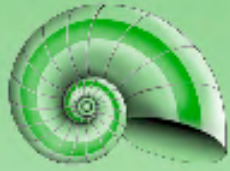




## Development of the Embryo/Fetus - 2

Dr Mark Hill  
Cell Biology Lab, SOMS  
Room G20 Wallace Wurth Bldg  
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BEGINNINGS GROWTH AND DEVELOPMENT



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BEGINNINGS GROWTH AND DEVELOPMENT

# Movie: Embryo Development





## Aims

- Aid in the development of an understanding of embryo/fetal development



- Lecture Slides
- <http://embryology.med.unsw.edu.au/class.htm>

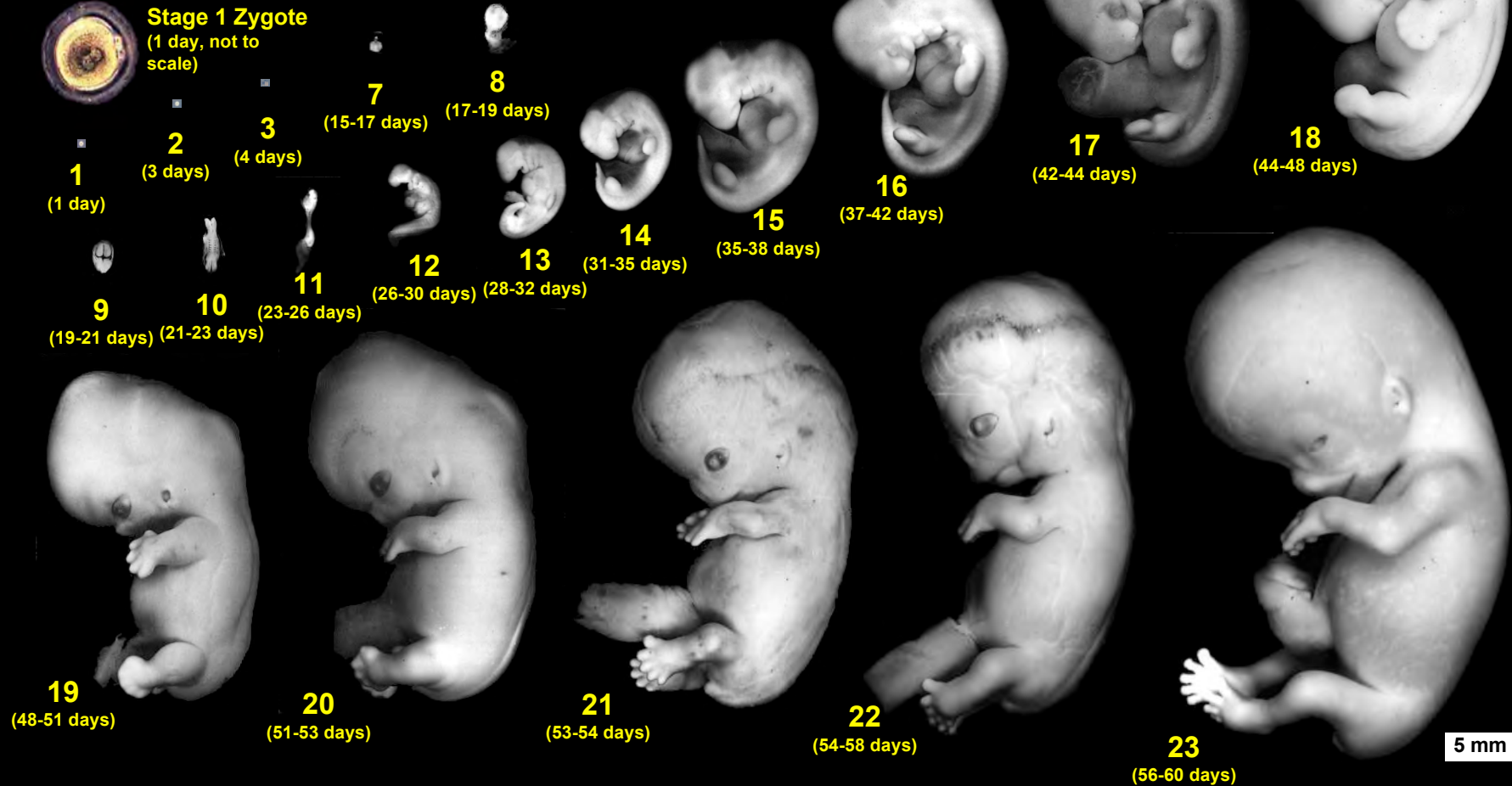


## Key Concepts

- Embryonic Development
- Organ / System
  - Development
  - Functioning / Not Functional
- Dynamic changes
- Carnegie stages
  - to understand external embryonic development
  - <http://embryology.med.unsw.edu.au/wwwhuman/Stages/CStages.htm>
    - Shows stages and key changes occurring

# Carnegie Stages of Human Development

Dr Mark Hill, Cell Biology Lab, School of Medical Sciences (Anatomy), UNSW



## Acknowledgements

Special thanks to Dr S. J. DiMarzo and Prof. Kohei Shiota for allowing reproduction of their research images and material from the Kyoto Collection and Ms B. Hill for image preparation.

Carnegie Stages Online -

<http://embryology.med.unsw.edu.au/wwwhuman/Stages/CStages.htm>

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**BGD1-2.A.S.TeenPreg.L.Embryo2**

Dr M.A. Hill, 2008 -Slide 6

UNSW Embryology

<http://embryology.med.unsw.edu.au/>

**UNSW  
MEDICINE**



## Week 1

- Early Implantation
  - Trophoblast differentiation
  - Embryonic disc
  - Bilaminar embryo
    - Epiblast, hypoblast
- 
- **Note** the following week by week summaries cover what is embryonic feature/process is found at the end of that specific week



## Week 2

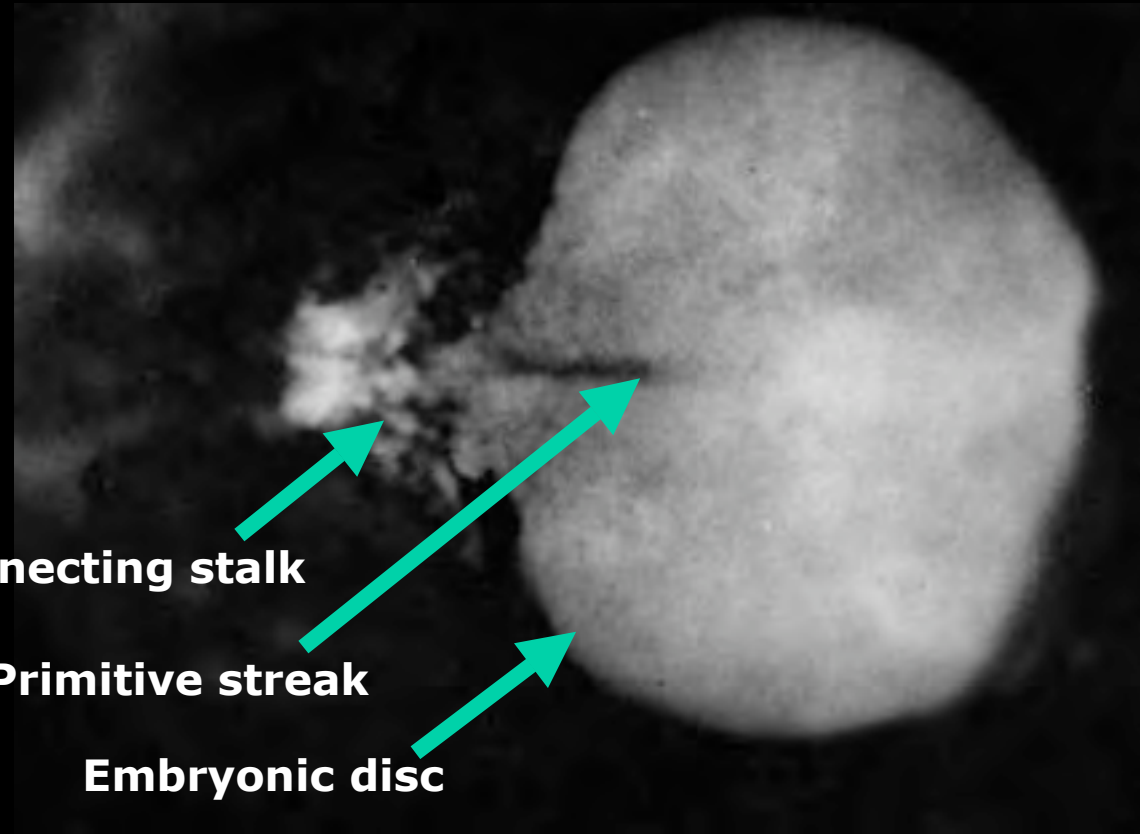
- Embryoblast
  - Gastrulation
    - Cell migration
    - Endoderm then mesoderm
  - Early Trilaminar Embryo
    - Continuing through week 3
- Trophoblast
  - Chorionic Villi
    - Primary, secondary then tertiary
- Uterine decidua changes





