BGDA Lecture - Development of the Nervous System

Introduction

	Neural development is a complex and ongoing process that commences in week 3 and continues through into the postnatal period. This lecture will introduce concepts about the timing, origin and abnormalities of the nervous system. Final lecture content will be added to this current page, the linked online textbook chapters are available as pre-reading for this lecture.

Aim

To develop an understanding of the development of the nervous system and the consequences of abnormal development.

Draft Lecture Timetable - Monday 29 May 2017 09:00 AM - 10:00 AM Development of the nervous system Kensington - Rex Vowels Theatre

Textbooks

Week 3

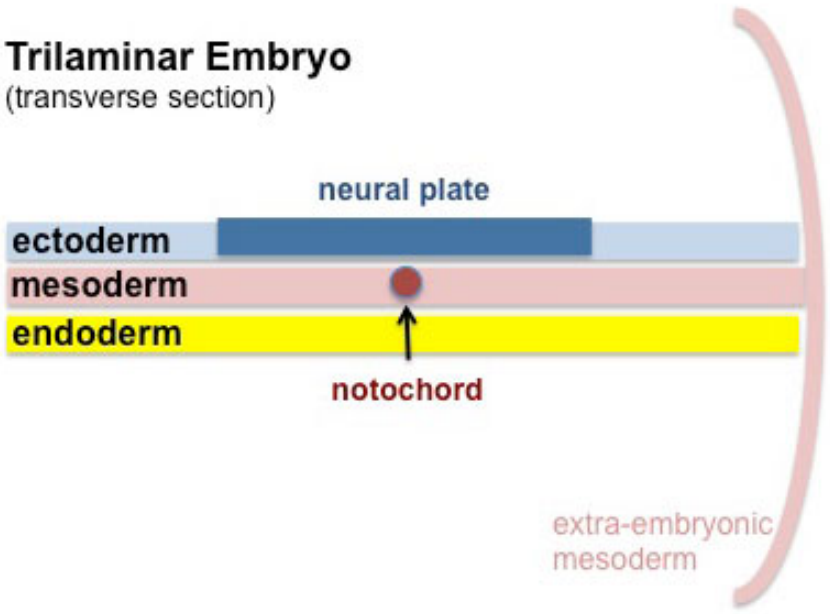
Ectoderm

- neural plate - midline (columnar cells)
    - neural crest - outside lateral edges of neural plate
- surface ectoderm - lateral (cuboidal cells)
    - head - sensory and anterior pituitary (placodes)
    - integument - epidermis of skin, hair, glands, teeth enamel

Neural Plate

- extends from **buccopharyngeal membrane** (oral membrane) to **primitive node** (Hensen's node)
- forms above notochord and paraxial mesoderm

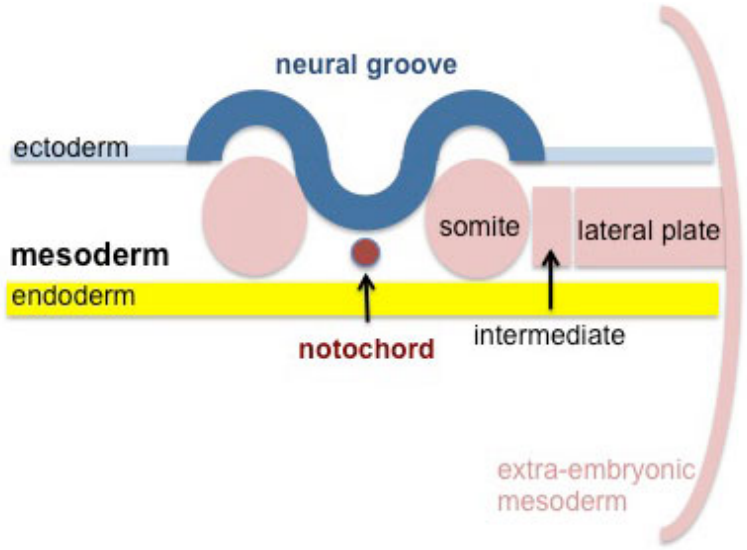
- neuroectodermal cells - neural plate, neural crest
- rostrocaudal width
    - brain plate (broad)
    - spinal cord (narrow)

