 25 Rostral neuropore closes
- Day 25 + 2 Caudal neuropore closes

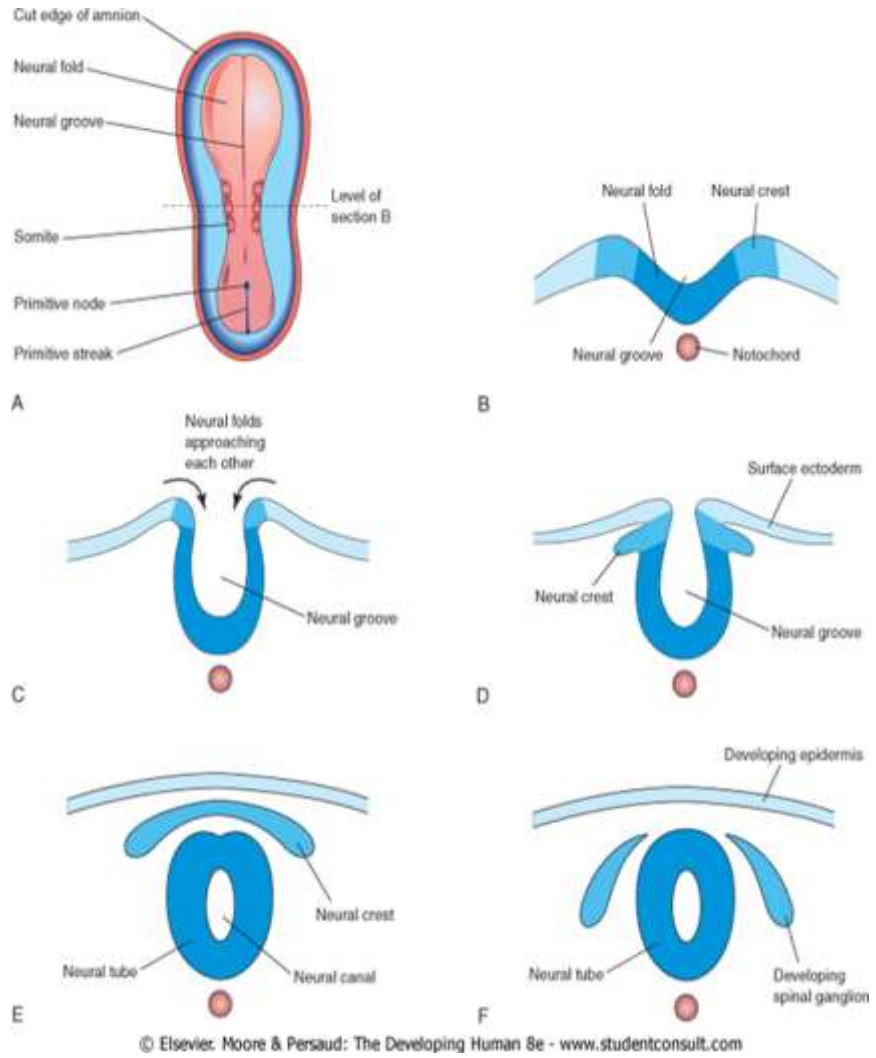




Core Concept

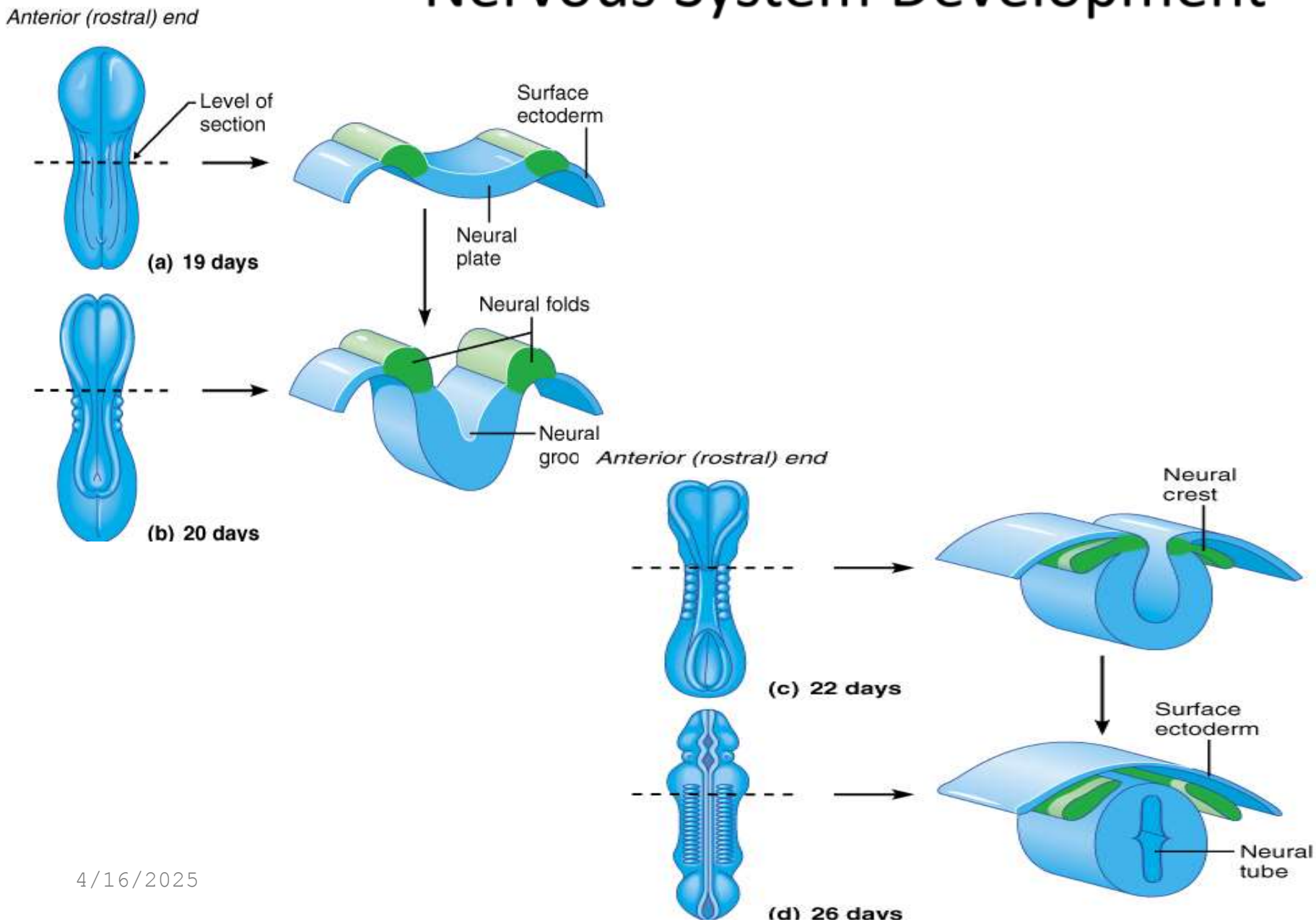
Neural crest formation

- As the neural folds fuses to form the neural tube, some ectodermal cells lying inside the margins of neural fold loose attachments to the neighboring cells
- The **neural crest cells** form a flattened irregular mass **neural crest** between neural tube and overlying ectoderm.
- Neural crest soon divide into right and left parts
- **Migration of NCC**