BEGINNINGS GROWTH AND DEVELOPMENT

## Carnegie stage 7

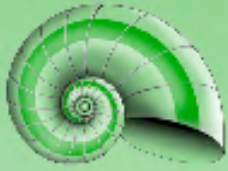


Connecting stalk

Primitive streak

Embryonic disc

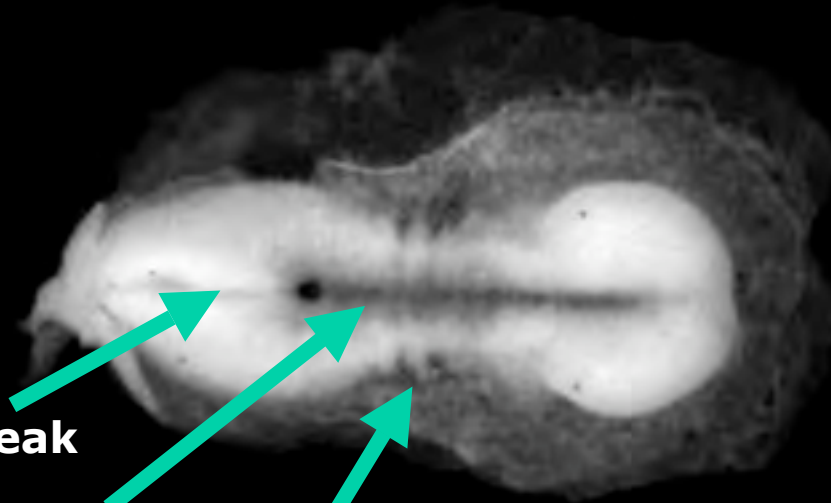
**15-17 days**



BEGINNINGS GROWTH AND DEVELOPMENT



# Carnegie stage 9



**Primitive streak**

**Neural groove**

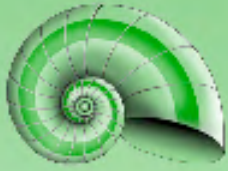
**Earliest somites**

**19-21 days**



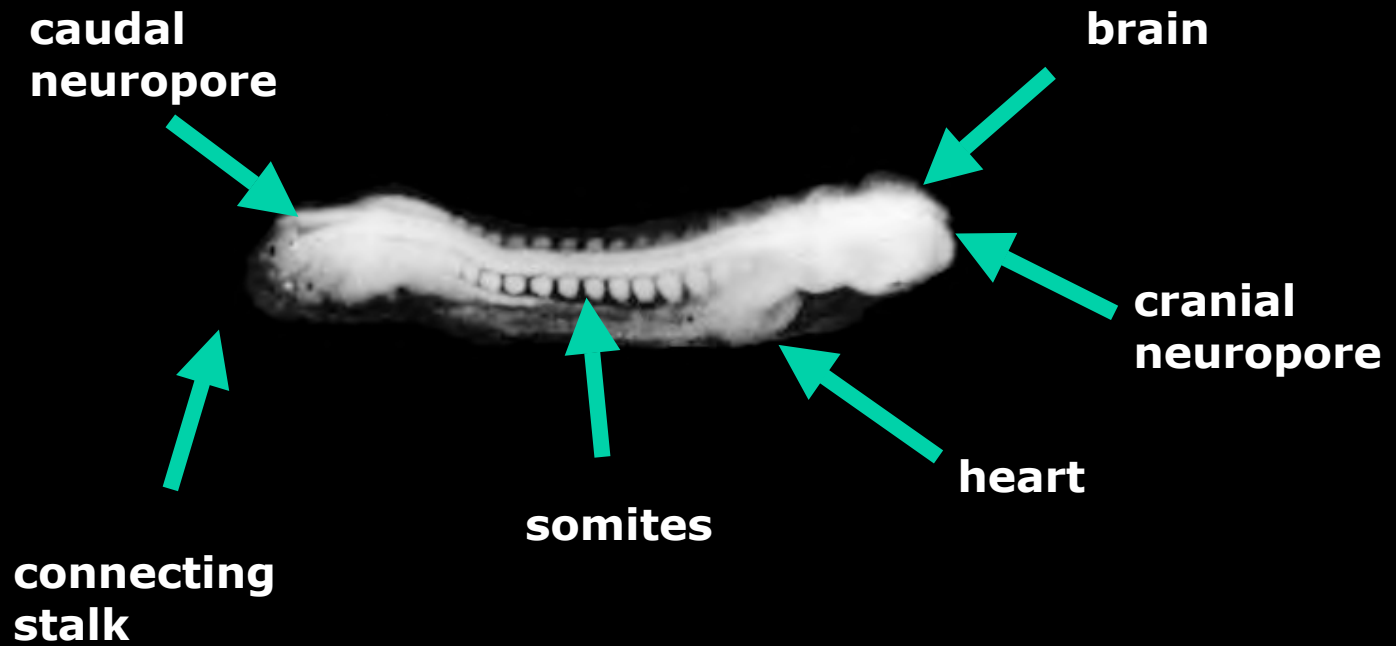
## Week 3

- Ectoderm
  - Nervous
    - Neural tube fusion
- Mesoderm
  - Prechordal
    - Heart tube fusion, folding
  - Intermediate mesoderm
  - Somites
    - Axial skeleton, dermis, musculature
- Fetal Membranes
  - Growth of amnion and chorion
- Placenta
  - Development of placental blood vessels



BEGINNINGS GROWTH AND DEVELOPMENT

# Carnegie stage 11

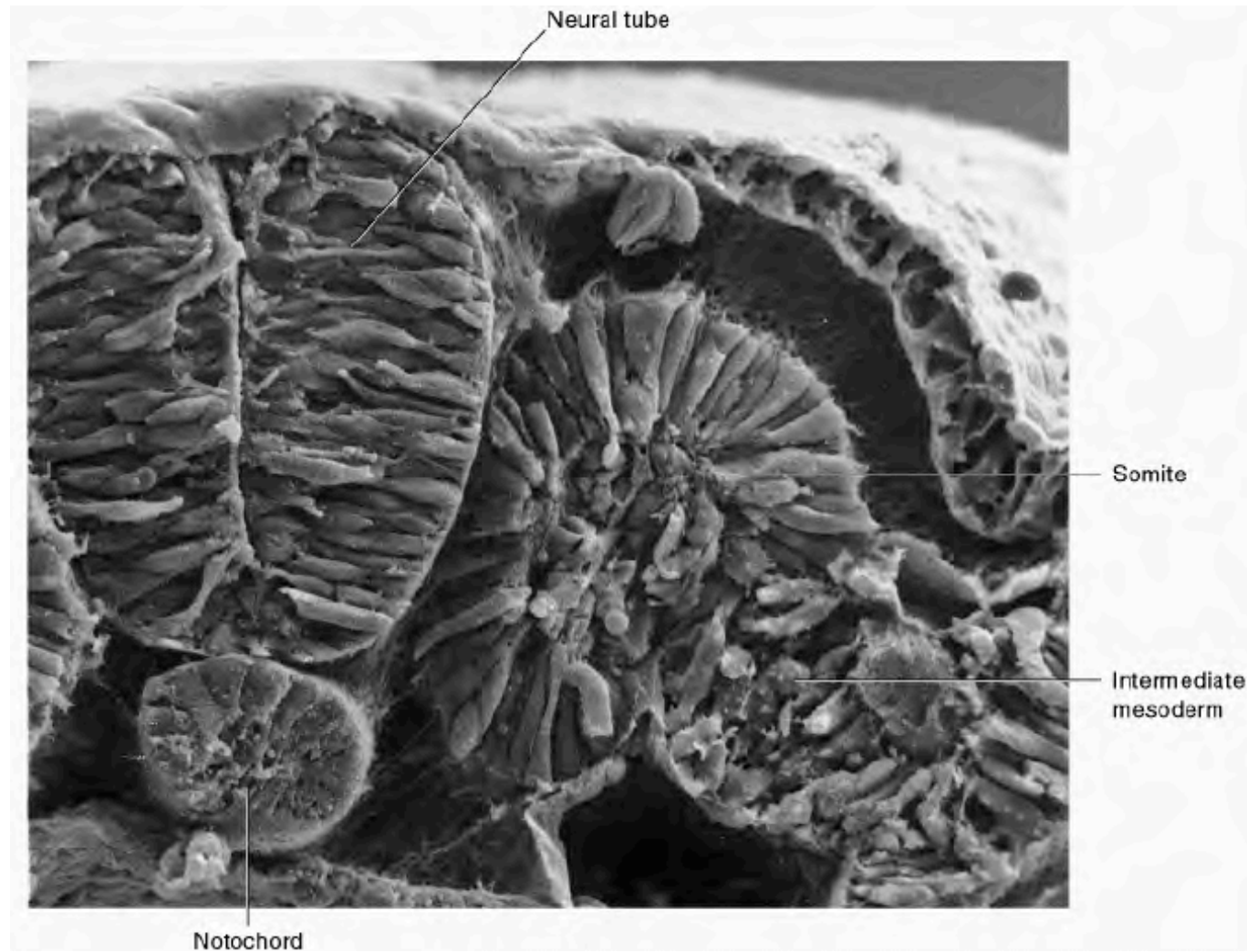


**23-26 days**



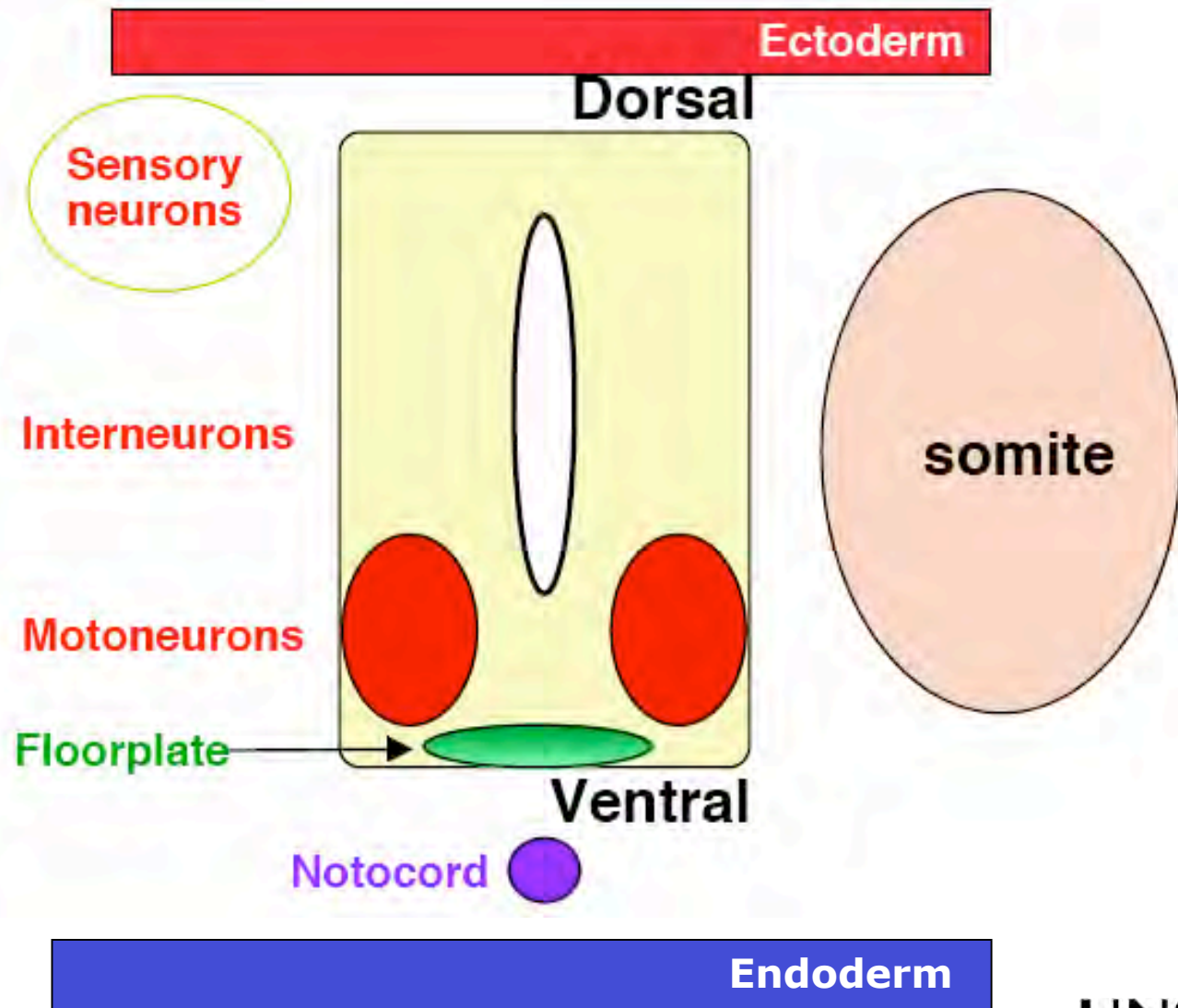
BEGINNINGS GROWTH AND DEVELOPMENT

# Somites





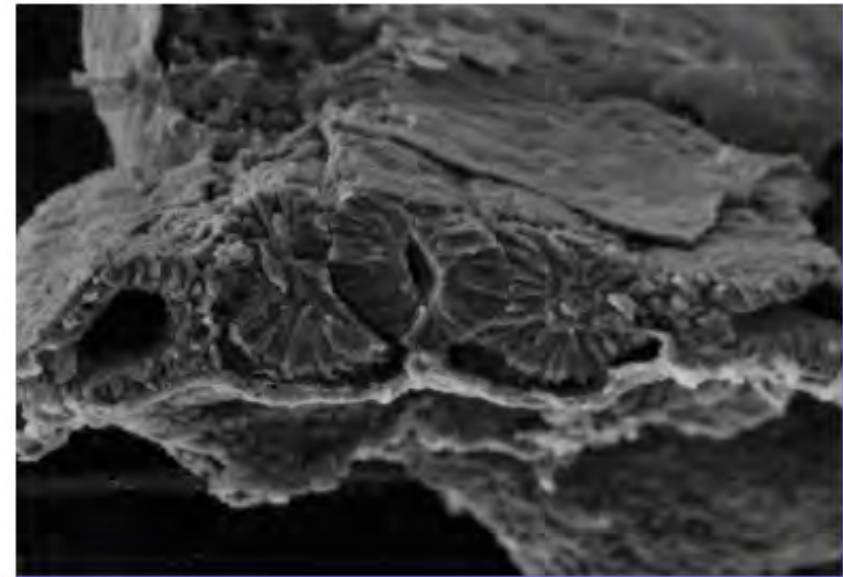
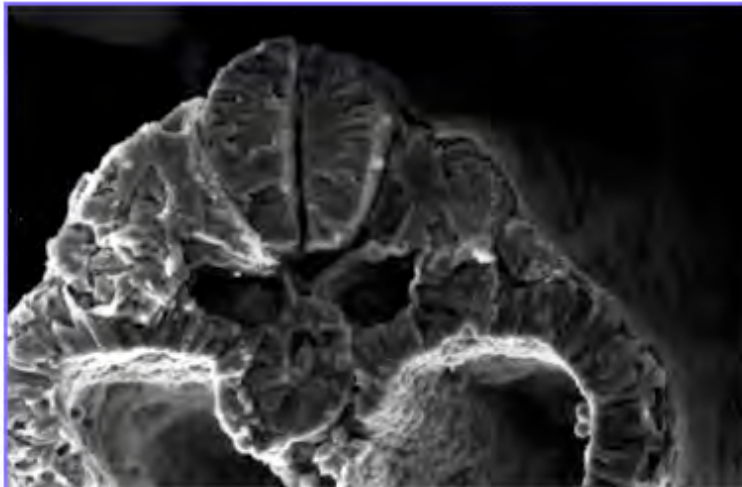
# Spinal Cord cross-section





