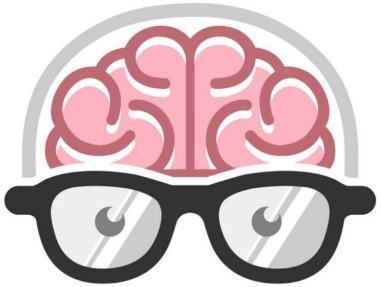


Development of Spinal Cord & Vertebral Column

Neuroanatomy block-Embryology -Lecture 1

Editing file

Anatomy team
med 438

MED438
KING SAUD UNIVERSITY

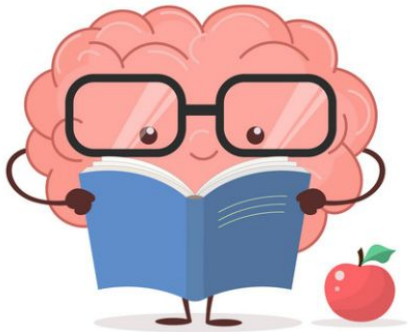
Reviewed by Razan AlRabah & Ibrahim AlDakhil

Objectives

Color guide :
Only in boys slides in Green
Only in girls slides in Purple
important in Red
Notes in Grey

At the end of the lecture, students should be able to:

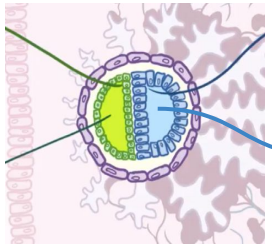
1. **Describe the development of the spinal cord from the neural tube.**
2. **List the layers of the spinal cord and its contents.**
3. **List subdivisions of mantle & marginal zones**
4. **List meningeal layers and describe positional changes of spinal cord.**
5. **Describe development of vertebral column from sclerotomic portion of paraxial mesoderm.**
6. **Describe chondrification & ossification stages in vertebral development.**
7. **Describe spina bifida and its types**



Introduction

Found only in girl's slides

It has 4 components:



Third week

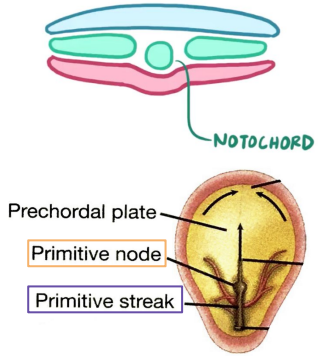
Second week

It forms Three Germ Layers

1) Ectoderm
2) Mesoderm
3) Endoderm

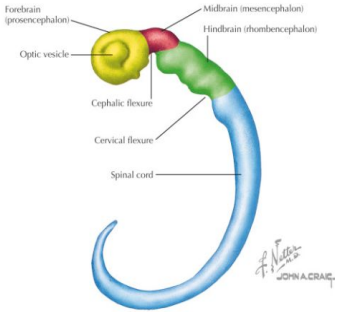
It has also

1) Primitive node
2) Primitive streak



Development of Neural Tube

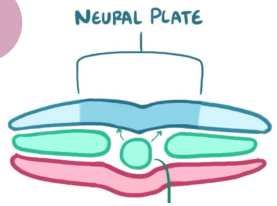
- The Neural Tube is a derivative of the ectoderm
- Gives rise to the brain and the spinal cord
- It has
  - 1)Cervical flexure
  - 2)Cephalic flexure



Development of Neural Tube

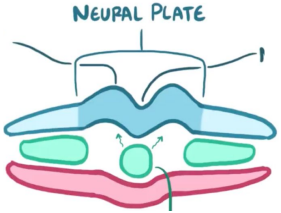
Stages of development:

1



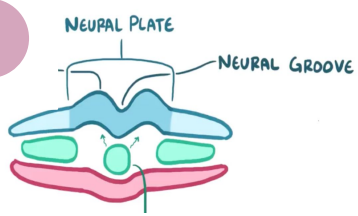
- Notochord stimulates neural tube formation which in turn stimulates development of the vertebral column.
- Notochord induces the ectoderm above it which thickens to form the neural plate.