Core Concept

Nervous System Development



Core Concept

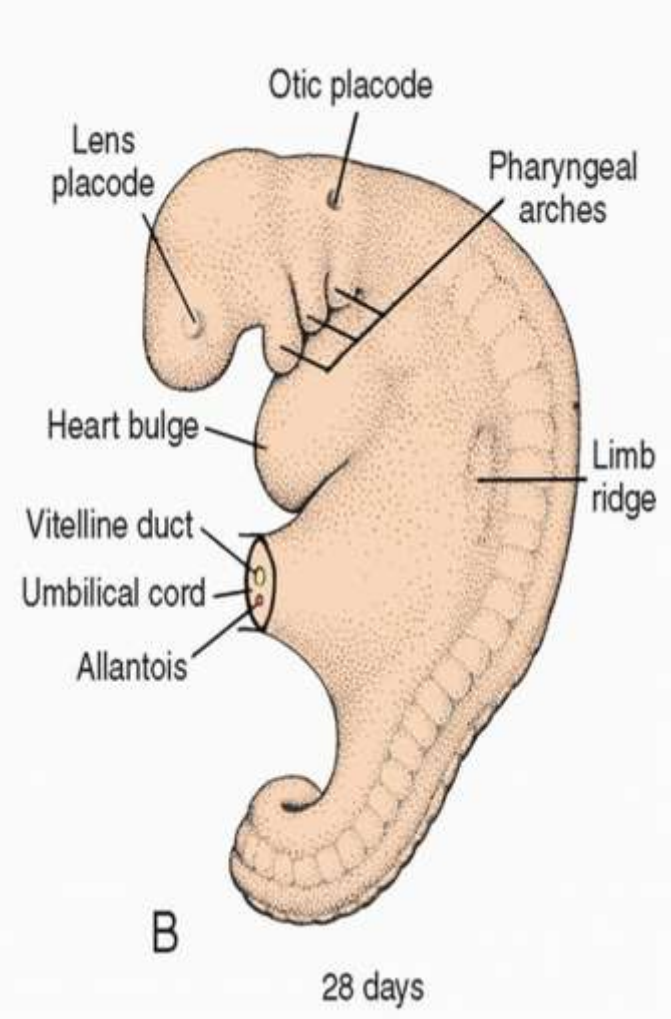
Neural Crest Cells give rise to

- Sensory ganglion of spinal and cranial nerves
- Dorsal root ganglion
- Neurolemma sheaths of nerves
- Ganglion of autonomic nervous system
- Contribute to the formation of leptomeninges
- Pigment cells
- Suprarenal medulla
- Connective tissue components in head
- Ganglion of cranial nerves V, VII, IX and X
- Smooth muscles of the blood vessels of forebrain and face

Core Concept

Lens Placodes/ Otic Placodes

- By the time the neural tube is closed, two bilateral ectodermal thickenings the **lens placodes** and **otic placodes** become visible in the cephalic region of the embryo.
- During further development, the **otic placodes** invaginate and form the otic vesicles,
- At approximately the same time, the **lens placodes** appear. These placodes also invaginate and, during the fifth week, form the lenses of the eyes



Core Concept

Neural Tube Defects

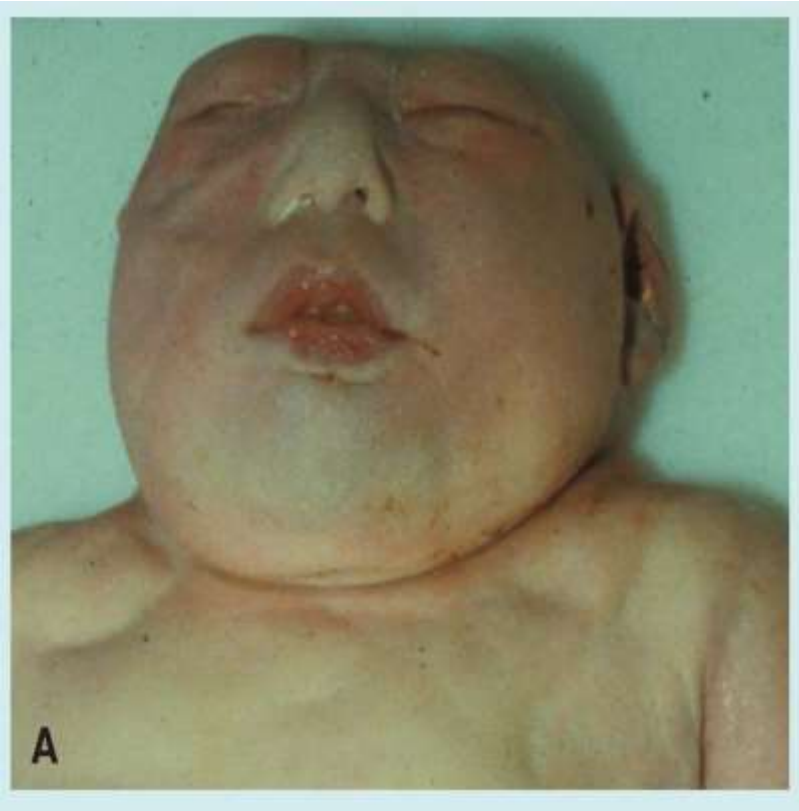
- There are two types of NTDs: open, which are more common, and closed.
- **Open NTDs** occur when the brain and/or spinal cord are exposed at birth through a defect in the skull or vertebrae (back bones). Examples of open NTDs
  are anencephaly, encephaloceles, hydranencephaly, iniencepaly, schizenc ephaly, and spina bifida.

