



Development of the Embryo/Fetus - 2

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BEGINNINGS GROWTH AND DEVELOPMENT

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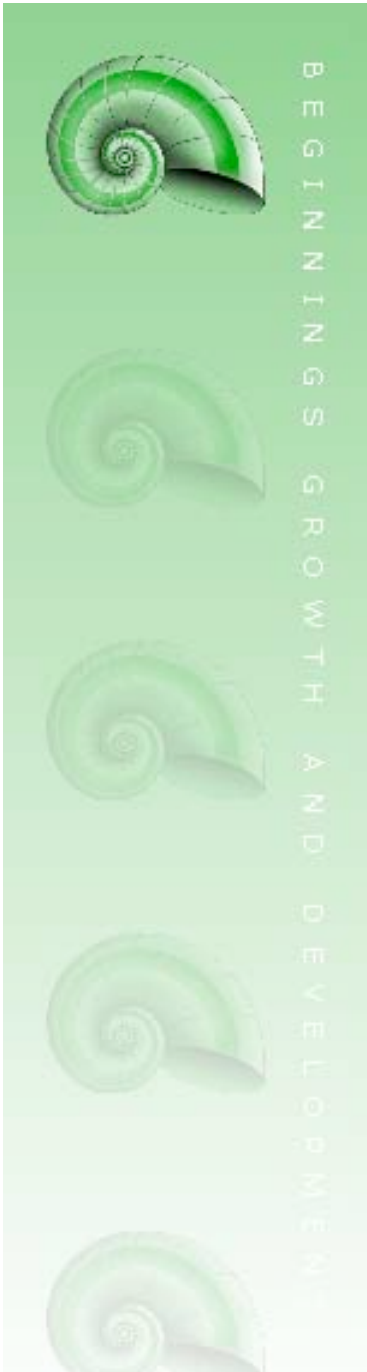
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Web: <http://anatomy.med.unsw.edu.au/cbl/cbl.htm>

Email: m.hill@unsw.edu.au

Movie: Embryo Development





Aims

- Aid in the development of an understanding of fetal development



- Lecture Slides
- <http://anatomy.med.unsw.edu.au/cbl/embryo/class.htm>

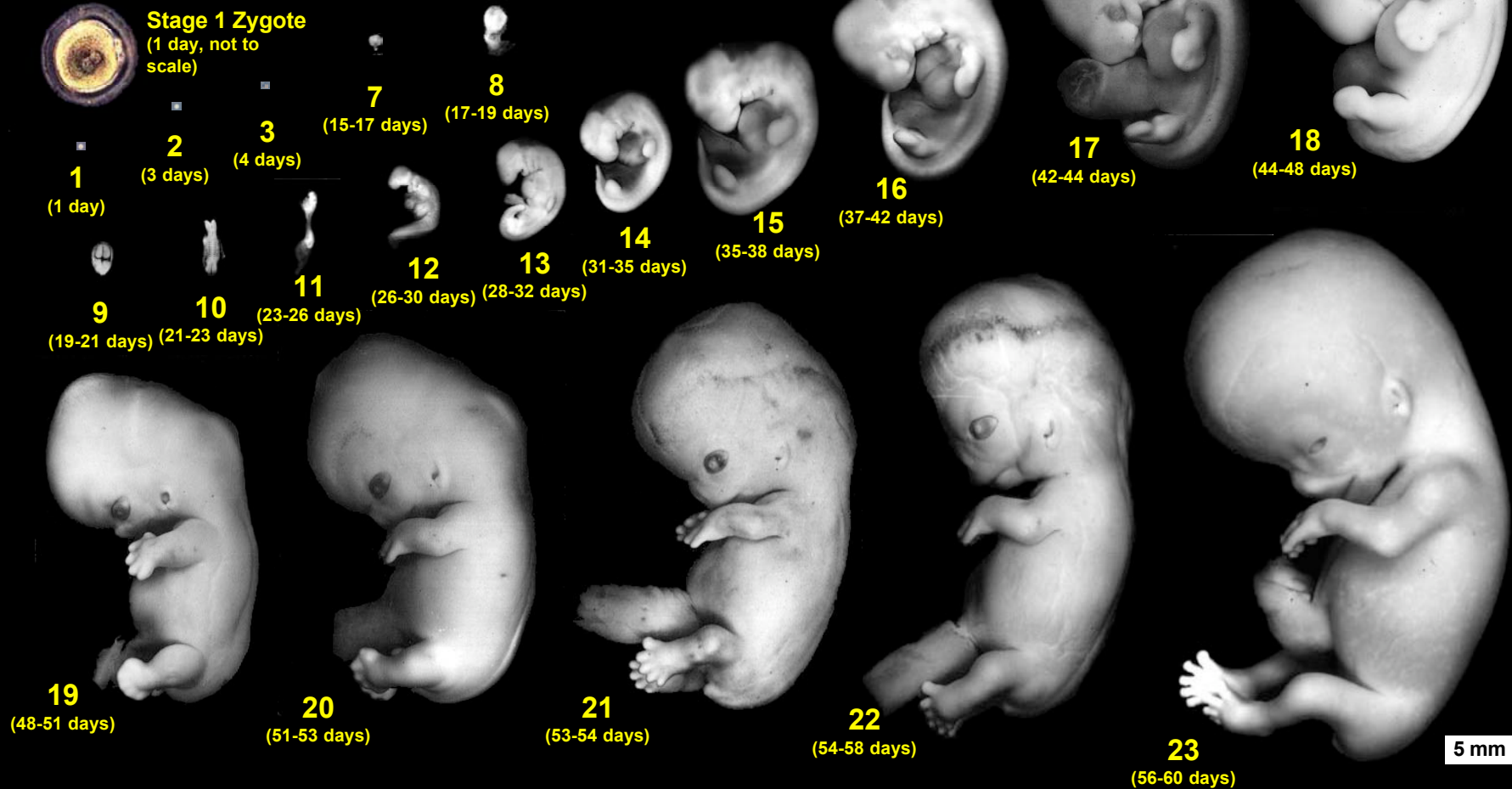


Key Concepts

- Embryonic and Fetal Development
- Organ / System
 - Development
 - Functioning / Not Functional
- Dynamic changes
- Carnegie stages
 - Used to understand embryonic development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/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.