2



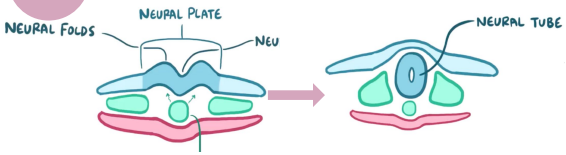
- Ectodermal cells dorsal to notochord thicken to form the neural plate.

3



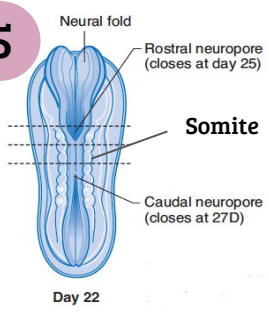
- The neural plate folds to form longitudinal groove (neural groove) with prominent neural folds.

4



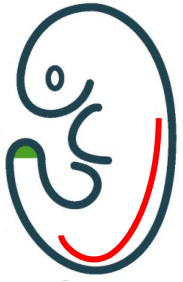
- The margins of the neural plate (neural folds) approach to each other and fuse to form the neural tube.
- The tube then separates from the overlying ectoderm.

5



- Closer of the neural tube begins in the future neck region (4th somite)
- Then proceeds cranially and caudally
- The most cranial and caudal ends of the tubes still open as
  - Anterior neuropores → will close at day 25 → lamina terminalis
  - Posterior neuropores → will close at day 27
- The lumen of the tube will give ventricles of the brain and central canal of spinal cord.

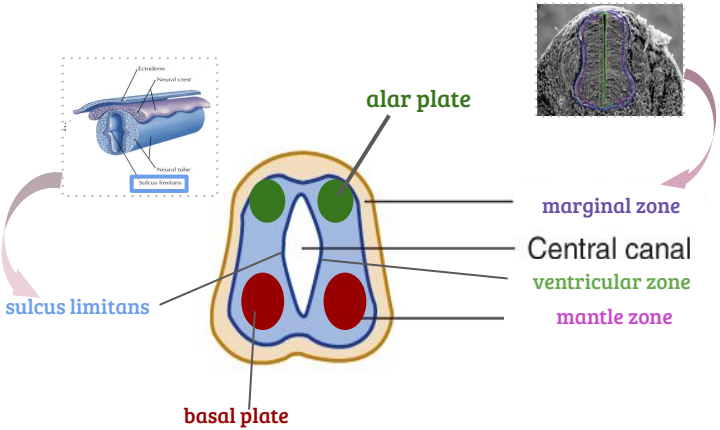
Development of the Spinal Cord



- The spinal cord develops from the caudal 2/3 of the neural tube

The cells of the neural tube
are arranged in three layers

ventricular zone	mantle zone	marginal zone
❖ Inner ❖ undifferentiated cells	❖ Middle ❖ cell bodies of neurons (future gray matter)	❖ Outer ❖ nerve fibers or axons of neurons (future white matter)



Neurons of mantle layer differentiate into :

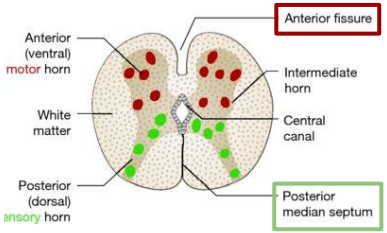
ventral basal plate	dorsal alar plate
(future ventral horn) containing motor neurons	(future dorsal horn) containing sensory neurons

❖ The 2 areas are separated by a longitudinal groove (sulcus limitans).