## Intermediate Mesoderm

- lies between paraxial and lateral mesoderm
- generates urogenital system
- Wolffian duct, kidney





## Week 4

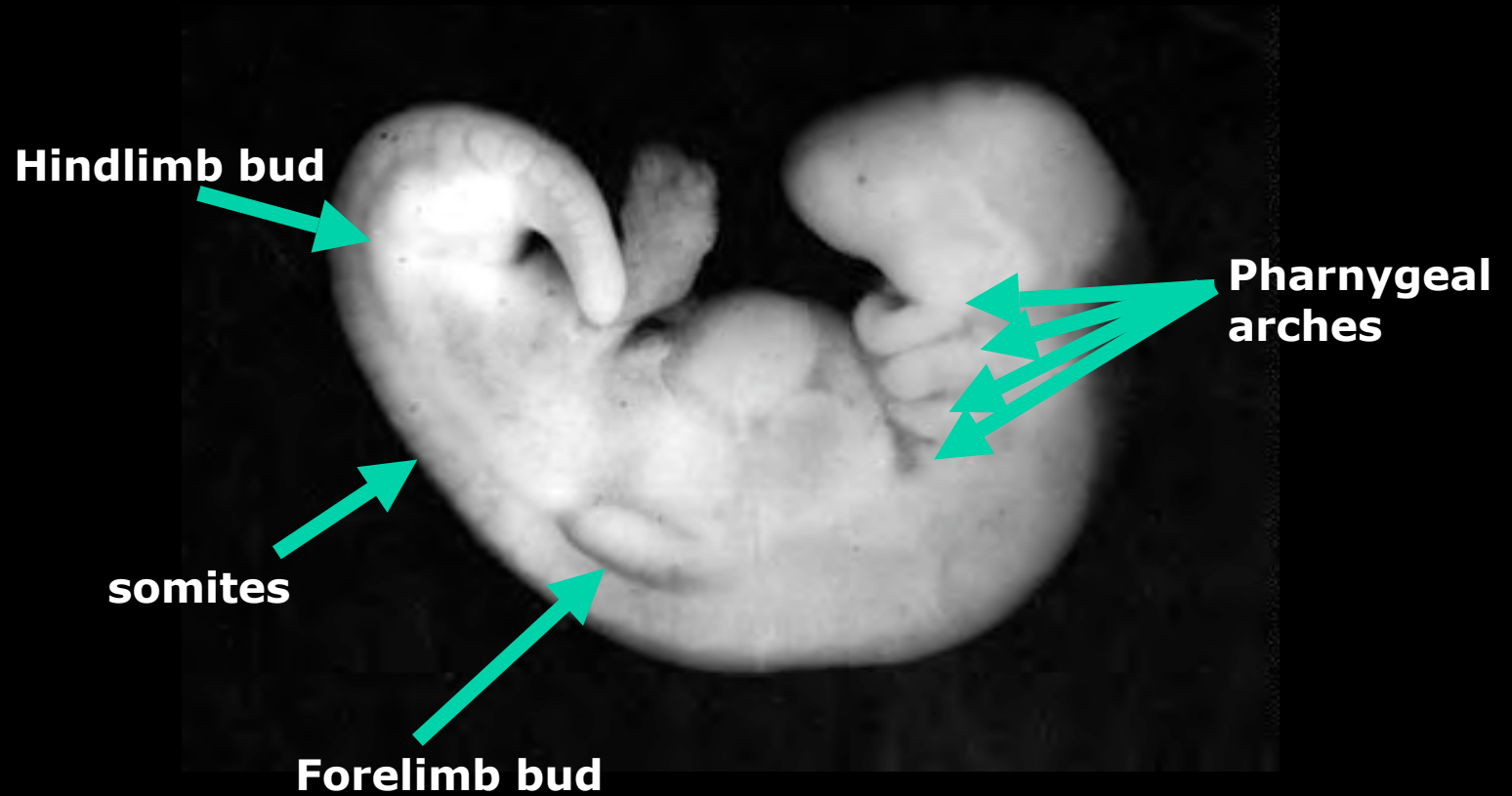
- Head
  - 4 pharyngeal arches
- Limb
  - Both upper and lower limb buds
- Sensory
  - Sensory placodes, otic vesicle
- Heart
  - Functioning (beats)
- Respiratory
  - Early lung buds



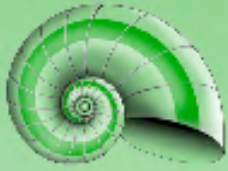


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# Carnegie stage 13



**28-32 days**



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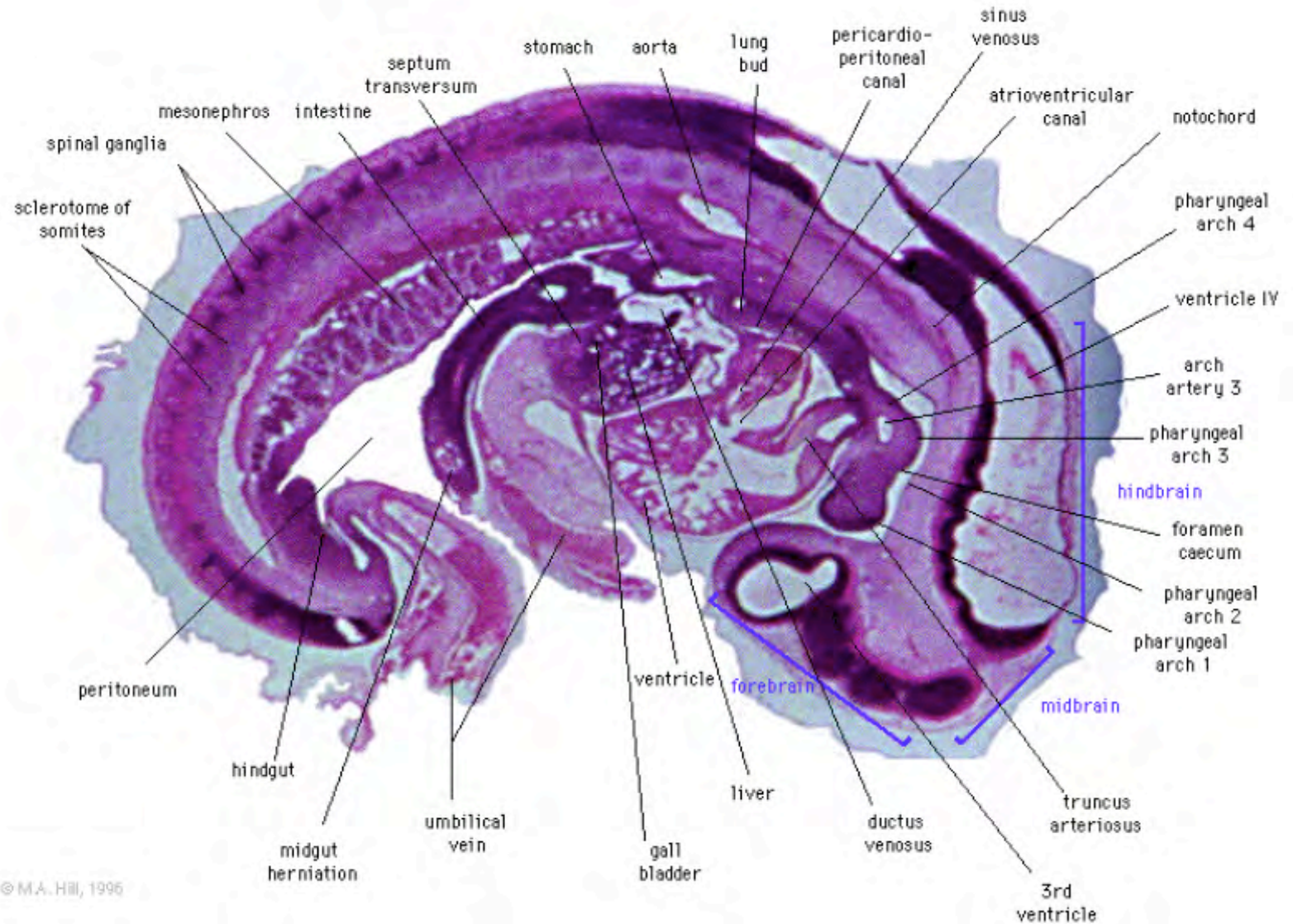
# Carnegie stage 14