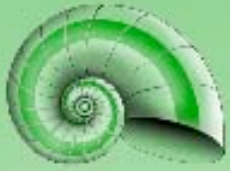
Carnegie Stages Online -

<http://anatomy.med.unsw.edu.au/cbl/embryo/wwwhuman/Stages/CStages.htm>

UNSW Embryology

<http://anatomy.med.unsw.edu.au/cbl/embryo/embryo.htm>





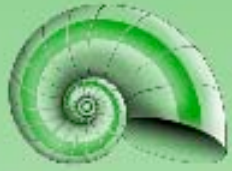
Week 1

- Early Implantation
 - Trophoblast differentiation
 - Embryonic disc
 - 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

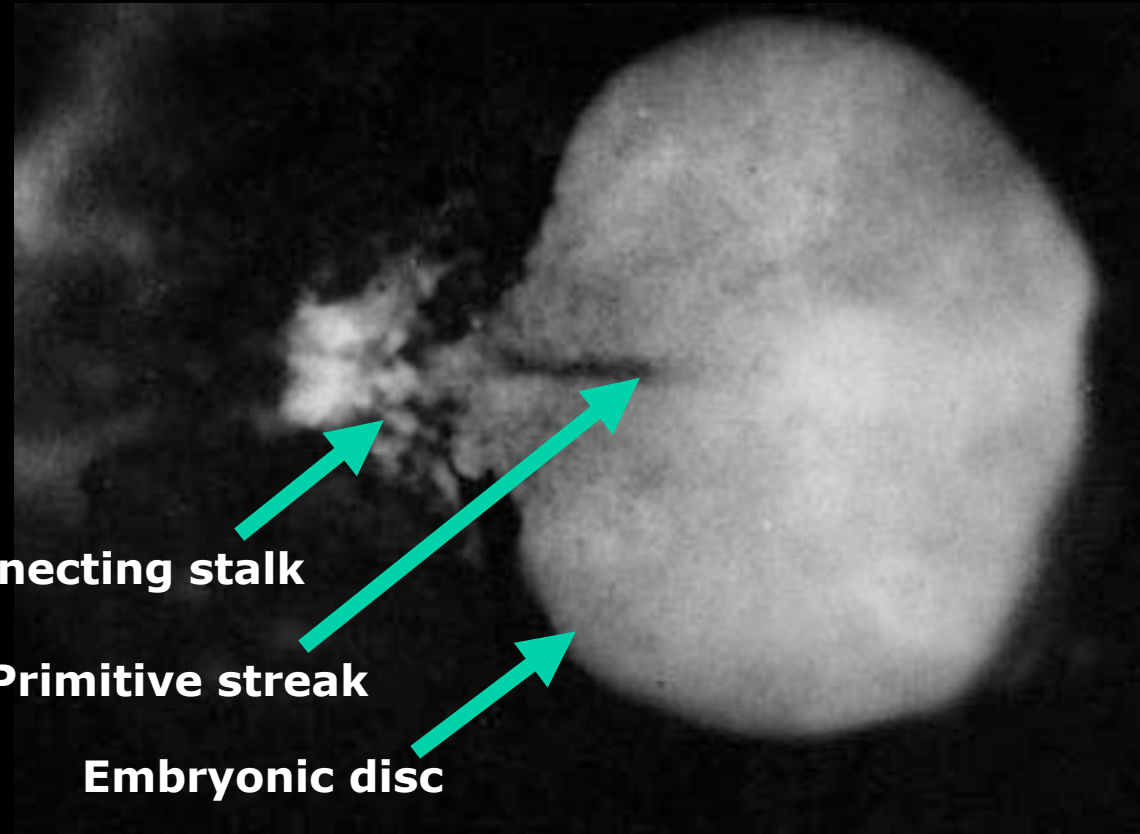
- Embryoblast
 - Gastrulation
 - Cell migration
 - Endoderm then mesoderm
 - Early Trilaminar Embryo
 - Continuing through week 3
- Trophoblast
 - Chorionic Villi
 - Primary, secondary then tertiary
- Uterine decidua changes