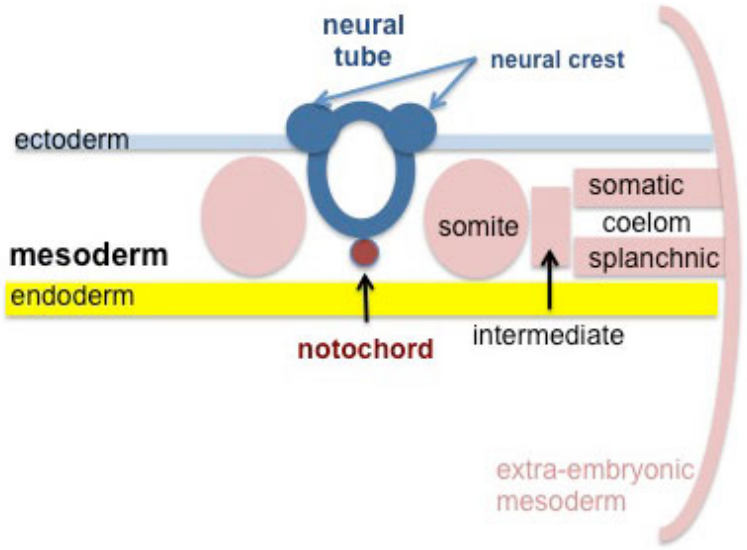
	

Week 4

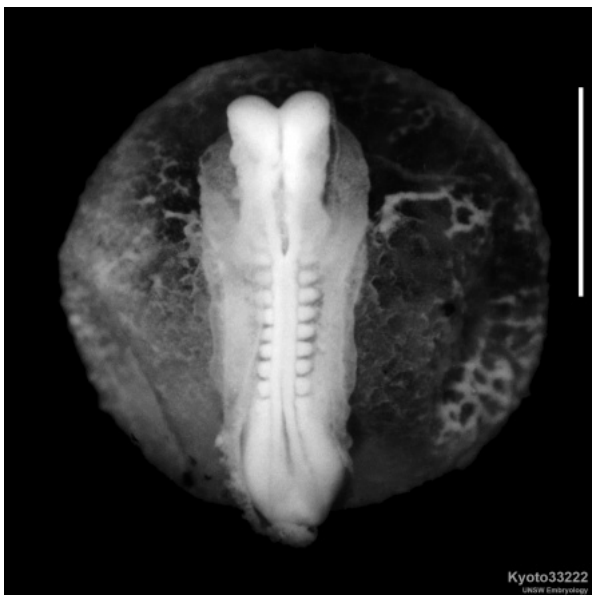
Neural Tube

neural groove	neural tube and neural crest





Stage 10 - Dorsal View



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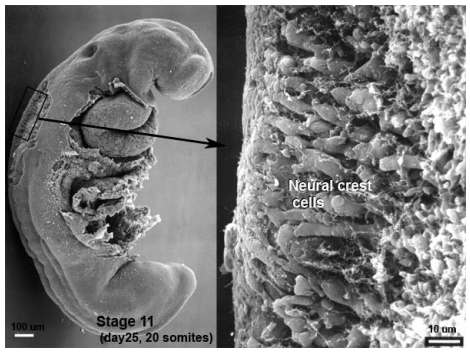
Neural Crest



Human embryo neural crest cells ([Week 4](), [stage 11]())]]

Chicken neural crest cell migration into pharyngeal arches.

Neural Crest Origin	
System	**Cell Type**
Peripheral Nervous System (PNS)	Neurons - sensory ganglia, sympathetic and parasympathetic ganglia, enteric nervous system, and plexuses Neuroglial cells Schwann cells
Endocrine	Adrenal medulla Calcitonin-secreting cells Carotid body type I cells
Integumentary	Epidermal pigment cells
Facial cartilage and bone	Facial and anterior ventral skull cartilage and bones
Sensory	Inner ear, corneal endothelium and stroma
	Tooth papillae smooth muscle, and adipose tissue of skin of head and neck

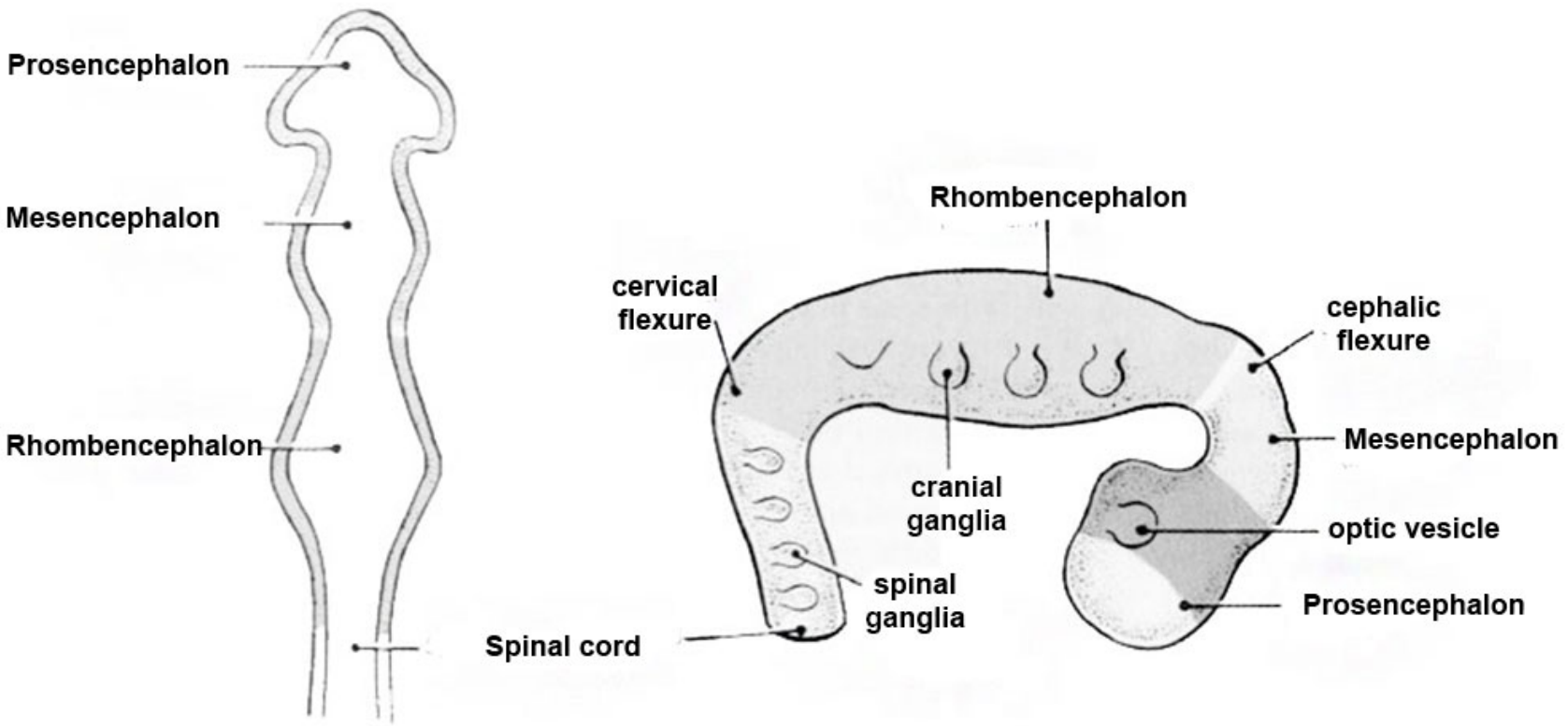
Connective tissue	Connective tissue of meninges, salivary, lachrymal, thymus, thyroid, and pituitary glands Connective tissue and smooth muscle in arteries of aortic arch origin

Links: Neural Crest Development | Category:Neural Crest | Neural Crest collapsible table

Neural Crest Development

Primary Brain Vesicles

Traditional vesicle description (simplified name and alternate neuromere description in brackets)