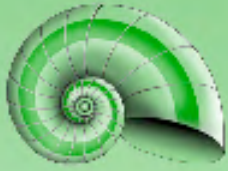
**31-35 days**



# Stage 13/14 Embryo

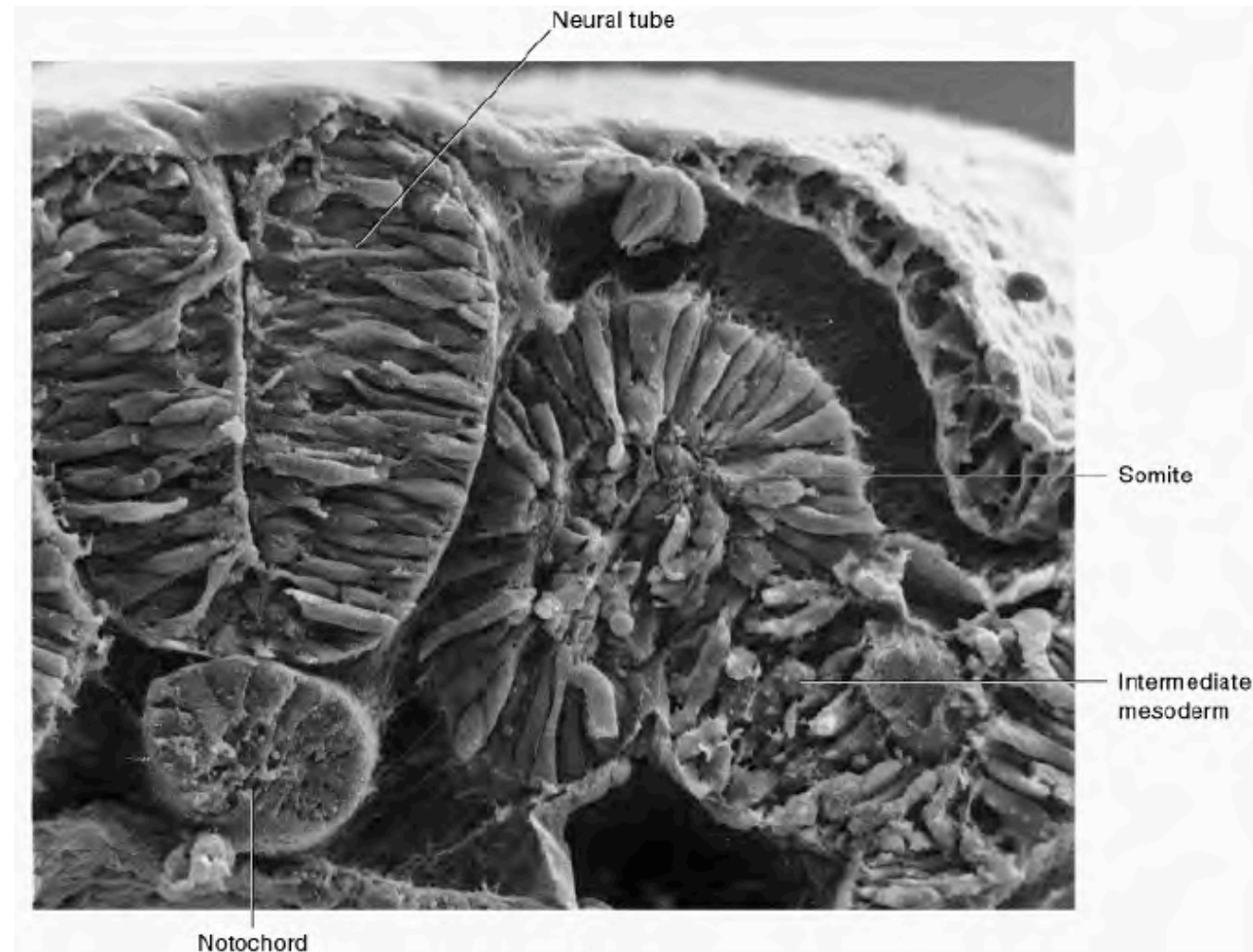


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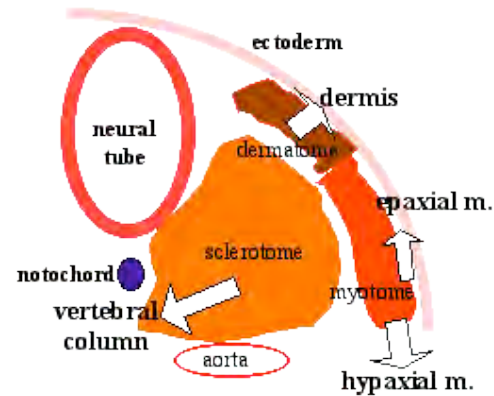
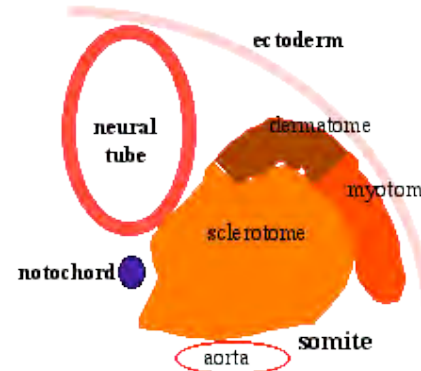
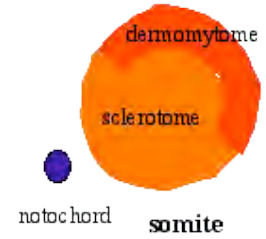
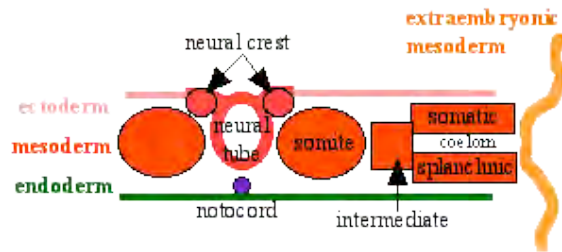
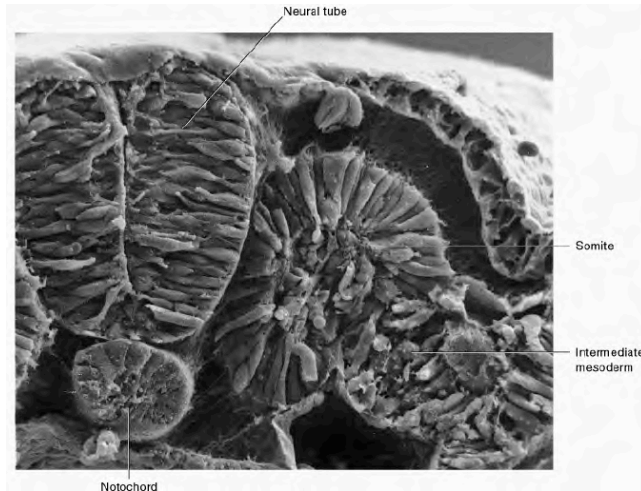
# Somites





BEGINNINGS OF GROWTH AND DEVELOPMENT

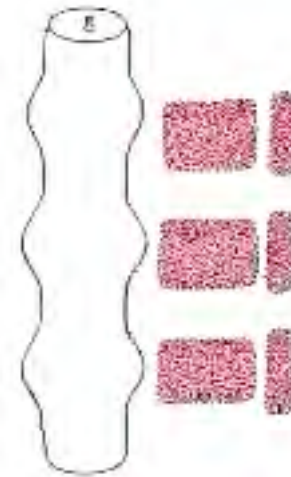
# Somites





BEGINNINGS GROWTH AND DEVELOPMENT

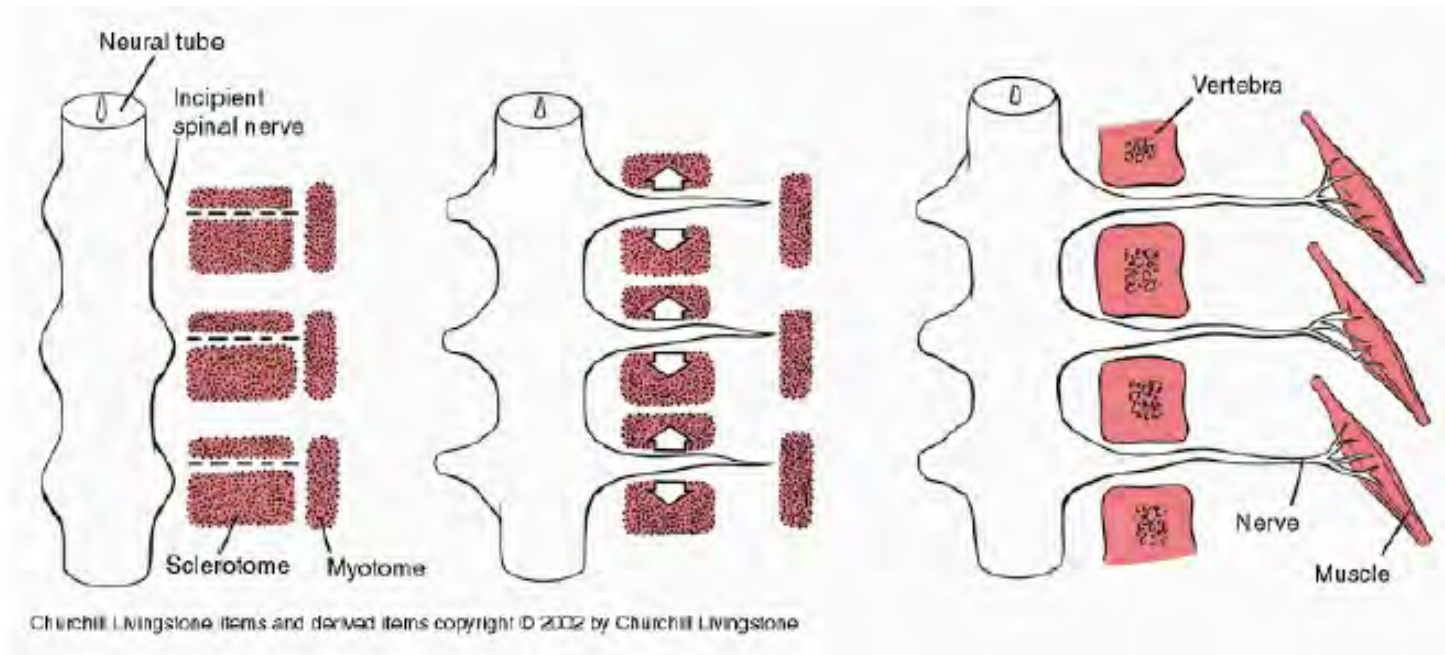
## Movies: Somite /Vertebra





BEGINNINGS GROWTH AND DEVELOPMENT

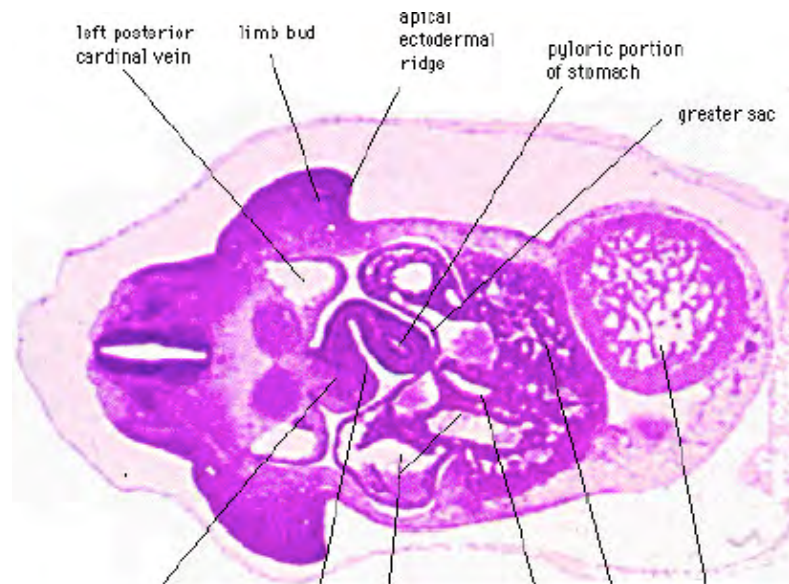
# Axial Segmentation





## Sclerotome

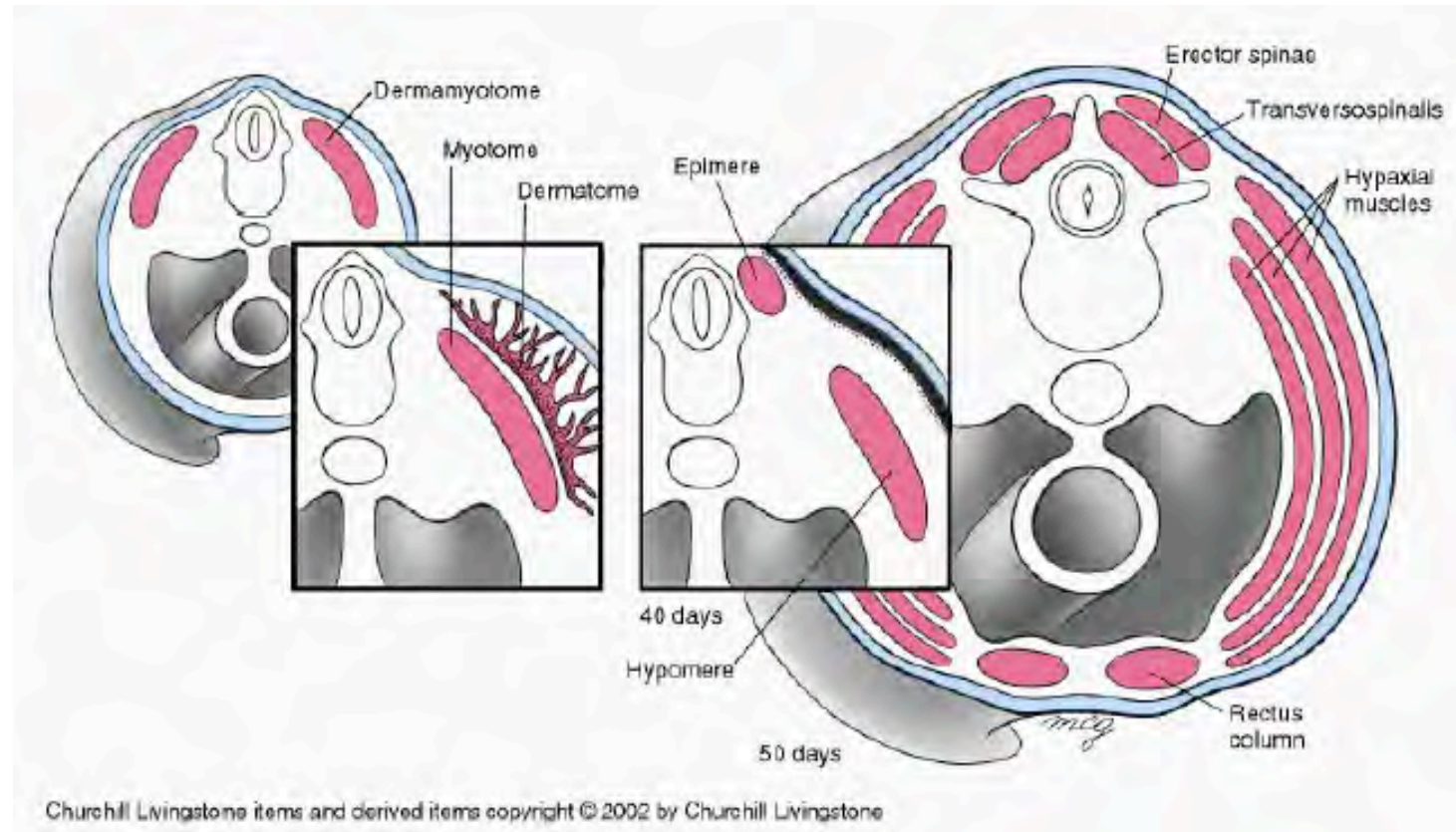
- sclerotome later becomes subdivided
- rostral and caudal halves separated laterally by von Ebner's fissure
  - half somites contribute to a single vertebral level body
  - other half intervertebral disc
    - therefore final vertebral segmentation "shifts"