BEGINNINGS GROWTH AND DEVELOPMENT



Carnegie stage 7



Connecting stalk

Primitive streak

Embryonic disc

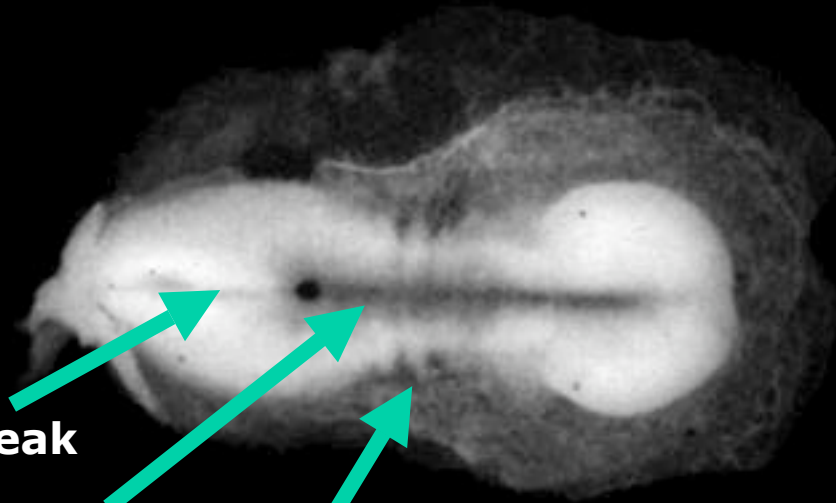
15-17 days



BEGINNINGS GROWTH AND DEVELOPMENT



Carnegie stage 9



Primitive streak

Neural groove

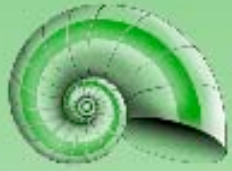
Earliest somites

19-21 days



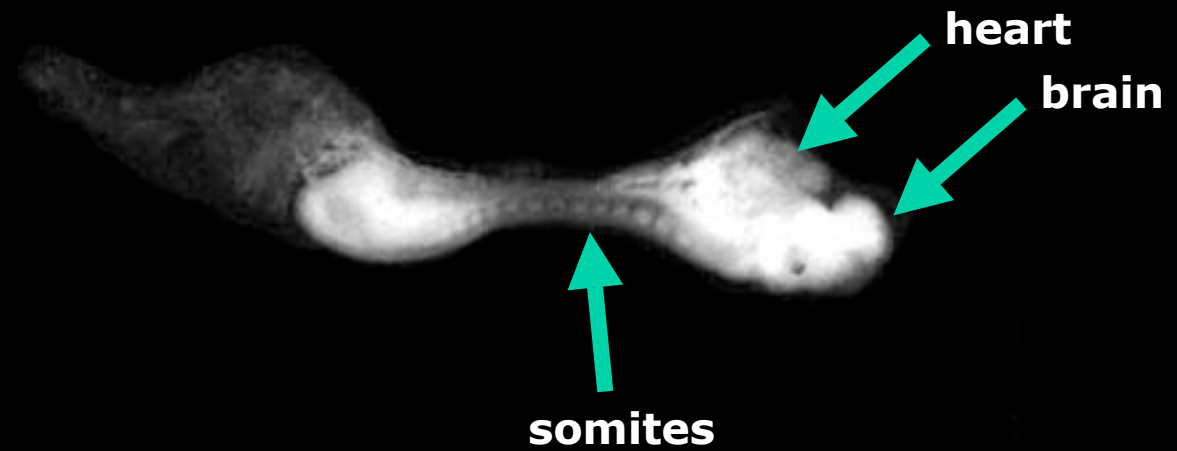
Week 3