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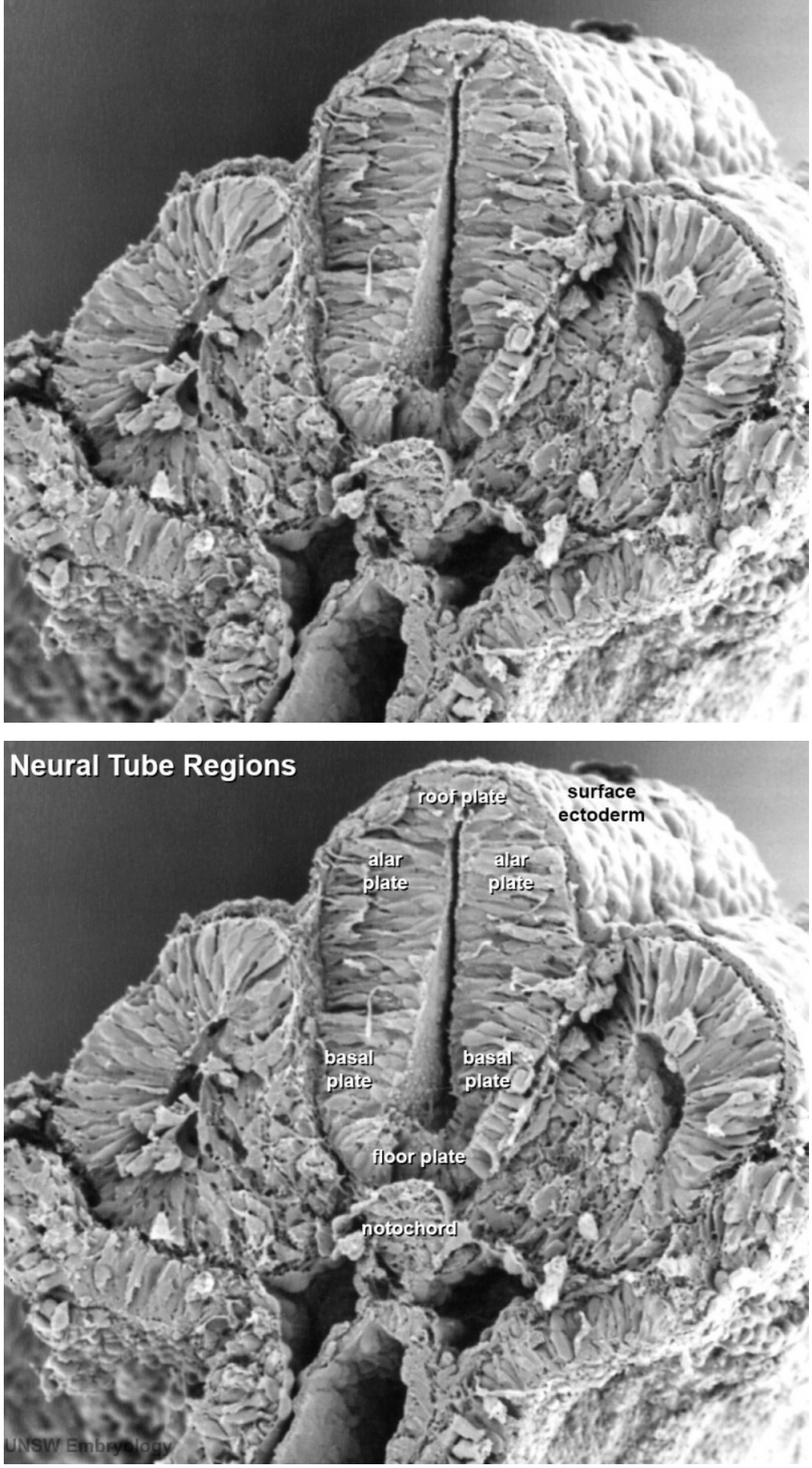
Brain

1. Prosencephalon (forebrain, prosomeres)
2. Mesencephalon (midbrain, mesomeres)
3. Rhombencephalon (hindbrain, rhombomeres)