Mantle Layer of Spinal cord (future gray matter)

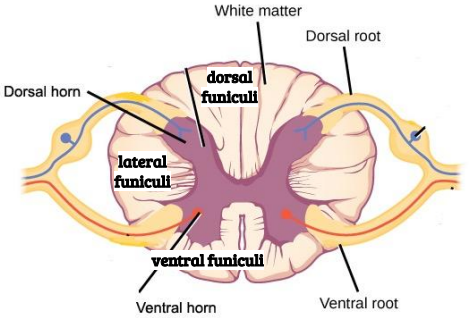
- Proliferation and bulging of both alar & basal plates result in:

1. Formation of dorsal median septum.
2. Formation of **ventral median fissure**.
3. Narrowing of the lumen of the neural tube to form a small **central canal**.



Marginal Layer of Spinal cord (future white matter)

- increases in size due to addition of ascending, descending & intersegmental nerve fibers.
- it is divided into : **dorsal**, **lateral** and **ventral funiculi** (white column).
- Myelination of nerve fibers starts at 4th month & continues during the 1st postnatal year.
- **Motor** fibers myelinated before **sensory** fibers.
- So, After a nerve injury, both motor and sensory axons have the ability to regenerate and, given a proper pathway.

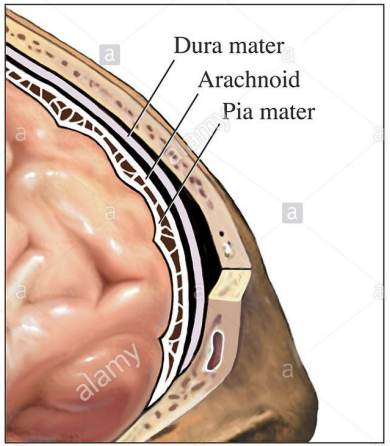


the cells that are still in ventricular zone, became ependyma for the central canal.

Meninges

These Are 3 Membranes covering the neural tube:

1. Outer thick dura mater
   Origin:
   Mesodermal
2. Middle arachnoid mater
   origin:
   Ectodermal
3. **subarachnoid** space: is a cavity appears between the arachnoid & the pia mater becomes filled with cerebrospinal fluid (CSF)
4. Inner thin pia mater
   origin:
   Ectodermal

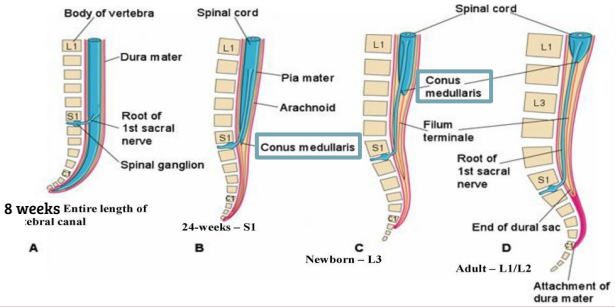


Positional Changes of Spinal Cord

- ★ Initially, the spinal cord occupies the **whole** length of the vertebral canal.
- ★ As a result a faster growth of vertebral column, the caudal end of spinal cord (conus medullaris) shifts gradually to a higher level.

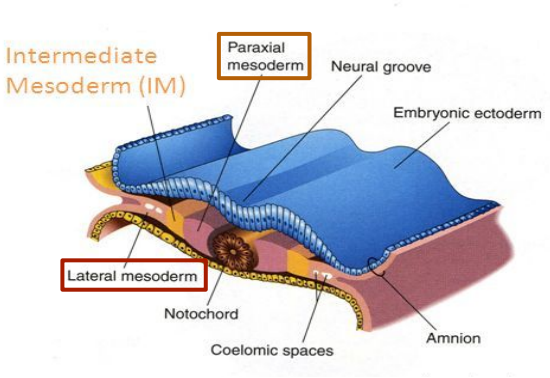
The spinal cord in 3rd month same length as vertebral canal

1. At birth spinal cord terminates at 3rd lumbar vertebra
2. In adult spinal cord terminates at L1



Specialization of Mesoderm

- Appearance of the notochord (first sign)
- Three collections of the mesoderm appear lateral to the notochord
  - Somites ➔ develop from the para-axial mesoderm.
  - Intermediate mesoderm
  - Double sheets of lateral plate mesoderm