- 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

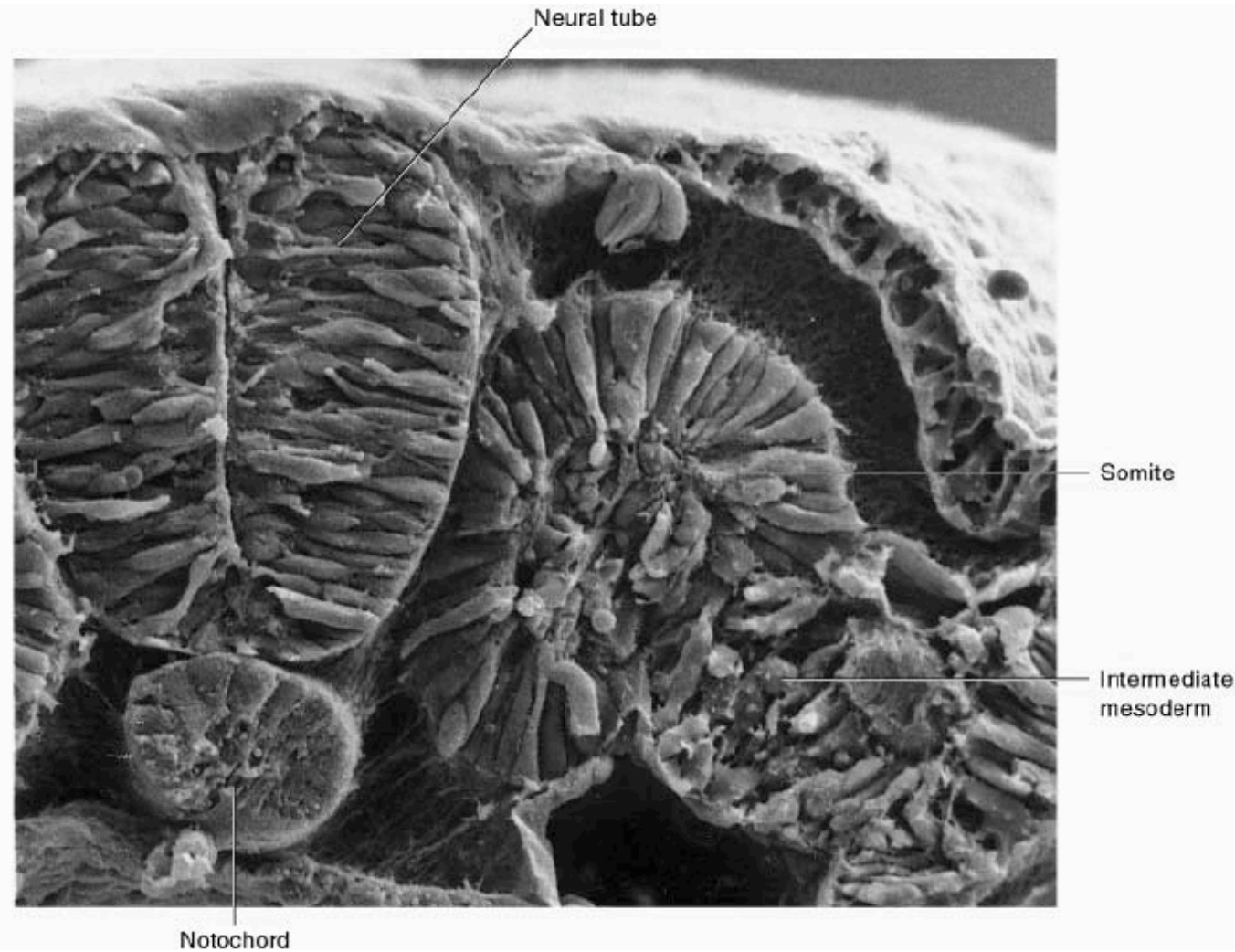


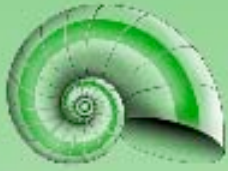
23-26 days



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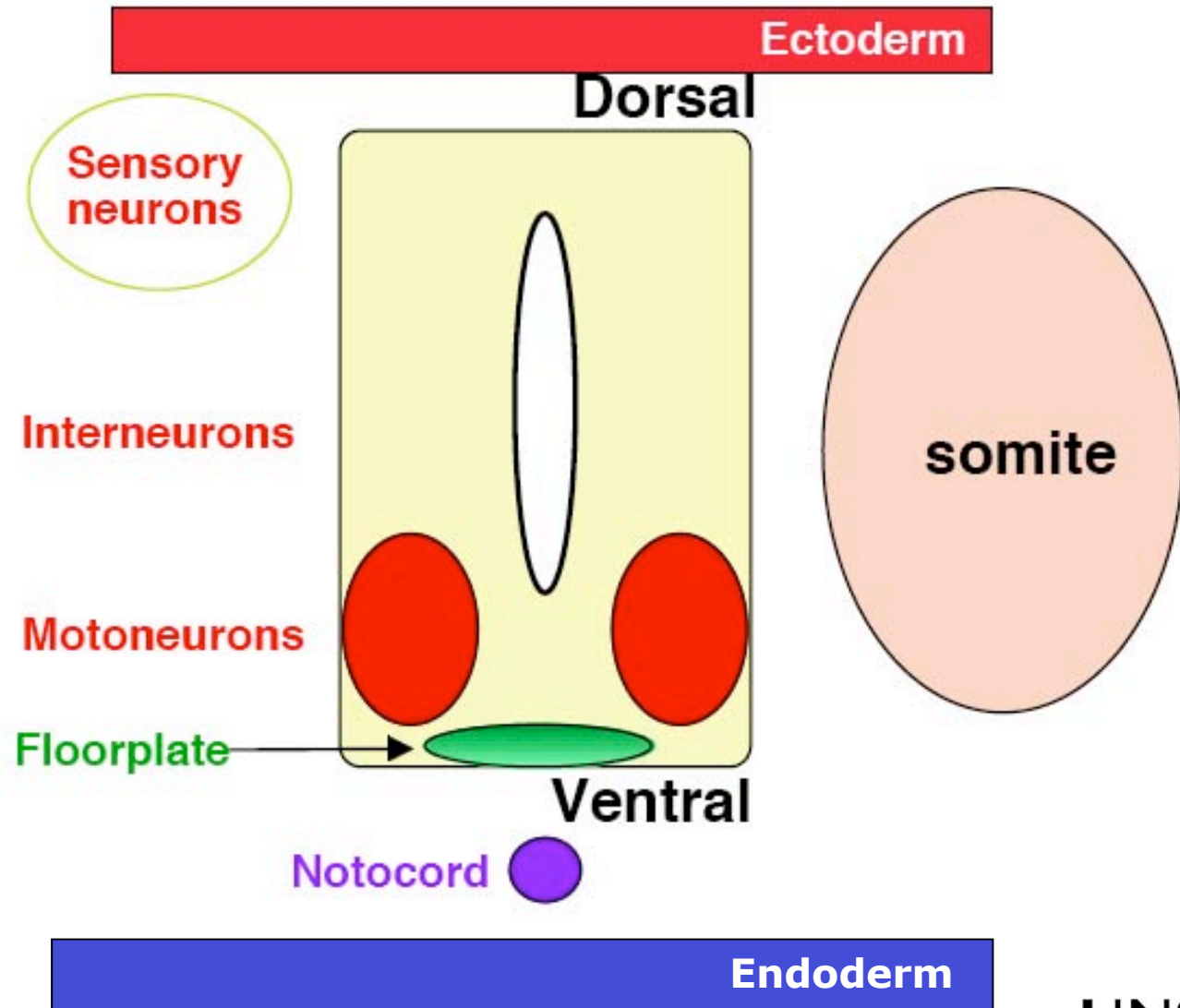
Somites





BEGINNINGS GROWTH AND DEVELOPMENT

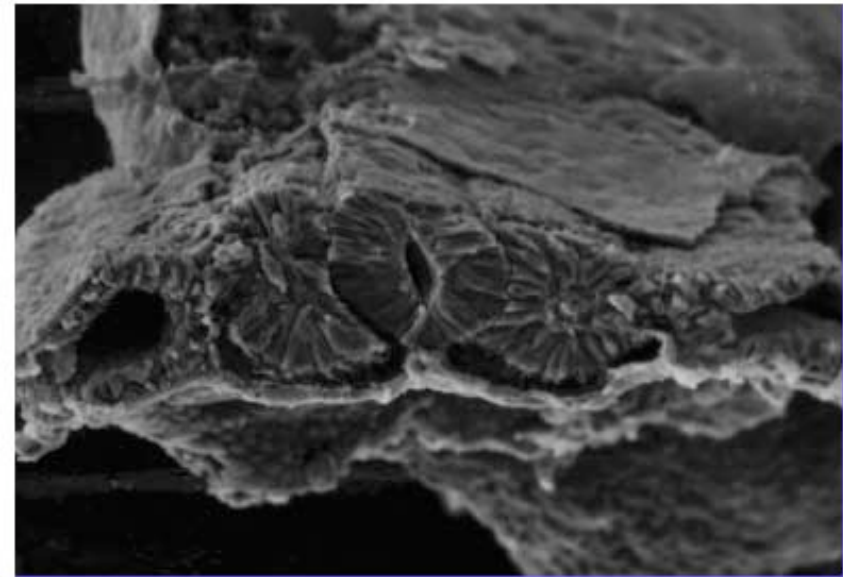
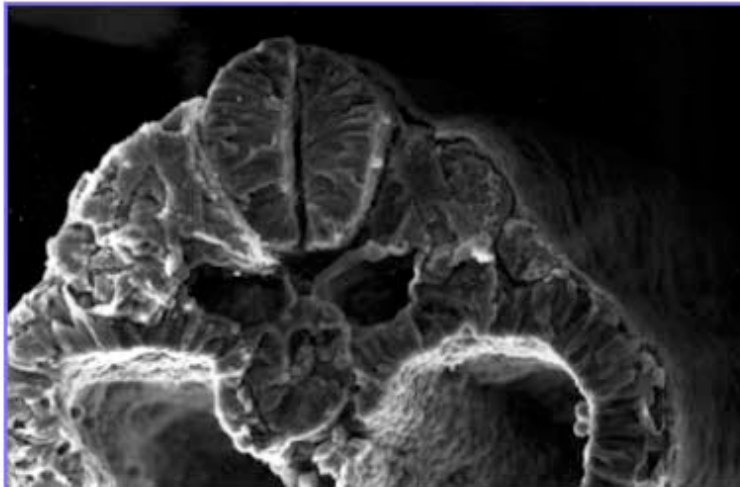
Spinal Cord cross-section