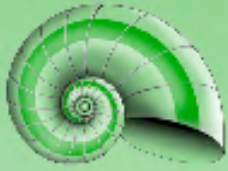






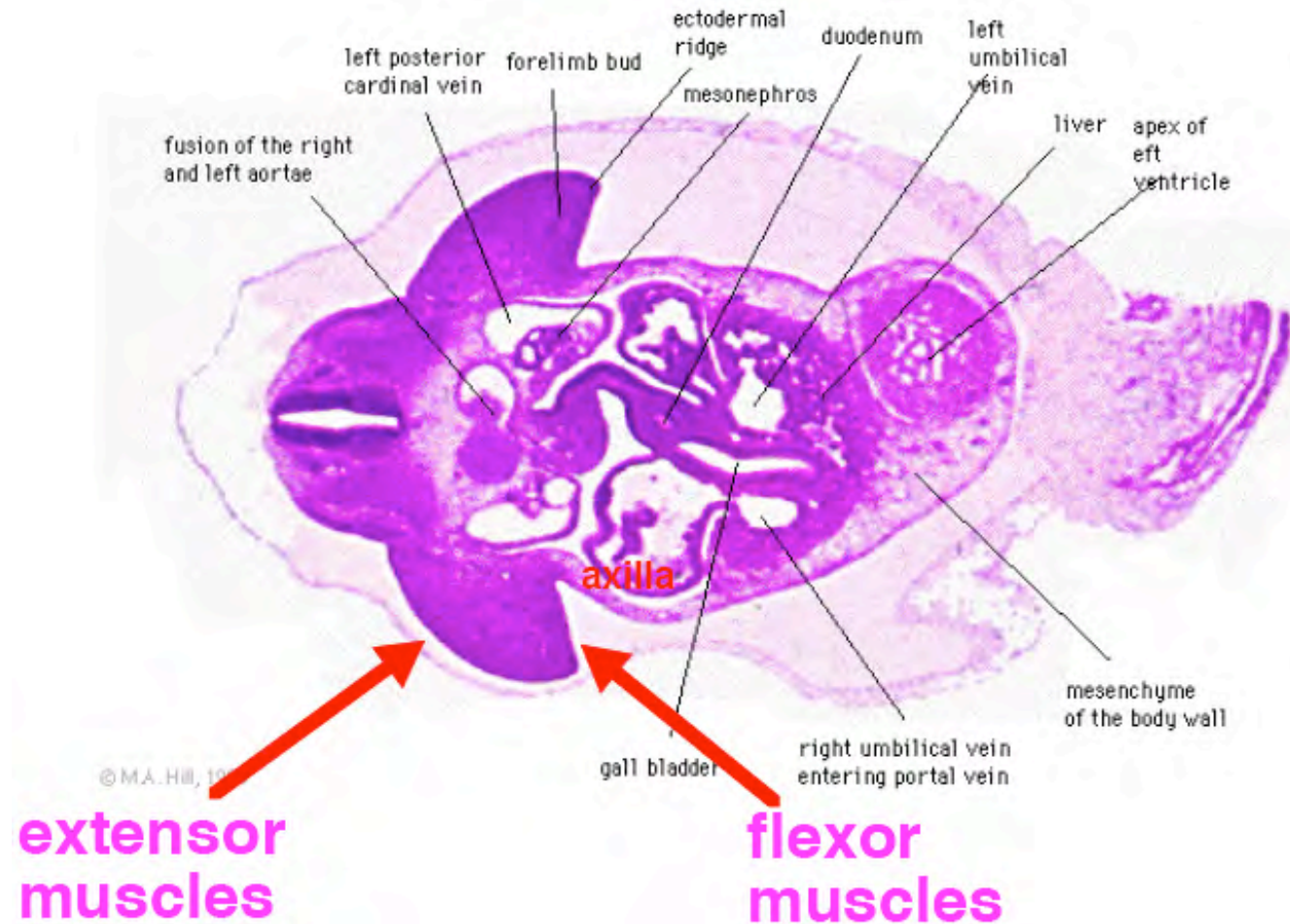
# Body Musculature





BEGINNINGS OF GROWTH AND DEVELOPMENT

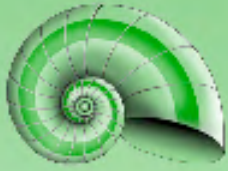
# Forelimb Muscles





## Week 5

- Neural
  - Primary brain vesicles
- Limb
  - Hand and foot plates
- Sensory
  - Sensory placodes
  - nasal pit, eyes
- Heart
  - Heart chamber formation



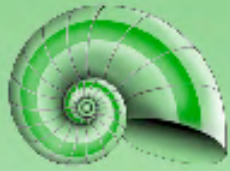
BEGINNINGS GROWTH AND DEVELOPMENT



# Carnegie stage 16

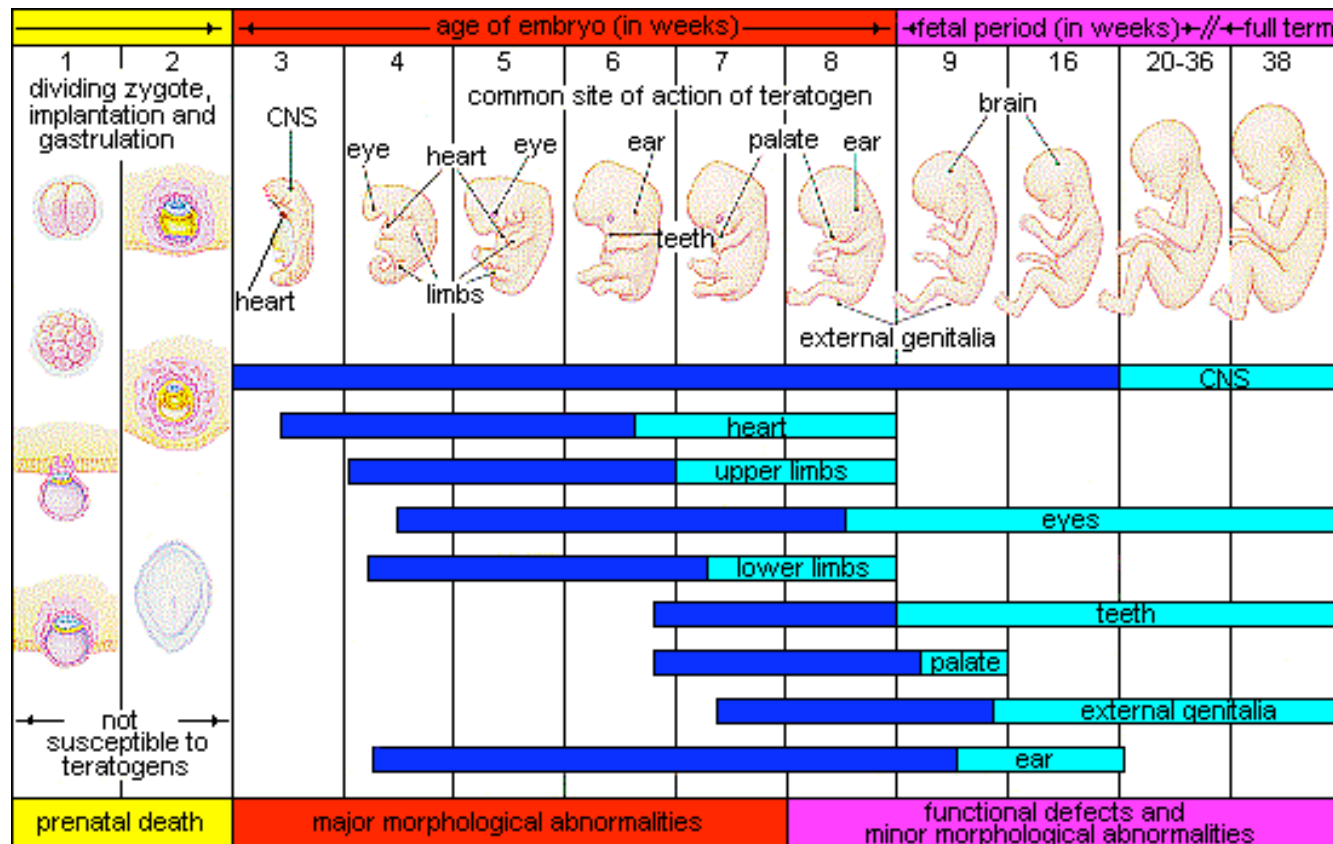


**37-42 days**



BEGINNINGS GROWTH AND DEVELOPMENT

# Critical Periods of Development

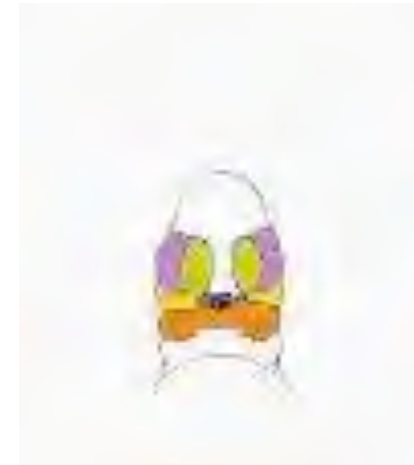


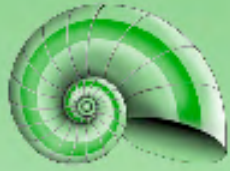
Dark Blue Bars  
very sensitive to teratogens