- **Closed NTDs** occur when the spinal defect is covered by skin. Common examples of closed NTDs are lipomyelomeningocele, lipomeningocele

Vertical Integration

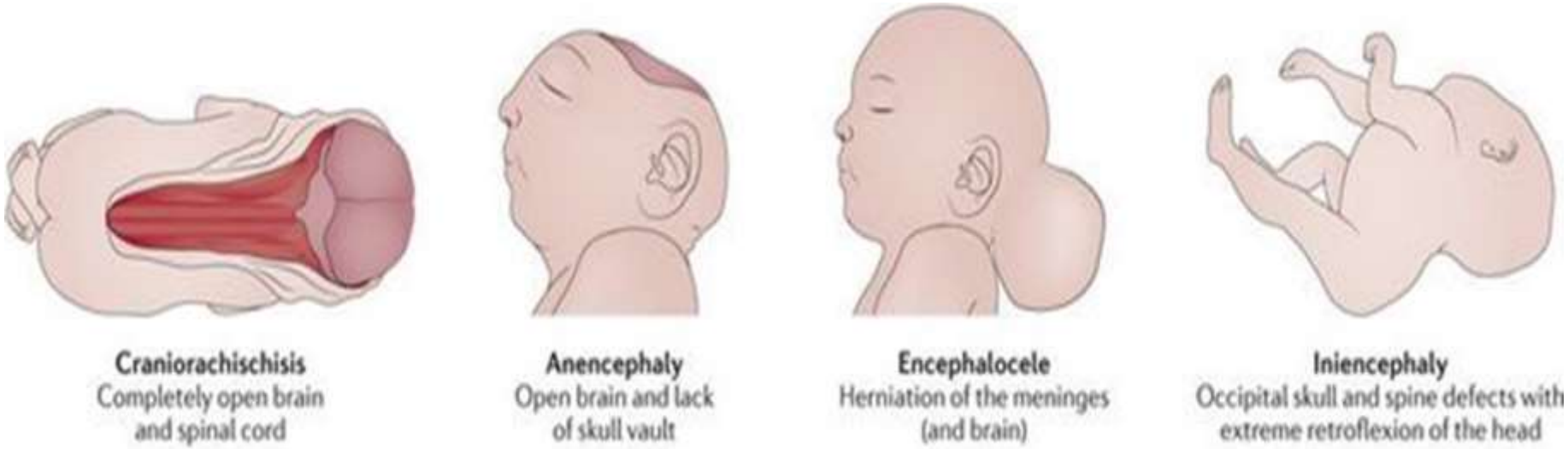
Anencephaly

- is a neural tube defect that occurs when the head end of the neural tube fails to close, usually during the 23rd and 26th days of pregnancy, resulting in an absence of a major portion of the brain and skull.
- without the main part of the forebrain—the largest part of the cerebrum—and are usually blind, deaf and unconscious.
- infant will never gain consciousness. Infants are either stillborn or usually die within a few hours or days after birth.