Intermediate Mesoderm

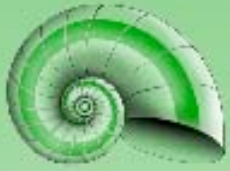
- lies between paraxial and lateral mesoderm
- generates urogenital system
- Wolffian duct, kidney





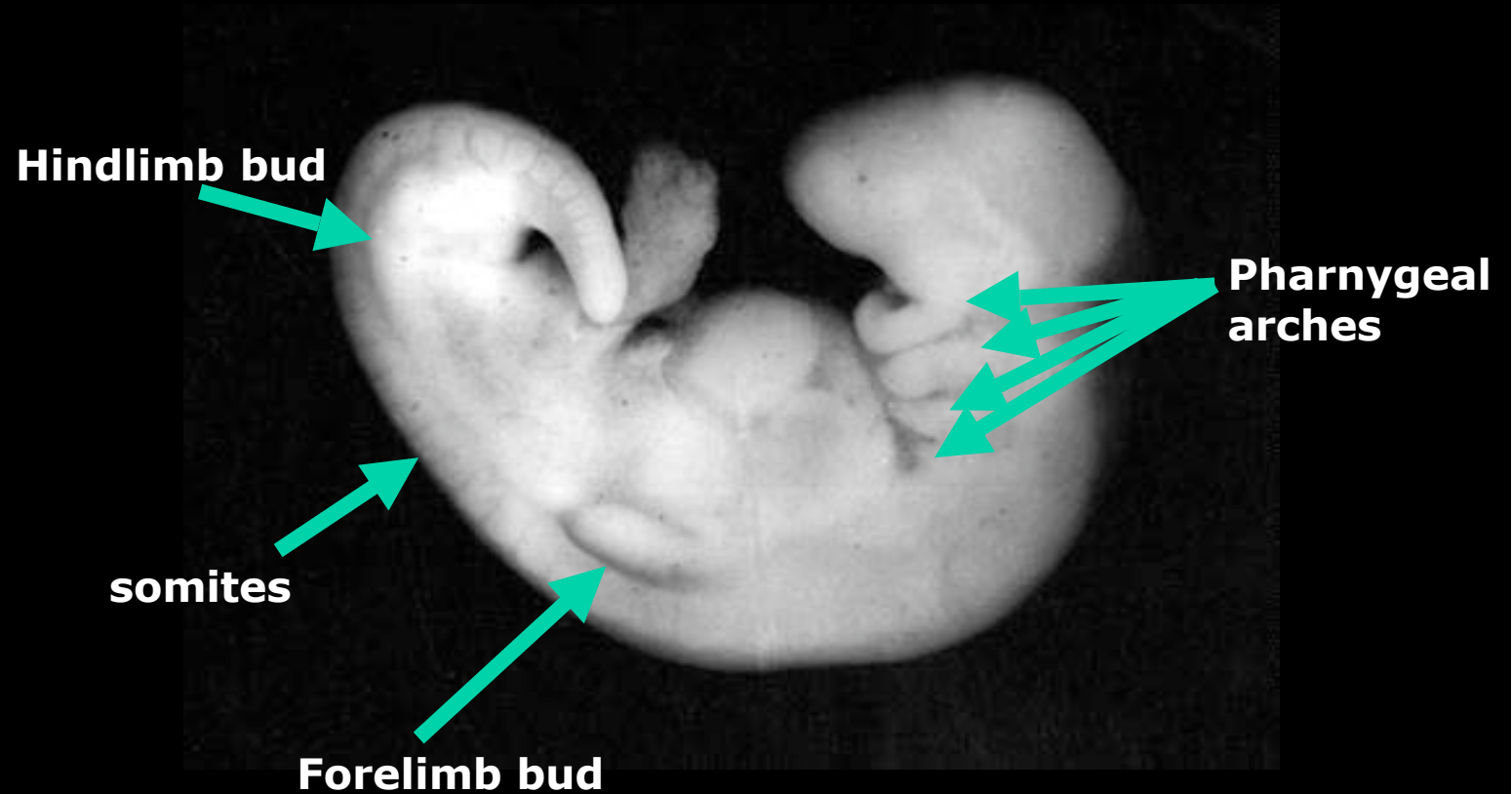
Week 4

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



BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 13