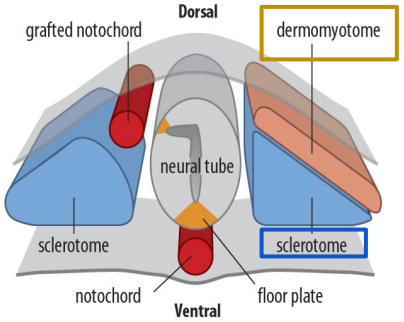


Intraembryonic Mesoderm

- Located: between Ectoderm & Endoderm **EXCEPT** in the central axis of embryo where NOTOCHORD is found.

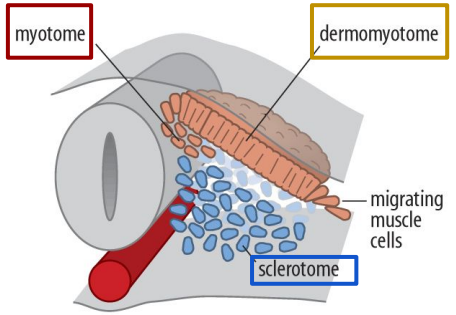
Differentiates into 3 parts:

- **Paraxial mesoderm** → **Somite**
  - Dermatome
  - Myotome
  - Sclerotome
  - ↳ Divides into segments called '*somites*'.
- **Intermediate mesoderm**
- **Lateral mesoderm**



Development of the Vertebral Column

- The vertebral column develops from the ventromedial parts (sclerotomes) of the somites
- Each one of somites divide into 3 parts:
  - Sclerotome: form the vertebrae & ribs
  - Dermatome: forms the dermis of the skin on the dorsal part of the body
  - Myotome: forms the skeletal muscles of the neck, trunk & limbs



Formation of Body of Vertebra

1

At 4th week, each sclerotome becomes subdivided into two parts :

- a cranial part, consisting of loosely arranged cells
- a caudal part, of more condensed tissue.

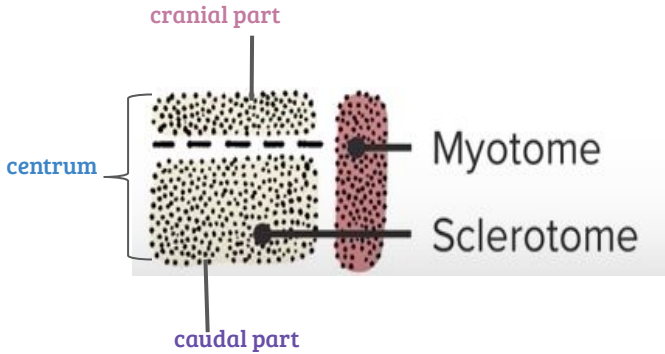
2

The caudal part of each somite fuses with the cranial part of the consecutive somite,around the notochord to form the body of the vertebra, called the centrum.

- each centrum develops from 2 adjacent sclerotomes.

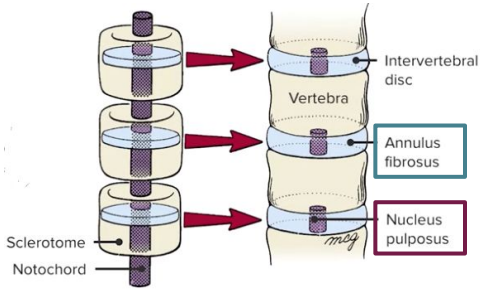
3

the bodies of the vertebrae are intersegmental in origin.