Encephaloceles

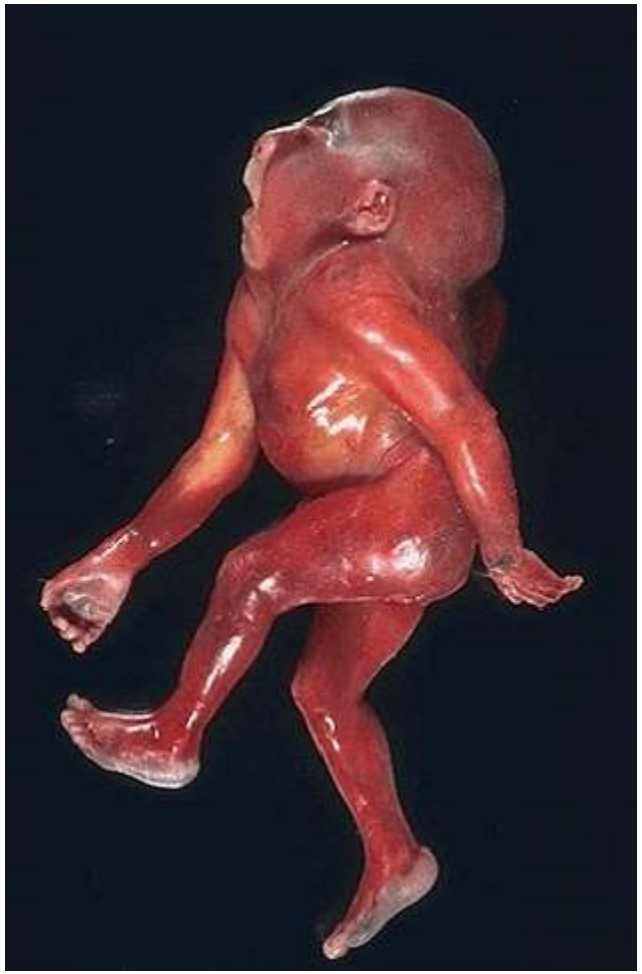
are characterized by protrusions of the brain through the skull that are sac-like and covered with membrane. They can be a groove down the middle of the upper part of the skull, between the forehead and nose, or the back of the skull. Encephaloceles are often obvious and diagnosed immediately. Sometimes small encephaloceles in the nasal and forehead are undetected.



Vertical Integration

Iniencephaly

- Iniencephaly is a rare neural tube defect that results in extreme bending of the head to the spine.
- The diagnosis can usually be made on antenatal ultrasound scanning, but if not will undoubtedly be made immediately after birth because the head is bent backwards and the face looks upwards. Usually the neck is absent. The skin of the face connects directly to the chest and the scalp connects to the upper back. The infant will usually not survive more than a few hours.



Anencephaly

Anencephaly is a significant developmental disorder of the central nervous system with substantial deformation of the brain and cranial vault.

Despite the lack of knowledge regarding the etiology and pathogenesis of anencephaly, it is believed that a number of environmental and dietary variables contribute to the disorder.

Folate deficiency is a significant nutritional risk factor that has been linked to the development of the disease.

Maternal serum alpha-fetoprotein (MSAFP) testing can detect the great majority of anencephaly patients during the second pregnant trimester. 2-dimensional prenatal ultrasonography which has advanced over time, has supplanted the screening approach of maternal serum alpha-fetoprotein values. Anencephaly is incompatible with life. Preventive care is the most crucial component of this condition's management. Recommending supplements of folic acid for females who are able to conceive is the simplest strategy to lower the prevalence of anencephaly.

Reference: Almufadhal MH, Mohammed ZQ. Anencephaly. InCongenital Brain Malformations: Clinical and Surgical Aspects 2024 May 22 (pp. 35-40). Cham: Springer Nature Switzerland.

A global update on the status of prevention of folic acid-preventable spina bifida and anencephaly in year 2022

Volume116, Issue5 May 2024 https://doi.org/10.1002/bdr2.2343

Study showed that only a quarter of all FAP SBA cases were averted through mandatory folic acid fortification in the year 2022; many countries are not implementing the policy, resulting in a large proportion of FAP SBA cases that can be prevented. Fortification will help countries with achieving 2030 Sustainable Development Goals on neonatal- and under-five mortality, disability, stillbirths, and elective terminations prevention, from FAP SBA. (Folic Acid-Preventable Spina Bifida and Anencephaly)

Research