28-32 days

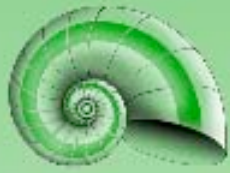


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Carnegie stage 14

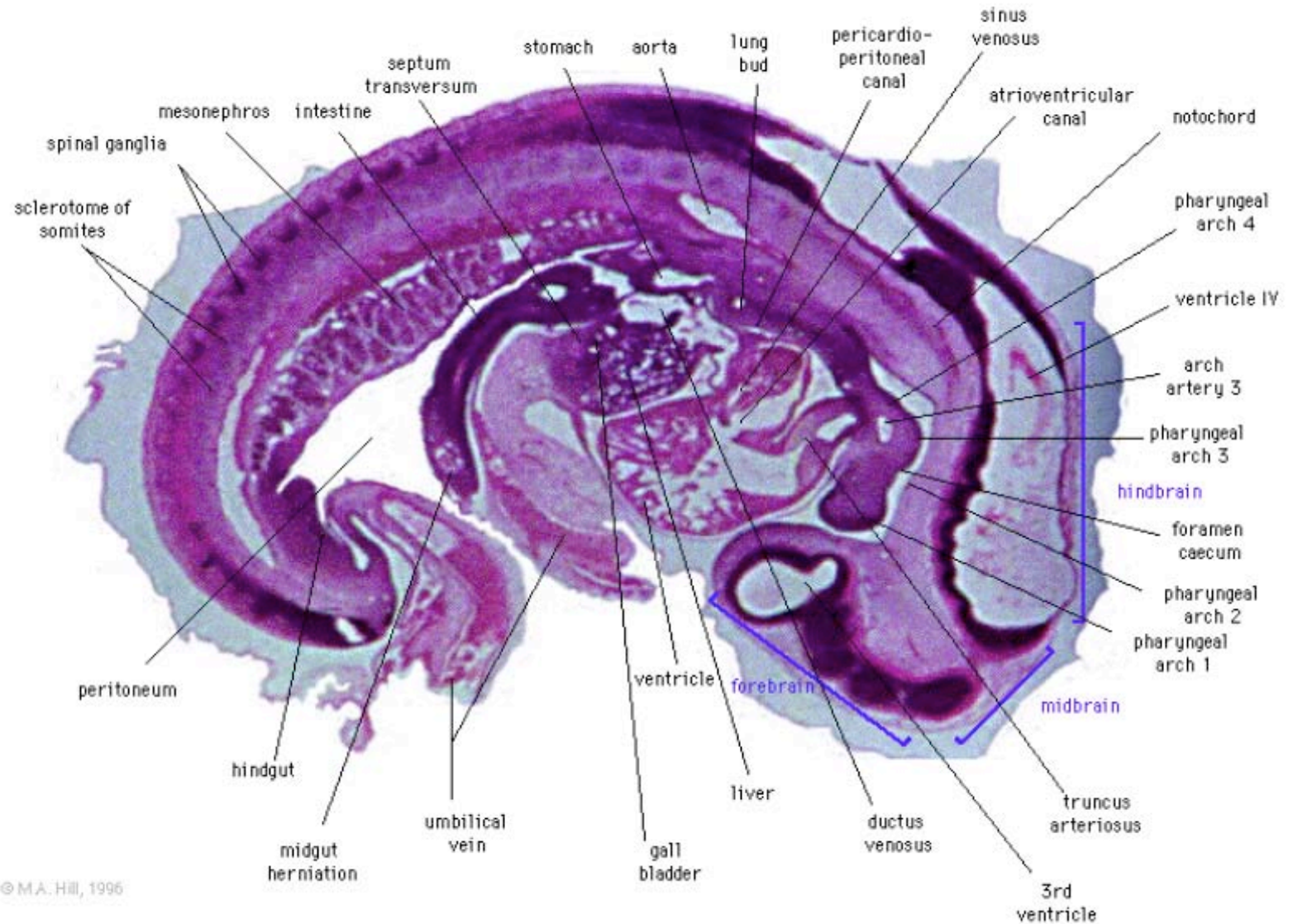


31-35 days

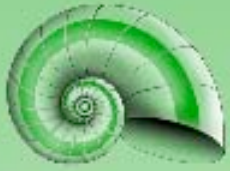


BEGINNINGS OF GROWTH AND DEVELOPMENT

Stage 13/14 Embryo

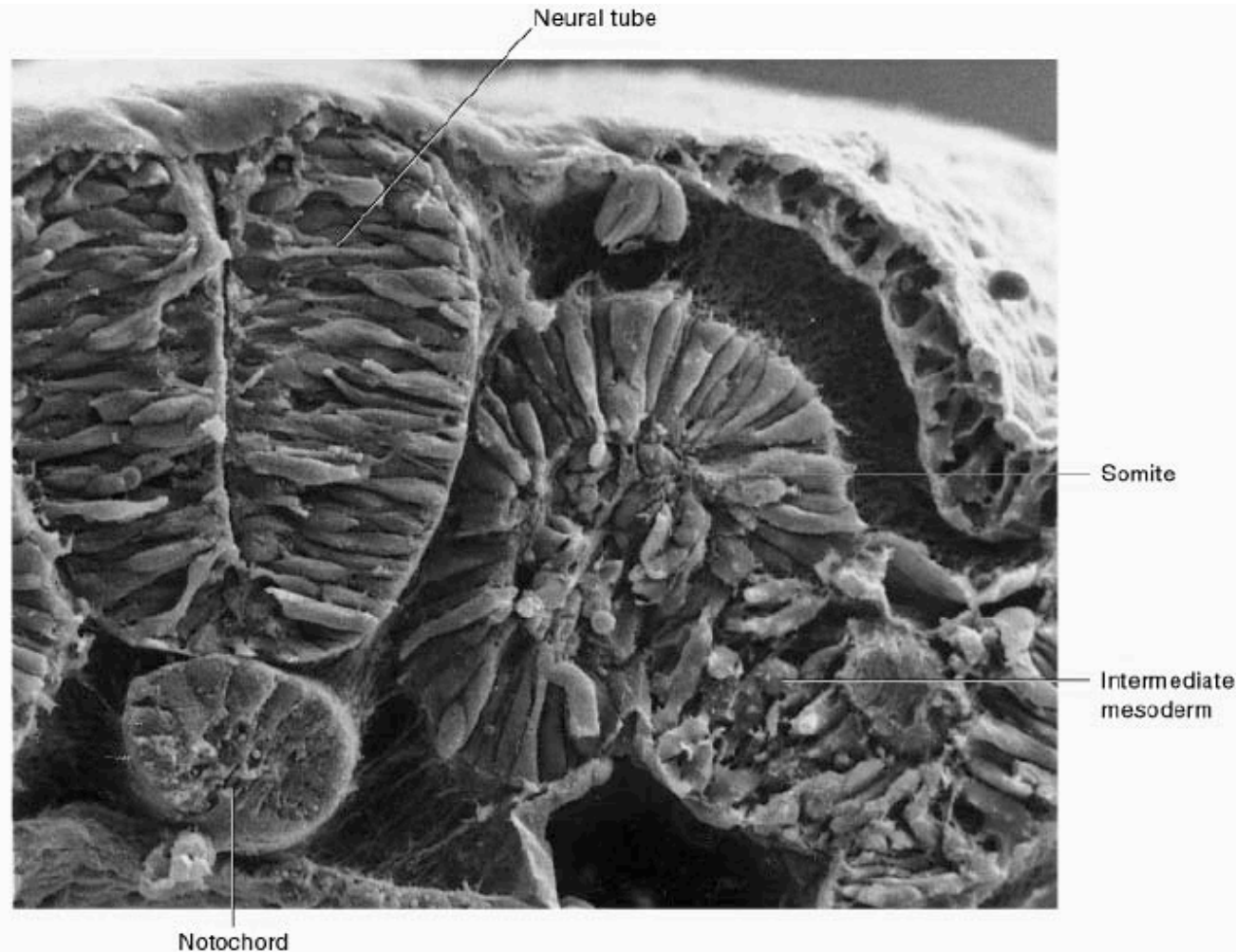