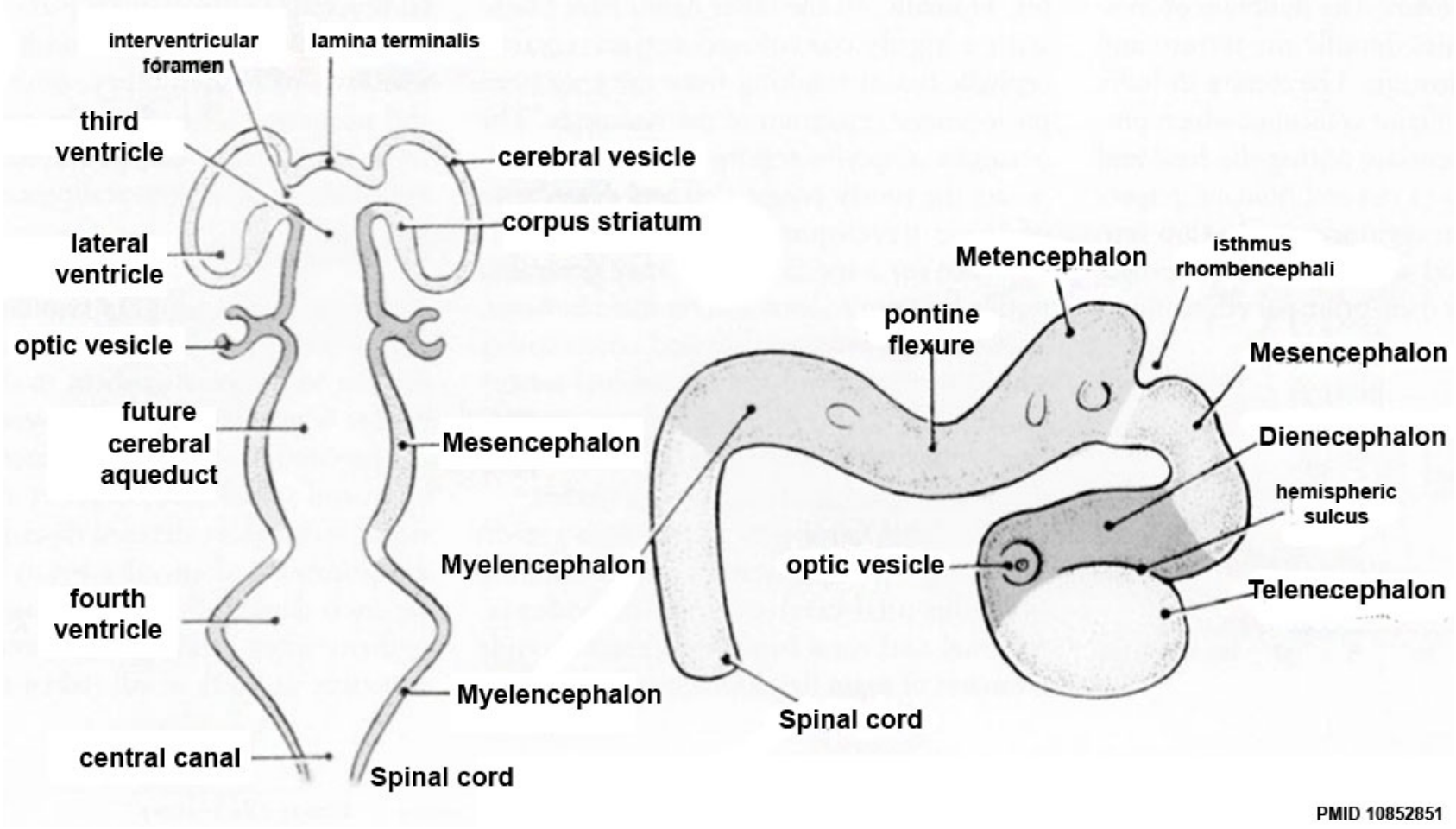
Spinal Cord



Links: Spinal Cord

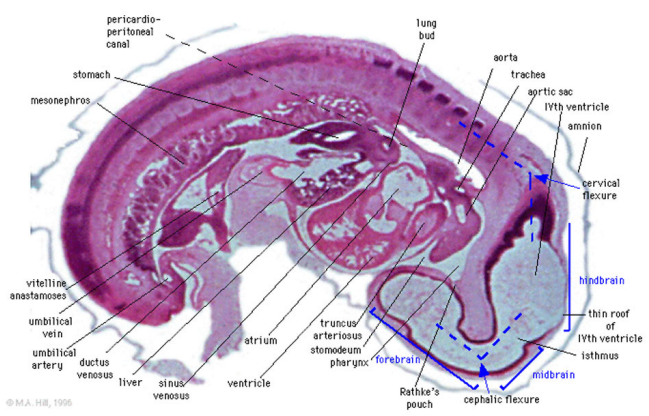
Week 5

Secondary Brain Vesicles



1. Telencephalon
2. Diencephalon
3. Mesencephalon
4. Metencephalon
5. Myelencephalon

Brain Flexures



Rapid growth folds the neural tube forming 3 brain flexures (cranial to caudal)

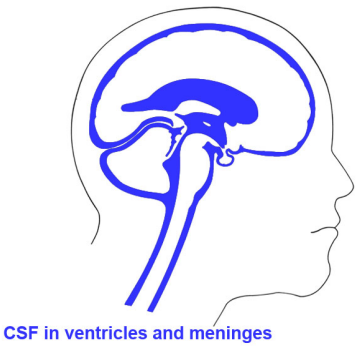
- **cephalic flexure** - (mesencephalic) pushes mesencephalon upwards
- **pontine flexure** - generates 4th ventricle (cerebellum will grow into this space)
- **cervical flexure** - between brain stem and spinal cord

Ventricles

- cavity within neural tube will form the contiguious space of the ventricules of the brain and central canal of spinal cord
- space is filled initially with amniotic fluid, later with

Cerebro**S**pinal **F**luid (CSF)

- CSF is secreted by
  - **chorioid plexus** modified vascular structures lying within the ventricles
    - floor of lateral ventricle and roof of the third and fourth ventricles
  - **ventricular ependymal cells** and cells lining the subarachnoid space
- CSF also fills the subarachnoid space (between arachnoid mater and pia mater).

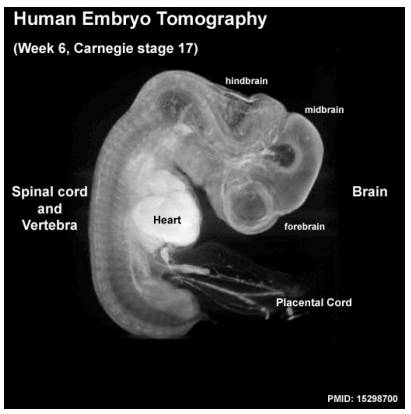


CSF-filled spaces in adult brain.

Adult Ventricular Structures [Expand]

Links: Neural - Ventricular System Development

Week 6



Note the shape and size of the different regions of the brain and spinal cord.

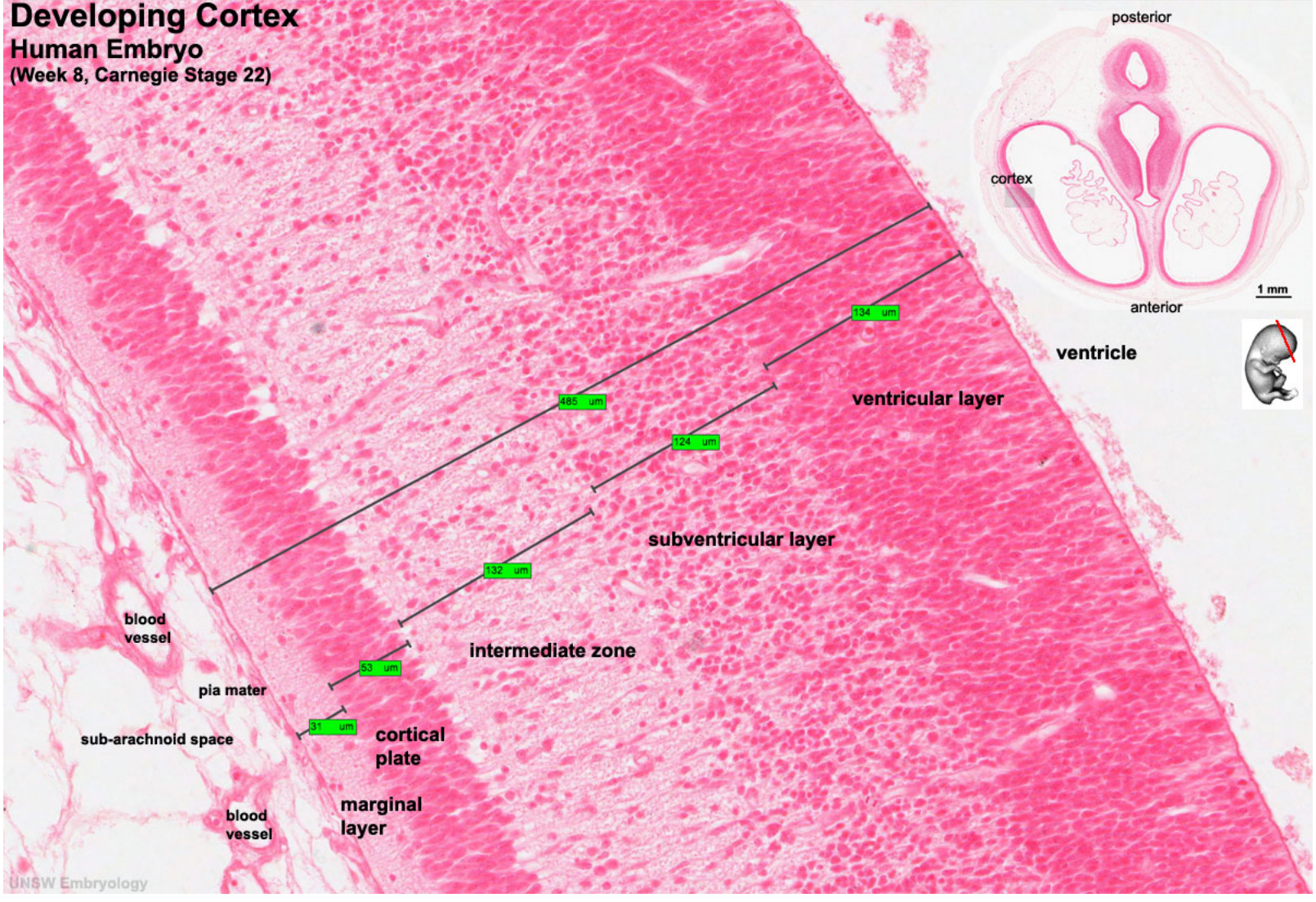
- Telencephalon (cerebrum) has begun to expand and will eventually cover the midbrain region.
- Dorsal root ganglia are visible outside the spinal cord.