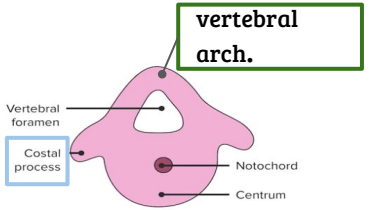
Fate of Notochord

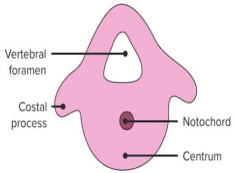
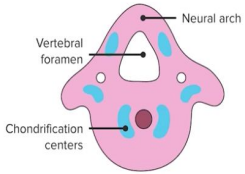
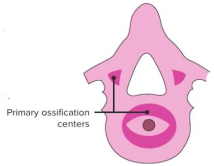
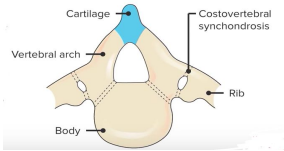
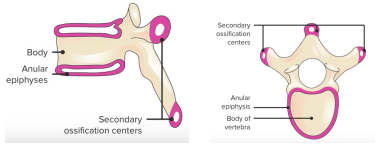
- In the region of the bodies of vertebrae: It degenerates.
- Between bodies of vertebrae: It forms the central part, 'nucleus pulposus' of the intervertebral discs.
- Annulus fibrosus of the intervertebral discs is formed by the mesoderm surrounding the notochord.



Vertebral Development

- The fused sclerotomes grow dorsally around the neural tube and form the vertebral (neural) arch.
- Ventrolaterally, costal processes develop that give rise to ribs in thoracic region.
- The development occurs in 5 stages:
- All centers unite around 25 years



1) Mesenchymal	2) Chondrification	3) Primary Ossification (3 centers)	4) Stage of Fusion (Fusion of 2 V.arches)	5) Secondary Ossification
	 Appear at 6th week	 Appear at the end of 8th week	 Fusion between halves of neural arch occurs at 3-5 years, between neural arch & body at 3-6 years	 Appear at puberty

Curvatures of Vertebral Column

Curvatures of Vertebral Column

Primary (concave anterior)

- develop prenatally
- contains

Thoracic

Pelvic or Sacral

Secondary (convex anterior)

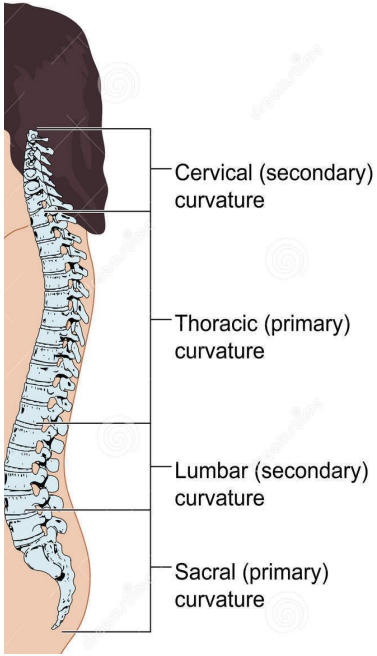
- develop postnatally
- contains

Cervical

- concave posteriorly
- as a result of lifting the head

Lumbar

- concave posteriorly
- as a result of walking
- Help support trunk, upper body



Spinal Cord Anomalies

Spina Bifida

- Failure of fusion of the halves of vertebral arches
- Incidence: 0.04 - 0.15% Sex: more frequent in females

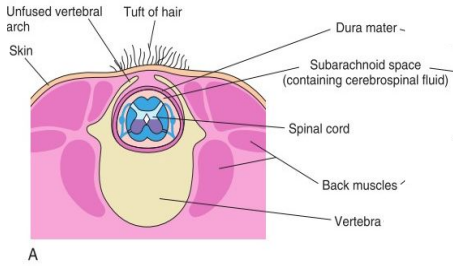
Has 2 types

Occulta 20%
1) Spinal dermal sinus
2)Tethered cord

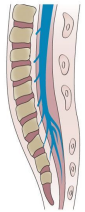
Manifesta (cystic) 80%
1. Meningocele
2. Meningomyelocele
3. Myelochisis