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BEGINNINGS GROWTH AND DEVELOPMENT

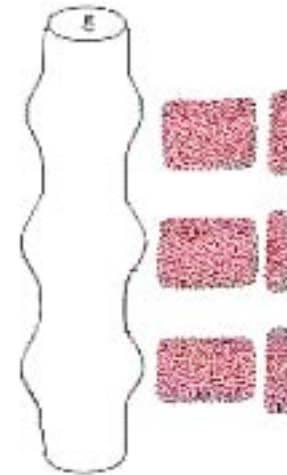
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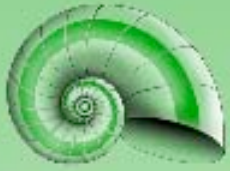




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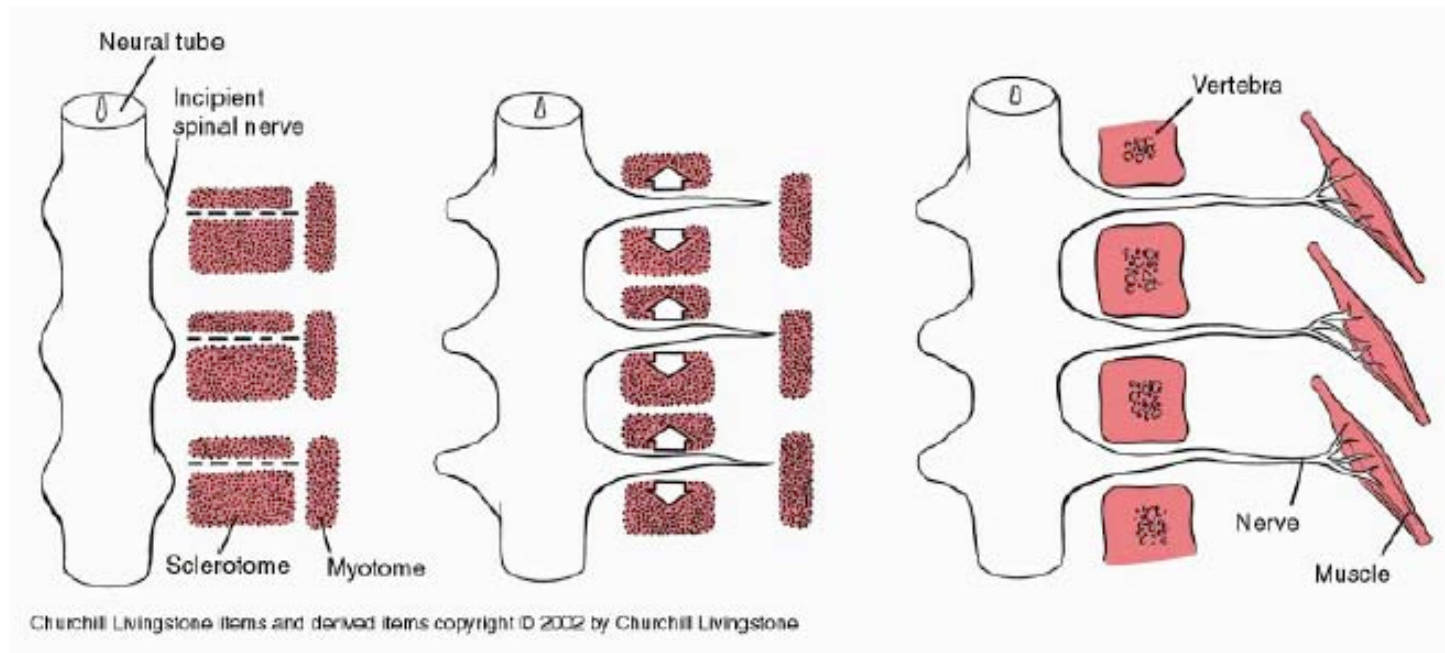
Movies: Somite /Vertebra