Movie	

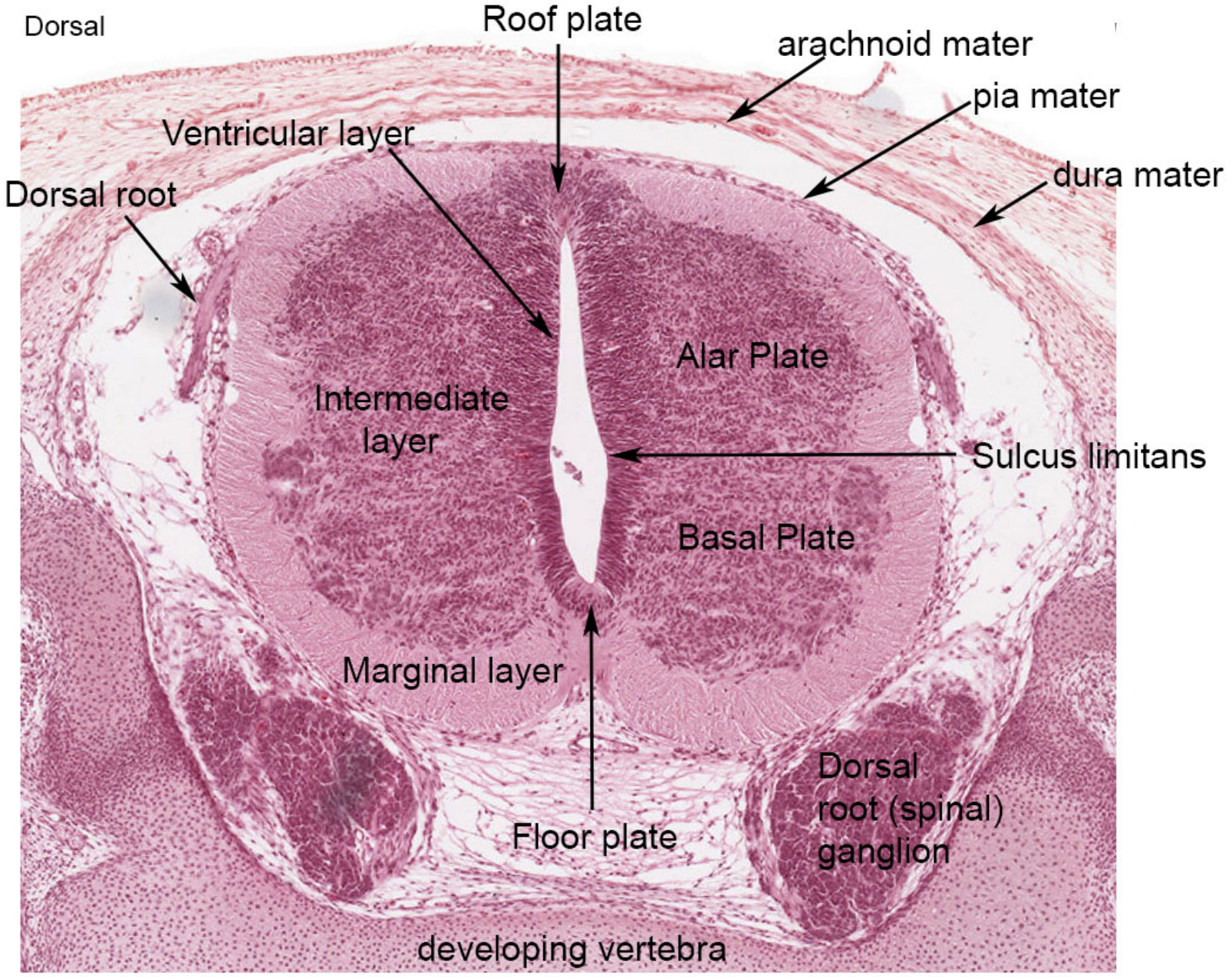
Week 8

The human MRI movie below (head, sagittal plane, left to right) shows the central nervous system (CNS) development at the end of the embryonic period (week 8; **GA** week 10).