BEGINNINGS GROWTH AND DEVELOPMENT

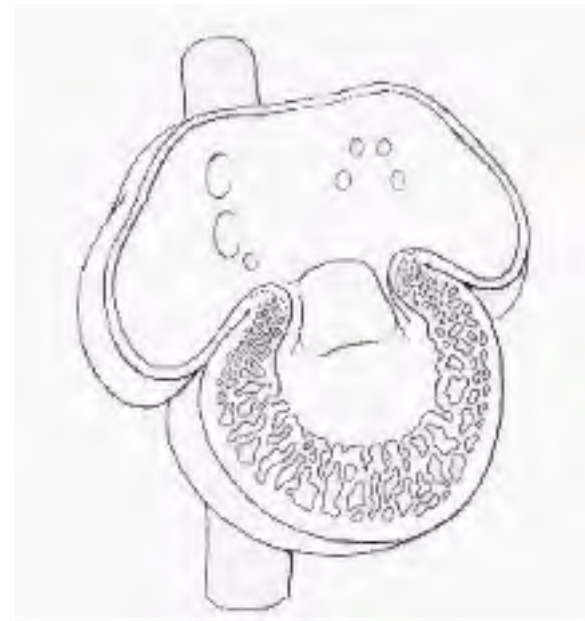
# Face Development





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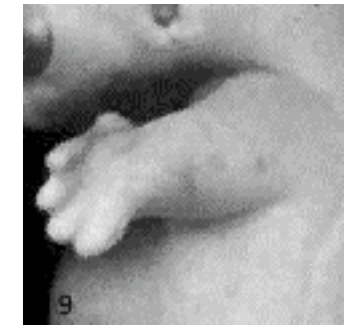
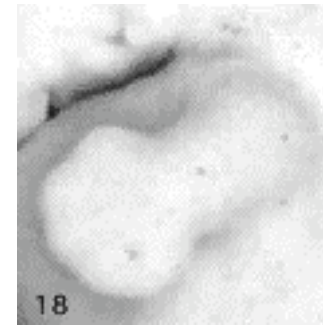
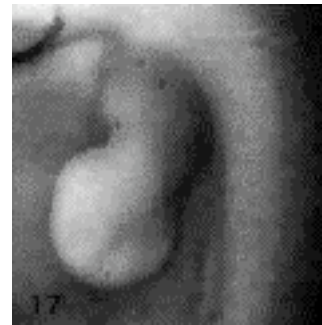
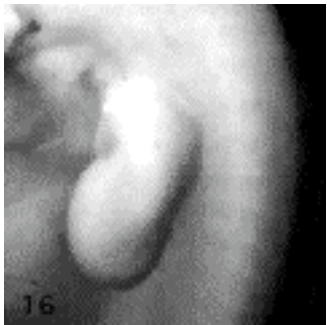
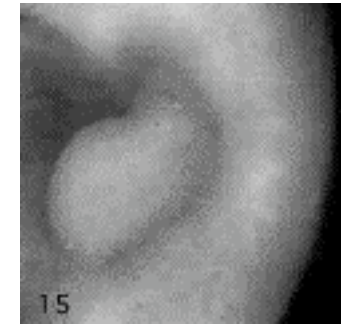
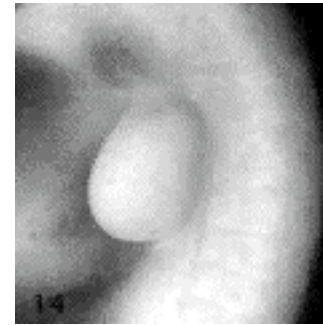
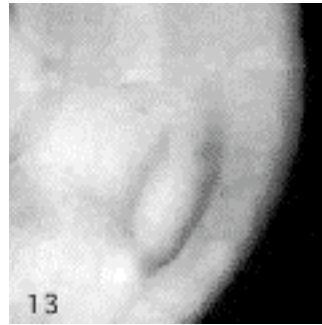
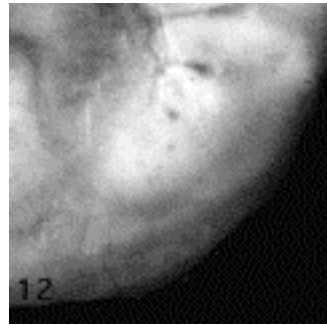
# Heart Development





BEGINNINGS GROWTH AND DEVELOPMENT

# Upper Limb Carnegie Stages

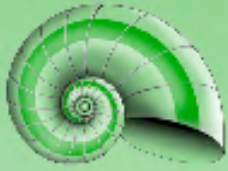






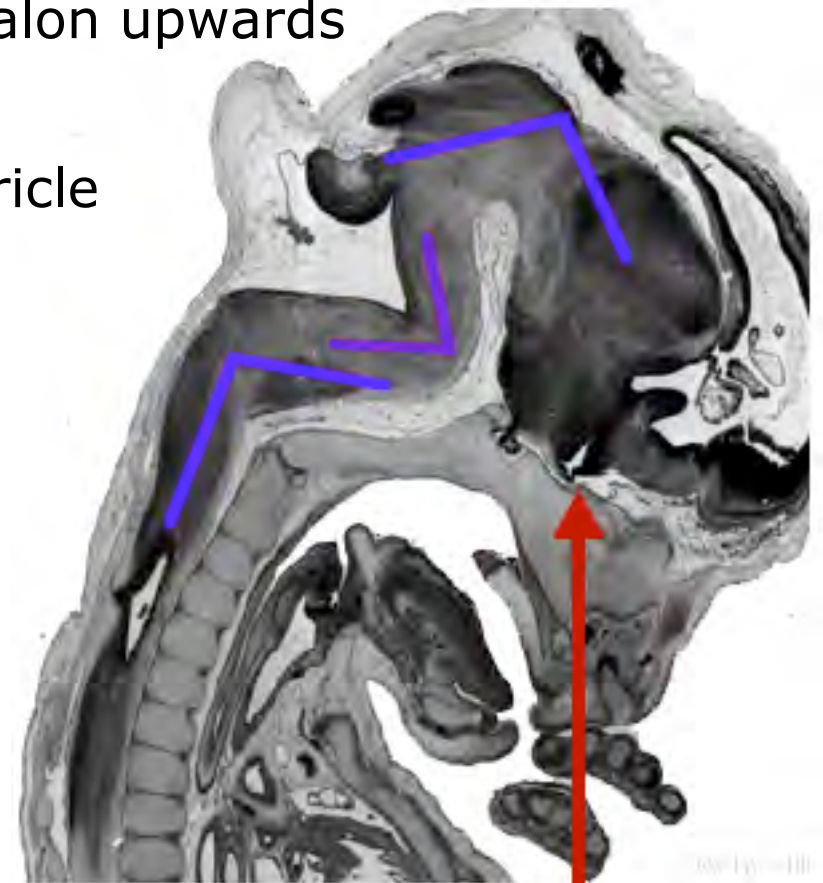
## Week 6

- Head
  - growth
- Neural
  - Flexures, 4th ventricle
- Endocrine
  - Pituitary, thyroid
- Limb
  - Digital rays
- Sensory
  - Sensory placodes (otic, nasal pit, optic)
- Heart
  - Heart chamber formation



## Brain Flexures

- cervical flexure
  - between brain stem and spinal cord
- midbrain flexure
  - pushes mesencephalon upwards
- pontine flexure
  - generates 4th ventricle



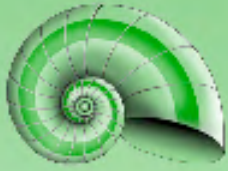


BEGINNINGS GROWTH AND DEVELOPMENT

# Carnegie stage 17

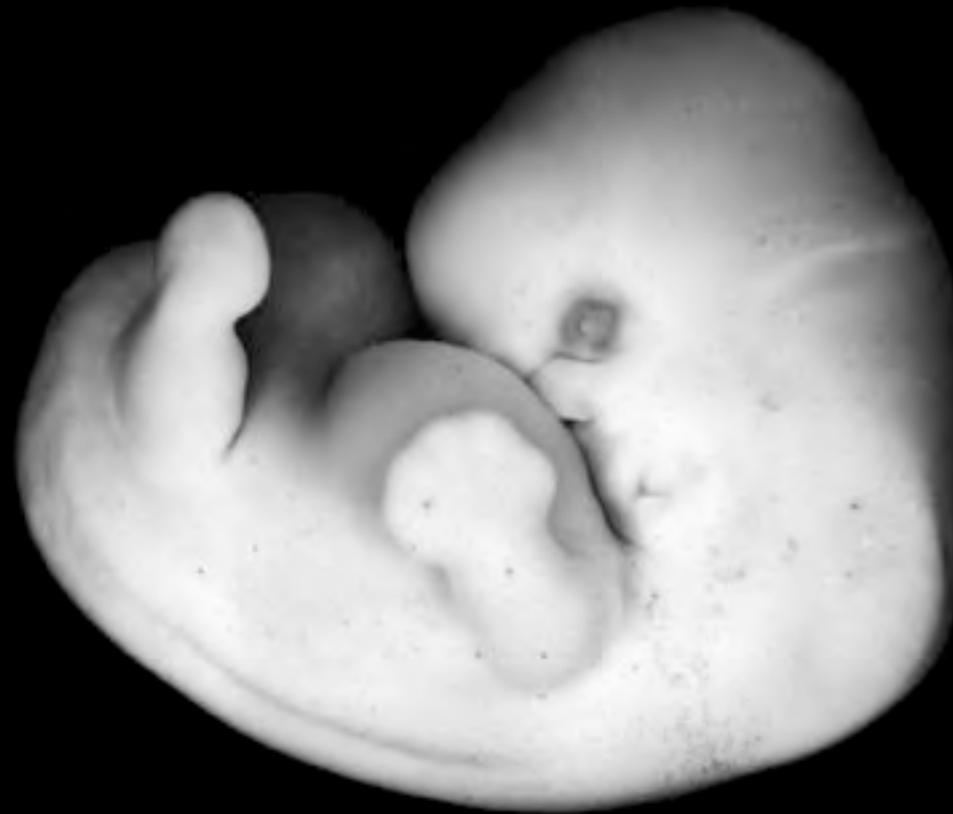


42-44 days



BEGINNINGS GROWTH AND DEVELOPMENT

# Carnegie stage 18



44-48 days



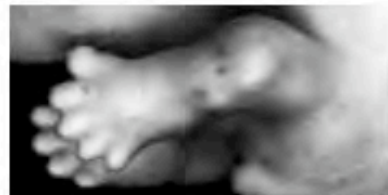
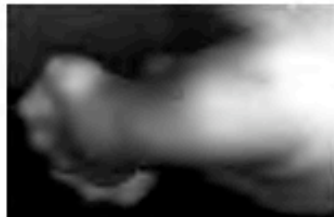
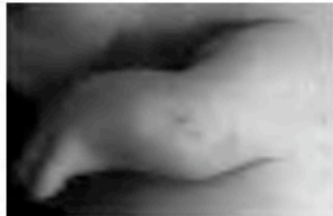
## Week 7

- Head
  - Facial features
- Neural
  - Flexures, 4th ventricle
- Endocrine
  - Pituitary, thyroid, external genitalia
- Limb
  - Elongation, rotation
- Sensory
  - Eyelids, auricles