A. Spina Bifida Occulta

- The closed type
- Only one vertebra is affected
- No clinical symptoms
- Skin overlying it is intact
- Sometimes covered by a tuft of hair
- Usually does not involve underlying neural tissue



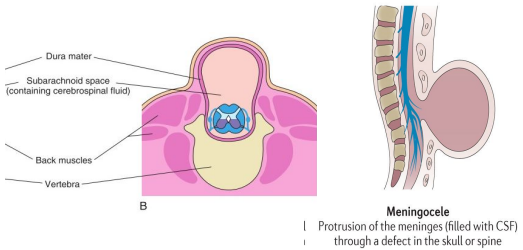
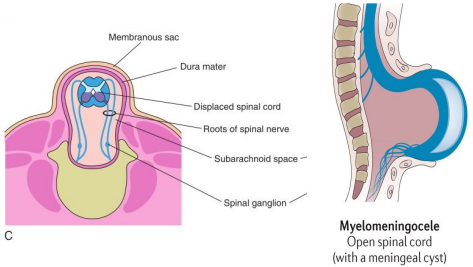
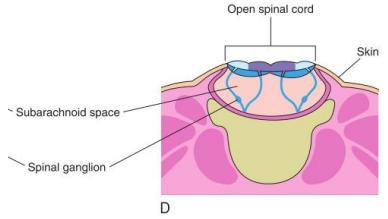
A



Spina bifida occulta
Closed asymptomatic NTD in which some of the vertebrae are not completely closed

B. Spina Bifida Cystica

- Cystica is the most severe and complex form of spina bifida.
- It usually involves serious neurological problems.
- A portion of the nerves and the spinal cord are exposed outside the body
- Neurological symptoms are present

It Subdivided into:		
1. Spina bifida with meningocele	**2. Spina bifida with meningomyelocoele**	**3. Spina bifida with myeloschisis**
protrusion of sac containing meninges & cerebrospinal fluid.	protrusion of sac containing meninges with spinal cord and/or nerve roots.	spinal cord is open due to failure of neural folds to develop.
		

Practice

Q1: The neural tube is derivative from:

A. endoderm

B. mesoderm

C. intermediate mesoderm

D.ectoderm

Q2: Which one of the following regions of spinal cord contains cell bodies of motor neuron?

A. Alar plate

B. Basal plate

C. Mantle zone

D. Dorsal funiculus

Q3: Myelination of nerve fibers starts at ___and continues during _____.

A. 2nd month - 1st postnatal year

B. 4th month - 1st postnatal year

C. 2nd month - 2nd postnatal year

D. 4th month - 2nd postnatal year

Q4: Dura mater originated from:

A. endoderm

B. mesoderm

C. intermediate mesoderm

D.ectoderm

Q5: Which part of mesoderm divides into segments called somites?

A. Paraxial

B. Intermediate

C. Lateral

D. Notochord

Q6: Each sclerotome becomes subdivided into cranial & caudal part at:

A. 5th week

B. 4th week

C. 4th month

D. 2nd month

Q7: The secondary curvature of spinal column is:

A. Concave anterior

B. Concave posterior

C. Convex anterior

D. Both B&C

Q8 : regarding spinal bifida which one of the statement is correct?

A. The closed type is more frequent than the open

B. The closed type presents with clinical symptoms

C. In cases of spina bifida with meningocele, the spinal cord is open.

D. Spina bifida is due to failure of fusion between the halves of vertebral arch.

Answers: Q1(D) Q2(B) Q3(B) Q4(B) Q5(A) Q6(B) Q7(D) Q8(D)

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med 438

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- Khalid Nagshabandi
- Omar Alammari
- Sameh nuser
- Abdullah Basamh
- Alwaleed Alsaleh
- Mohaned Makkawi
- Abdullah Alghamdi

Ateen Almutairi

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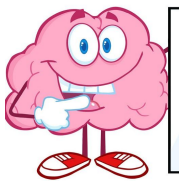

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