Cortex

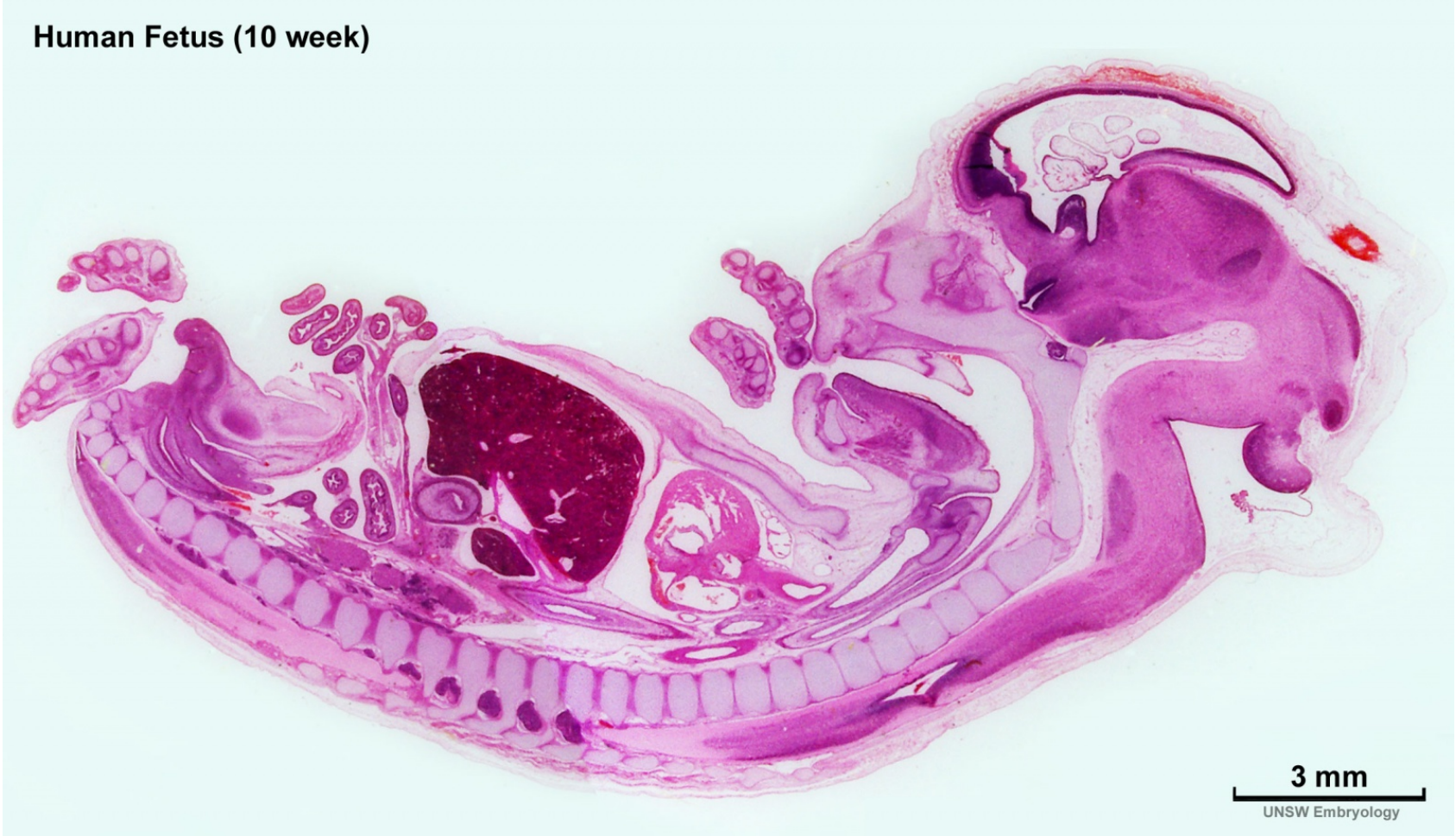

Developing Cortex
Human Embryo
(Week 8, Carnegie Stage 22)
posterior
cortex
anterior
1 mm
ventricle
ventricular layer
subventricular layer
intermediate zone
cortical plate
marginal layer
blood vessel
pia mater
sub-arachnoid space
blood vessel
485 um
134 um
124 um
132 um
53 um
31 um
UNSW Embryology