BEGINNING

# Limb External Appearance



Day 50

Day 56

There are critical stages/times that impact on development of specific systems



BEGINNINGS GROWTH AND DEVELOPMENT

# External Ear



Early fetus

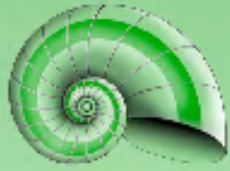


Late fetus



Newborn

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# Carnegie stage 19



**48-51 days**



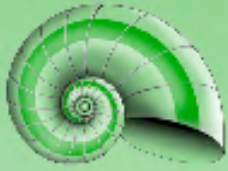


BEGINNINGS GROWTH AND DEVELOPMENT

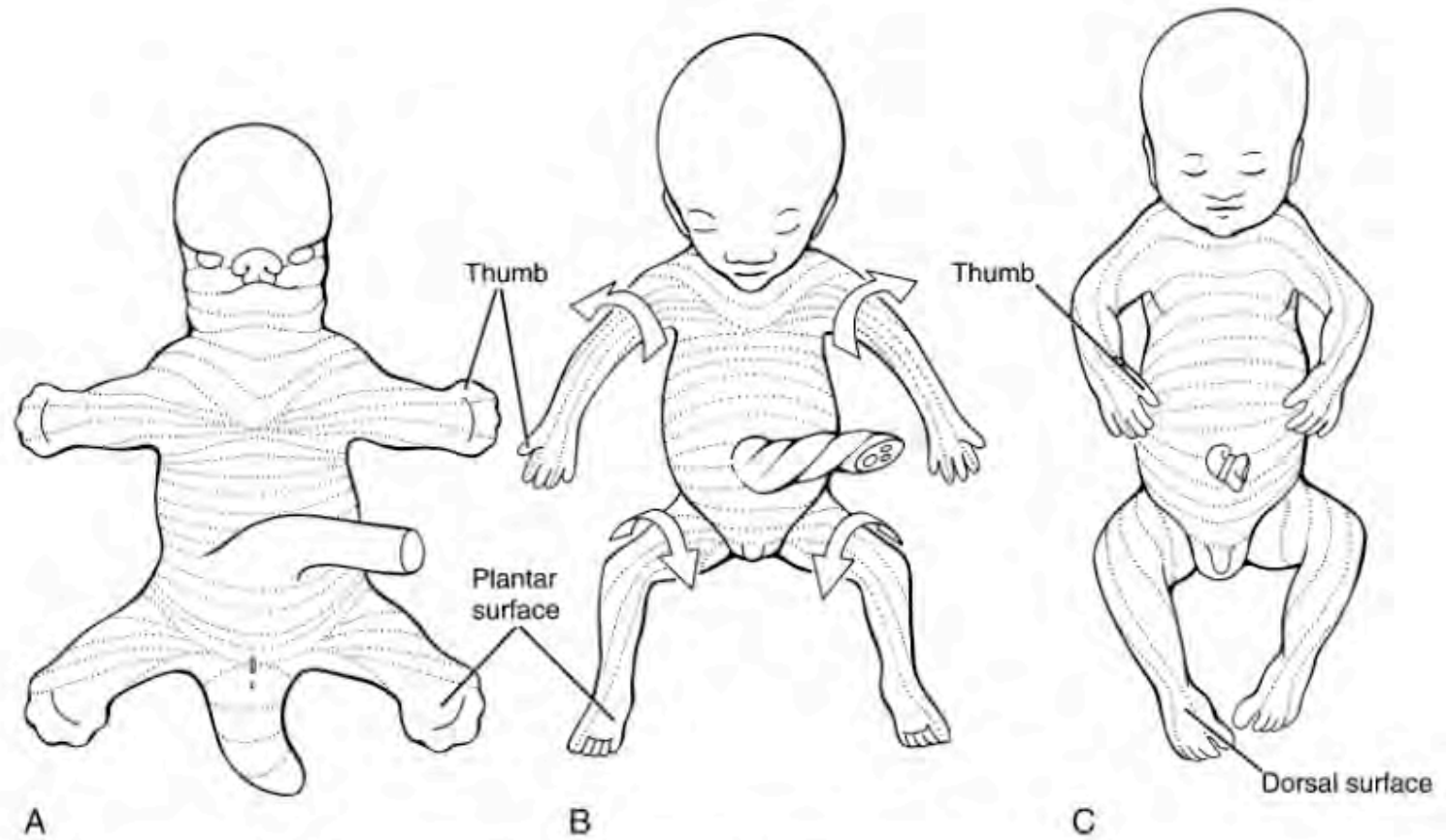
# Carnegie stage 20



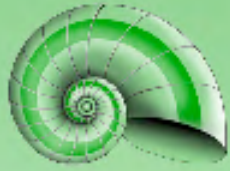
**51-53 days**



# Limb Rotation



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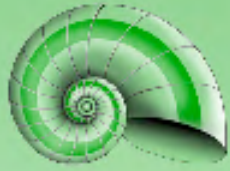


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# Carnegie stage 21



53-54 days

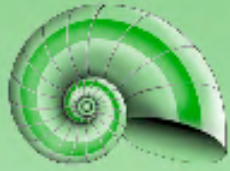


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# Carnegie stage 22



54-58 days



BEGINNINGS GROWTH AND DEVELOPMENT

# Carnegie stage 23

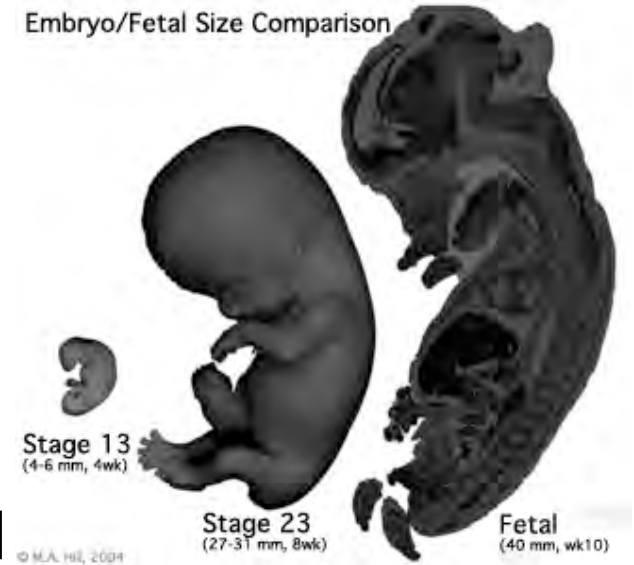


**56-60 days**



## Week 8

- End of Embryonic Period
  - Most organs formed
  - Not all functioning
- Beginning of Fetal Period





## End of Week 8 Systems

- Nervous
  - CNS, PNS, sensory
- Cardiovascular
  - Heart, blood vessels
- Skeletal
  - Axial, Limbs, Muscle, connective tissue
- Digestive
  - Gastrointestinal tract and associated organs
- Urogenital
  - Kidney, gonad
- Respiratory
  - Upper respiratory tract, lungs



# Nervous System

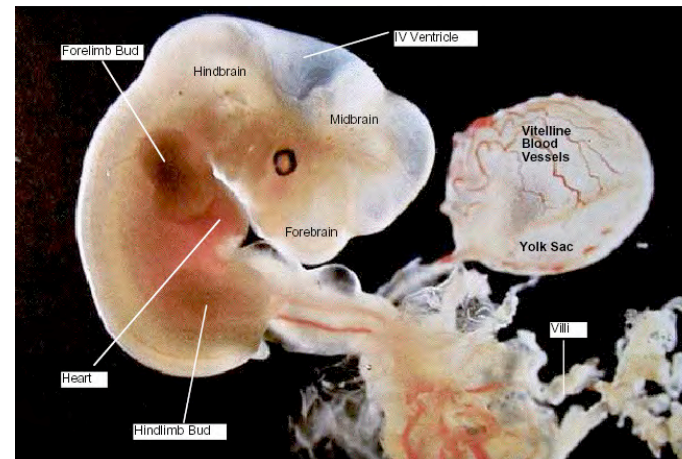
- Spinal cord
  - extends to coccygeal level
  - Basal and alar plates
- Brain
  - 5 secondary vesicles
  - Olfactory bulb
  - Cranial nerves

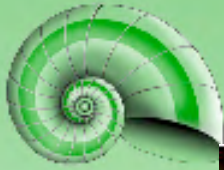




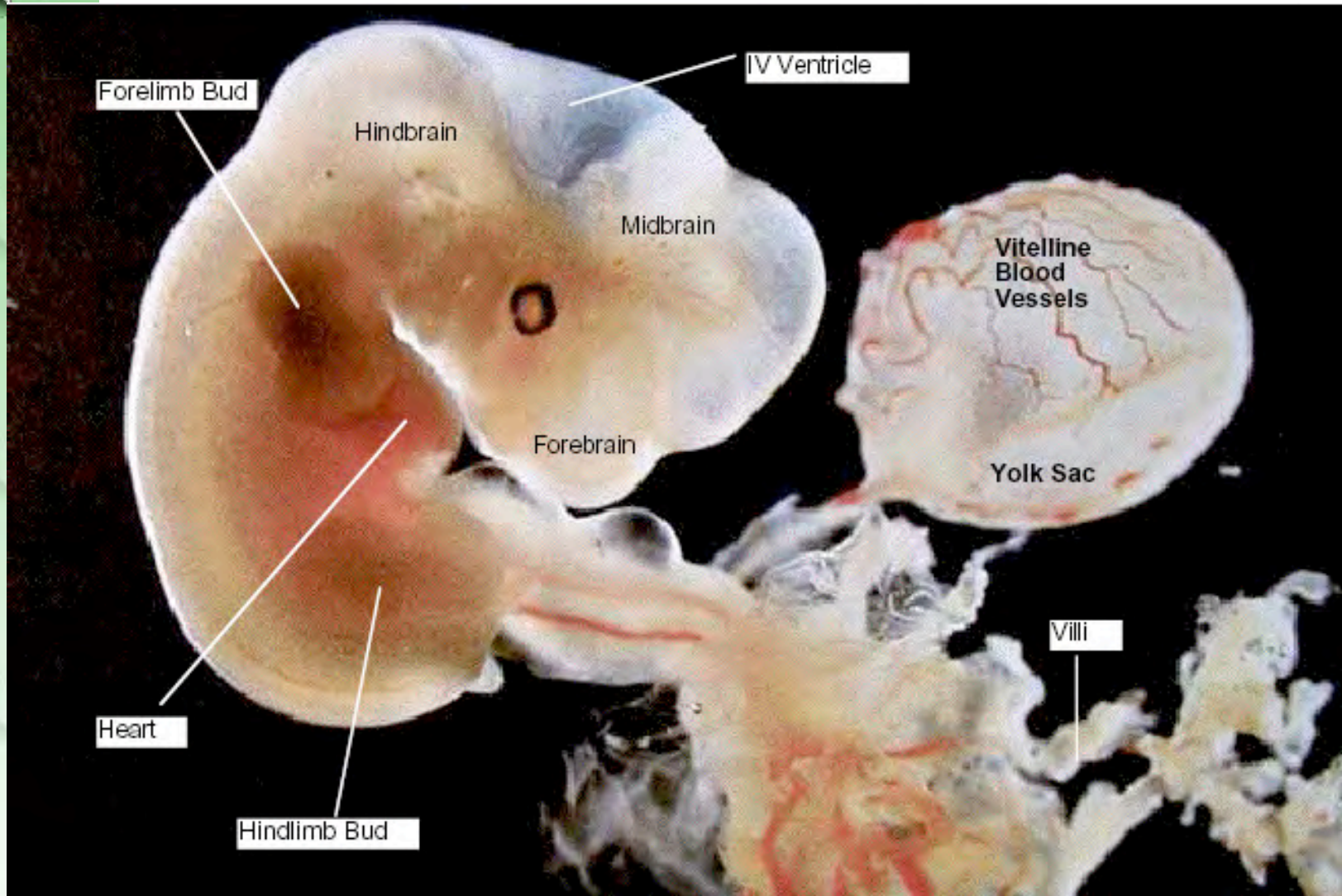
# Cardiovascular System

- Heart
  - 4 chambered heart
- Cardiac outflow
  - Transformed aortic arches
  - Pulmonary trunk
- Blood Vessels
  - Systemic, vitelline, placental
  - Vascular bed development in tissues