Spinal Cord

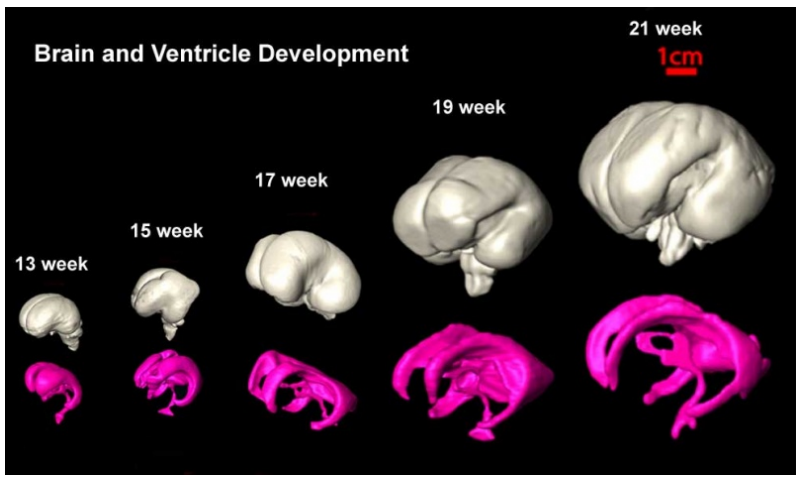


Fetal

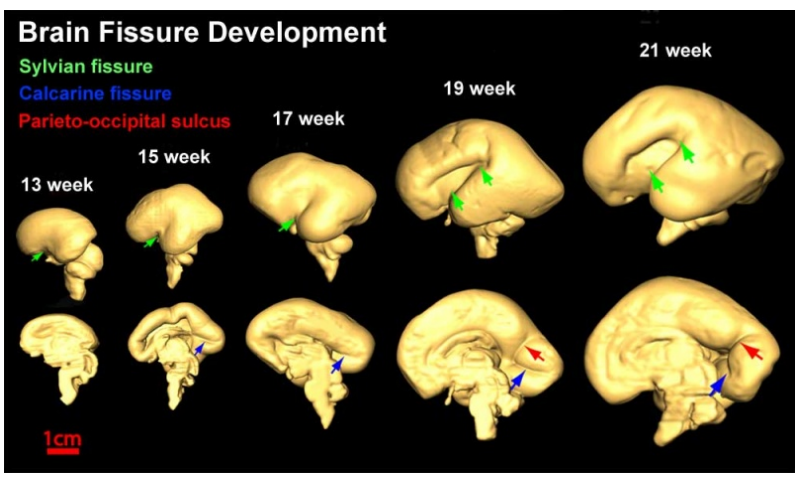
Second Trimester



Human week 10 fetus



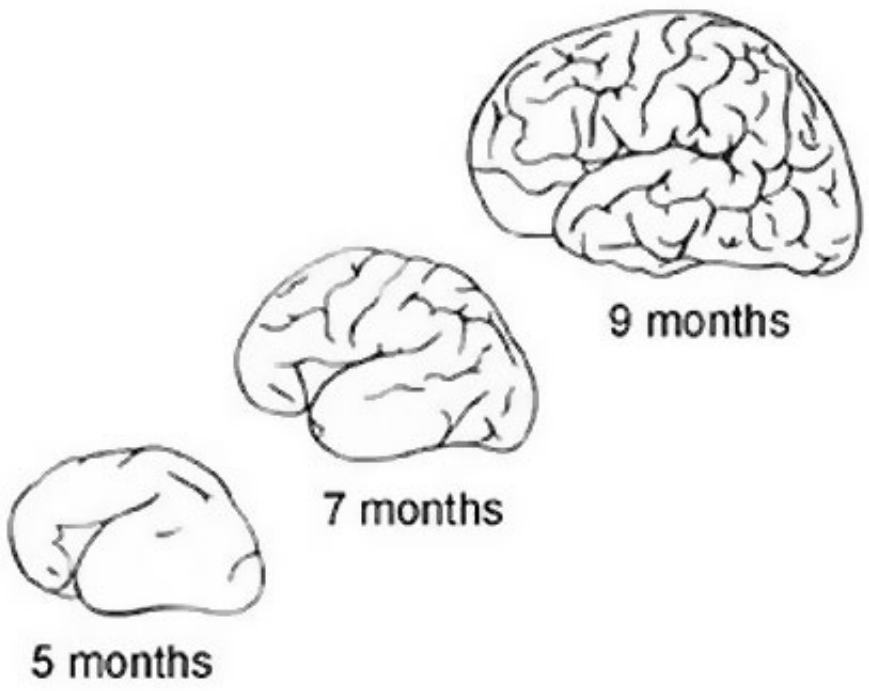
Brain and Ventricular Development[2]

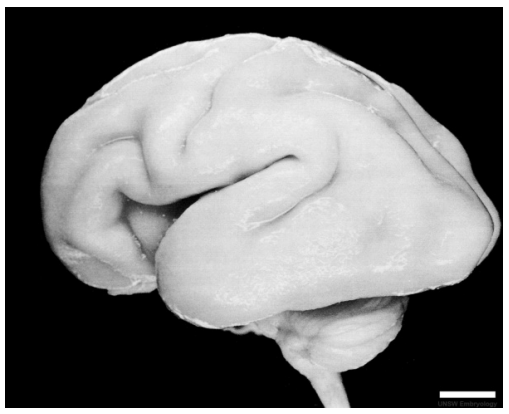


Brain Fissure Development[2]

Sylvian Fissure Development

Third Trimester





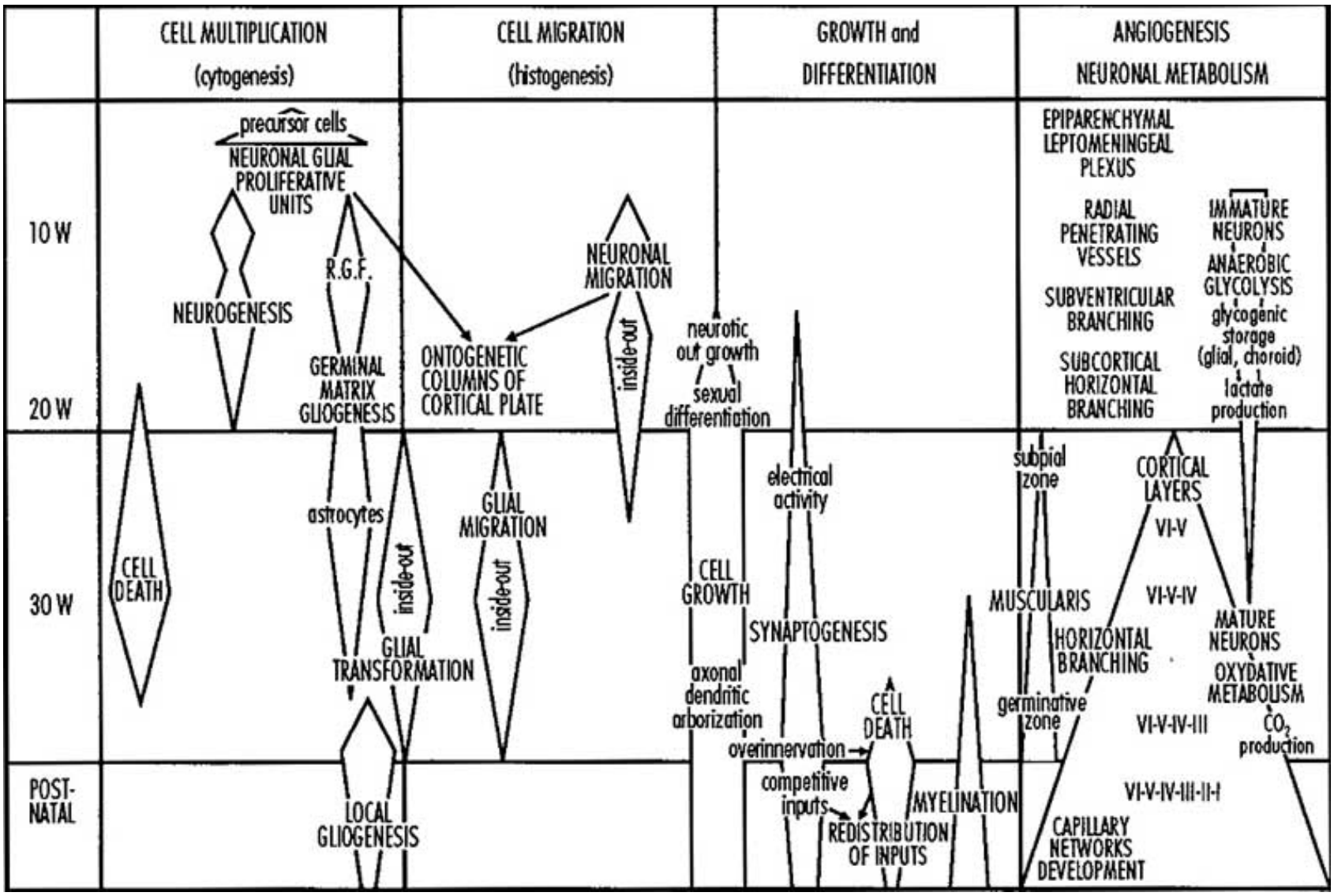
Human Fetus (CRL 240mm) Brain

The brain goes from a smooth surface to begin to fold.

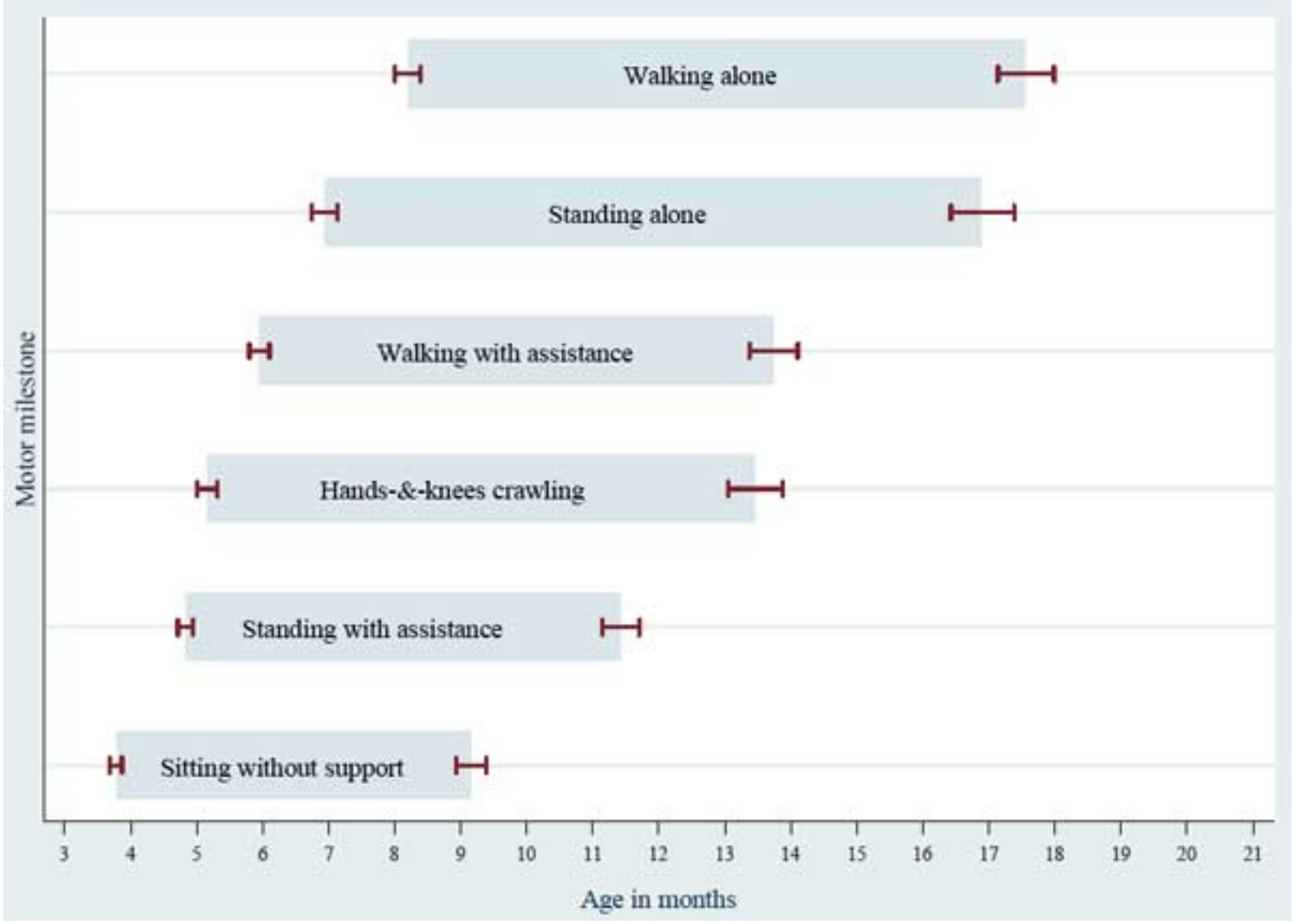
- Folds occur as millions of cells push into the cortex, increasing the surface area.
- **groove** - fissure (plural, fissures).

- **fold** - gyrus (plural, gyri).

Fetal Timeline



Postnatal

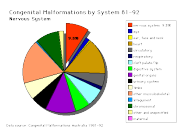


Movies

Abnormalities

There are a large number of different neural abnormalities associated with genetic, environmental and unknown causes. These can also involve several different systems including: neural tube, neural crest, sensory development, ventricular and vascular system development.

It would be difficult to cover all in this current lecture so a few examples are given and students should explore the topic more widely themselves.



Links: Neural System - Abnormalities | Neural Crest Abnormalities | Ventricular Abnormalities

- spina bifida and anencephaly
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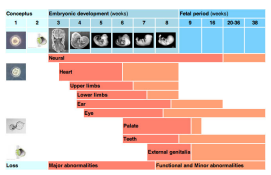
- Congenital hydrocephalus (MRI)
- Dandy Walker malformation (MRI)
- Intestinal aganglionosis

Environmental

	The long time course of neural development (week 3 through to postnatal) also means that a large number of different environmental factors, including dietary deficiency, can impact upon its development and also have a range of different effects. • Infections • Folate • Iodine • Alcohol

Postnatal Neural Assessment - there are several basic clinical motor assessments that can identify normal and abnormal development.

Terms

1. ↑ **Embryonic vertebrate central nervous system: revised terminology. The Boulder Committee.** Anat. Rec.: 1970, 166(2);257-61 PubMed 5414696
2. ↑ [2.0] [2.1] Hao Huang, Rong Xue, Jiangyang Zhang, Tianbo Ren, Linda J Richards, Paul Yarowsky, Michael I Miller, Susumu Mori **Anatomical characterization of human fetal brain development with diffusion tensor magnetic resonance imaging.** J. Neurosci.: 2009, 29(13);4263-73 PubMed 19339620 | PMC2721010 | J Neurosci.

BGDA: Lecture 1 | Lecture 2 | Practical 3 | Practical 6 | Practical 12 | **Lecture Neural** | Practical 14 | *Histology Support* - Female | Male | Tutorial

Glossary Links

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What Links Here?