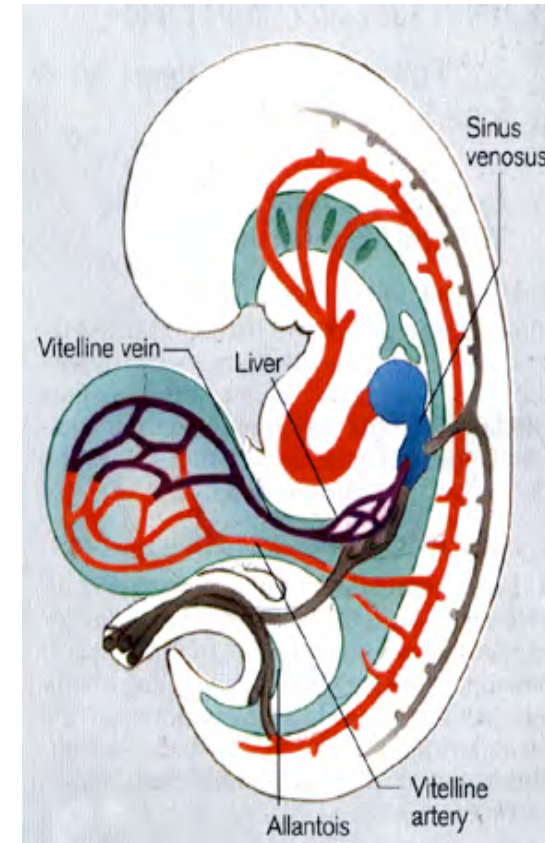
# Embryonic Blood Vessels

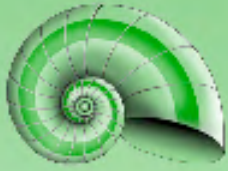




## Vitelline Blood vessels

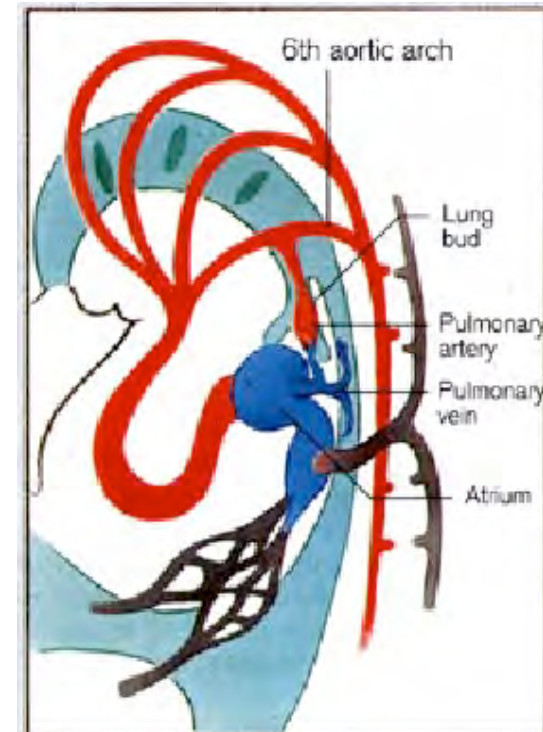
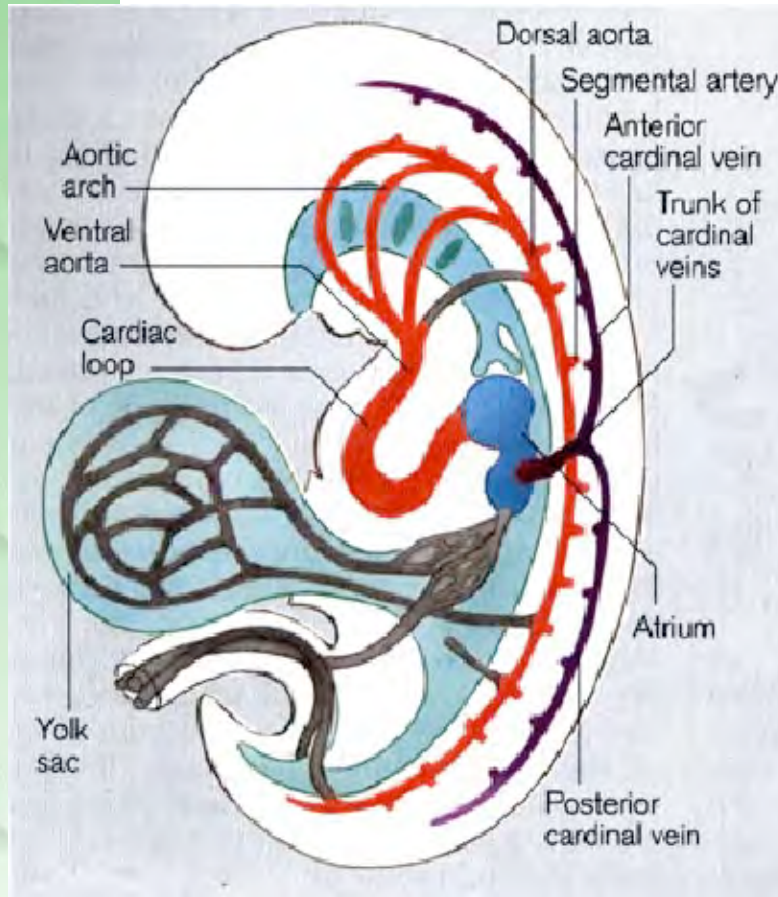
- cover entire surface of yolk sac
- connect to embryo through yolk stalk
- Arteries
  - arises from dorsal aorta
  - contribute to adult GIT arteries
- Veins
  - empties into sinus venosus
  - contribute to the adult portal system





BEGIN

# Systemic Circulation

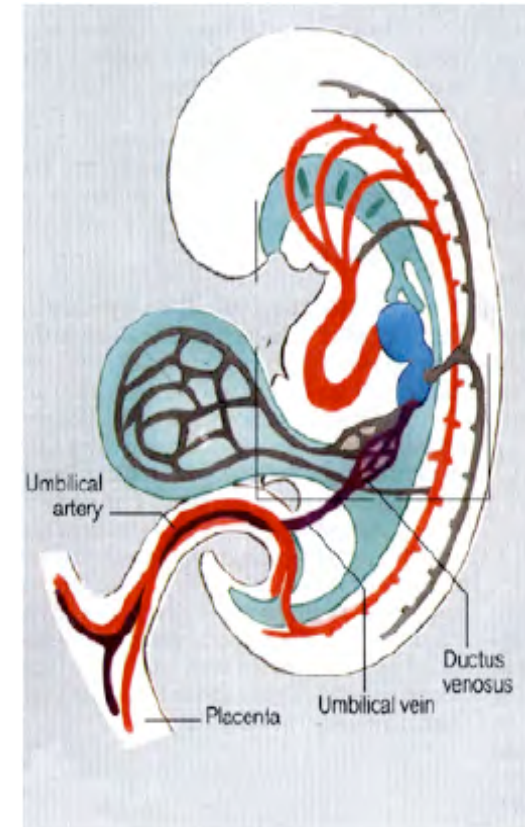


Pharyngeal arch arteries



## Placental Blood vessels

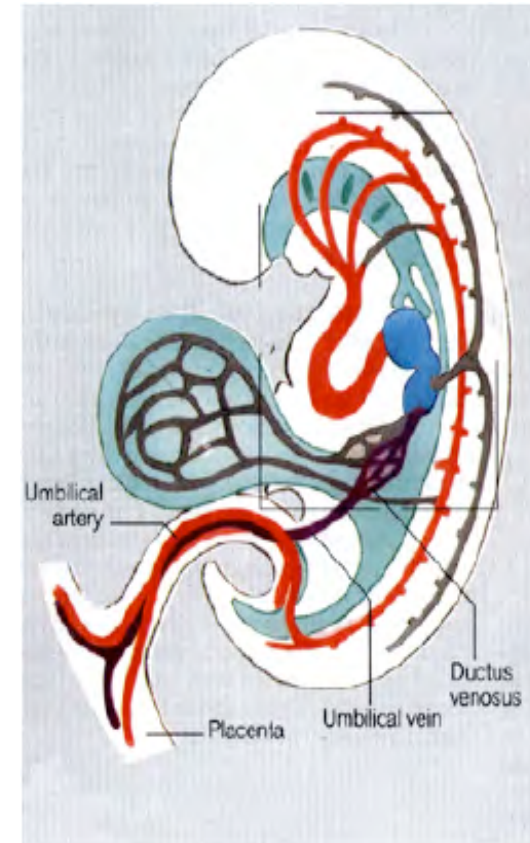
- Initially form in the connecting stalk
- Then umbilical cord
  - anastomose in chorion
  - extend maternally toward chorionic villi
  - extend embryonically to the sinus venosus and dorsal aorta





# Placental Blood vessels

- Arteries
  - paired
  - carry deoxygenated blood (from dorsal aorta) and waste products
  - To the placental villi
- Veins
  - paired initially then only left at end of embryonic period
  - carry oxygenated blood to the embryo (sinus venosus)





# Skeletal System

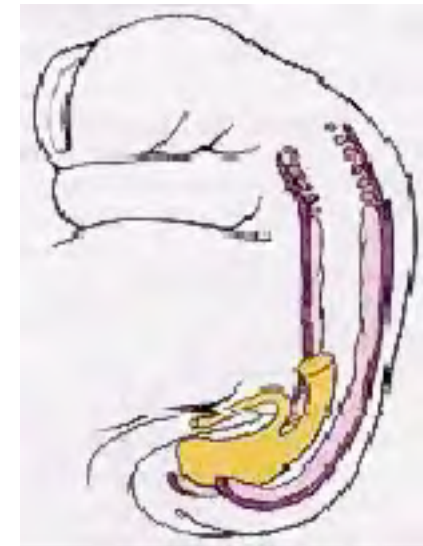
- Base of Skull
  - Cartilagenous
- Limbs, upper and lower
  - Upper more developed
  - Limb rotation
- Hands and feet
  - Developed and bending ventrally
  - Separated digits
- Axial skeleton
  - Cartilagenous vertebral bodies, IVD formation
- Primary ossification centres





# Digestive System

- Digestive tract
  - Esophagus
  - Stomach growth and rotation
  - Intestines herniated at umbilicus
  - Gut recanalization
- Digestive organs
  - liver, spleen, pancreas
- Cloaca divided
  - Common urogenital sinus

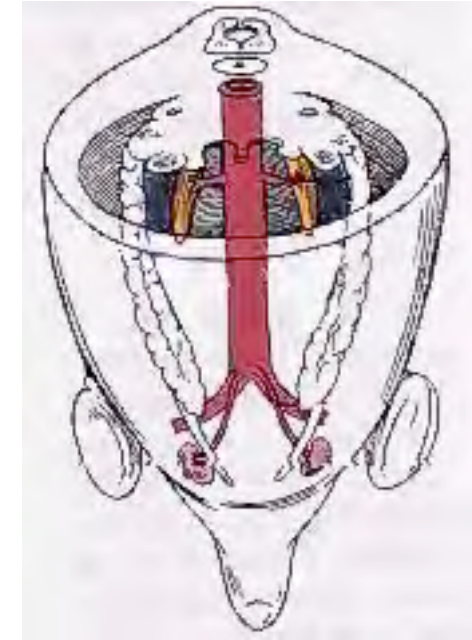


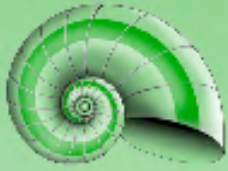




# Urogenital System

- Kidney development
  - Pronephros, mesonephros, metanephros
  - Ascend
- Tract
  - Ureters, genital tubercle
- Gonads
  - Early differentiation





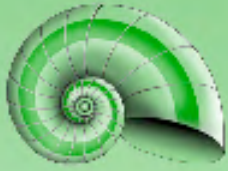
# Respiratory System

- Upper respiratory tract
  - Divided from oesophagus
  - Epiglottis, trachea
- Lung
  - Segmented bronchi
  - Continues development into very late fetal period
    - Premature infants respiratory underdeveloped



## Key References: UNSW Embryology

- This is a key educational resource developed for learning concepts in embryological development
  - <http://embryology.med.unsw.edu.au/>
- Class Notes
  - A class resource page designed to link with lecture and practical support materials for new medical curriculum
  - <http://embryology.med.unsw.edu.au/class.htm#BGD>
- Early Development
  - This page links to specific concepts associated with the early weeks of development
  - <http://embryology.med.unsw.edu.au/devnote.htm>
- Abnormal Development
  - This page links to specific concepts associated with genetic and environmental effects on development
  - <http://embryology.med.unsw.edu.au/Defect/page1.htm>



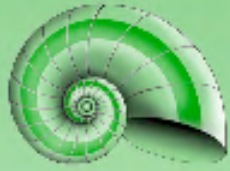
## Key Ref: Developmental Biology

- 6th ed. Gilbert, Scott F. Sunderland (MA): Sinauer Associates, Inc.; c2000
  - textbook covering development in all species
- Textbook Online
  - <http://www.ncbi.nlm.nih.gov:80/books/bv.fcgi?call=bv.View..ShowTOC&rid=dbio.TOC&depth=2>
- Early Mammalian Development
  - <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Search&db=books&rid=dbio.section.2609>



## Key References:

- **Developmental Biology**
  - 6th ed. Gilbert, Scott F. Sunderland (MA): Sinauer Associates, Inc.; c2000
    - Searchable online textbook
  - <http://www.ncbi.nlm.nih.gov:80/books/bv.fcgi?call=bv.View..ShowTOC&rid=dbio.TOC&depth=2>
- **Online Mendelian Inheritance in Man (OMIM) Database**
  - Searchable catalogue of human genes and genetic disorders
  - <http://www.ncbi.nlm.nih.gov:80/entrez/query.fcgi?db=OMIM>



BEGINNINGS GROWTH AND DEVELOPMENT

# Ultrasound 12 Weeks