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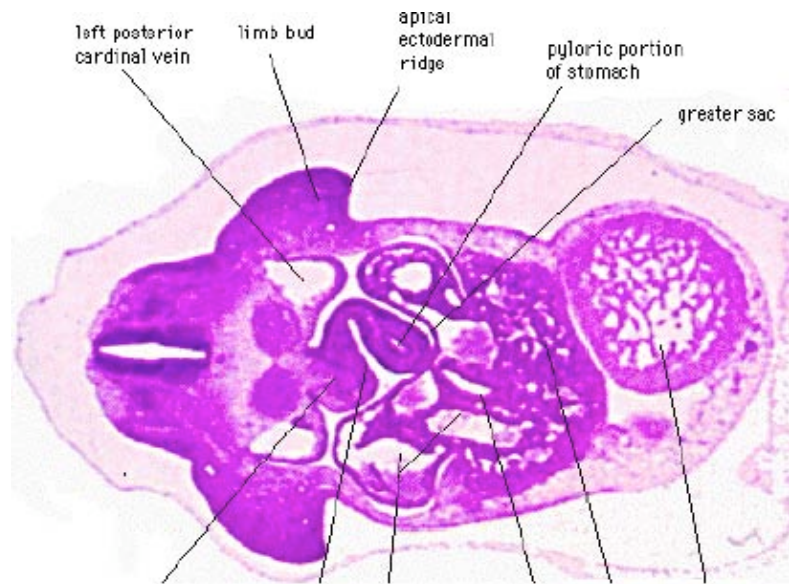
Axial Segmentation

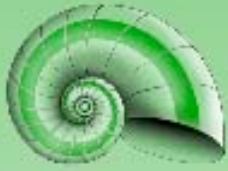




Sclerotome

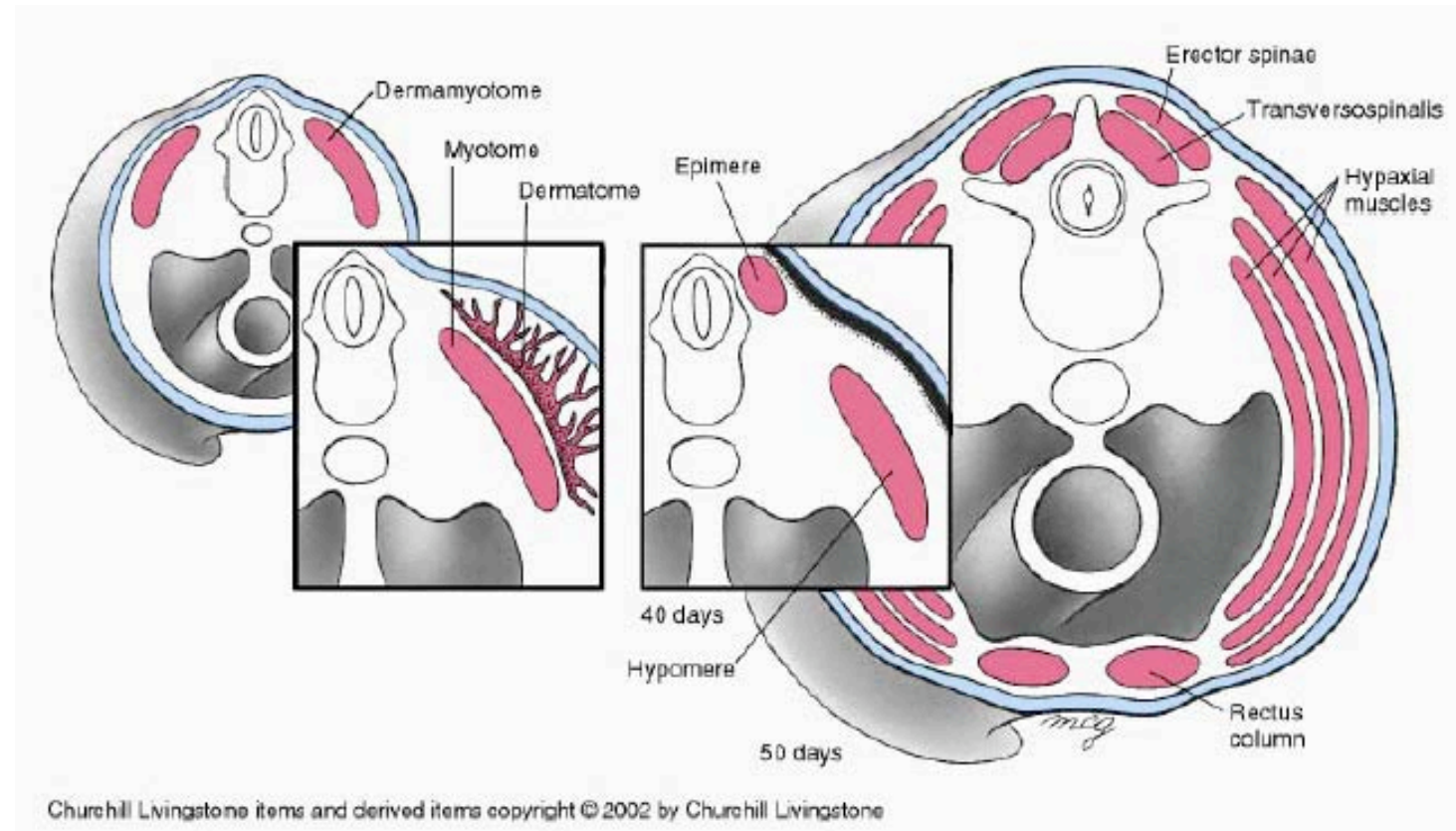
- sclerotome later becomes subdivided
- rostral and caudal halves separated laterally by von Ebner's fissure
 - half somites contribute to a single vertebral level body
 - other half intervertebral disc
 - therefore final vertebral segmentation "shifts"





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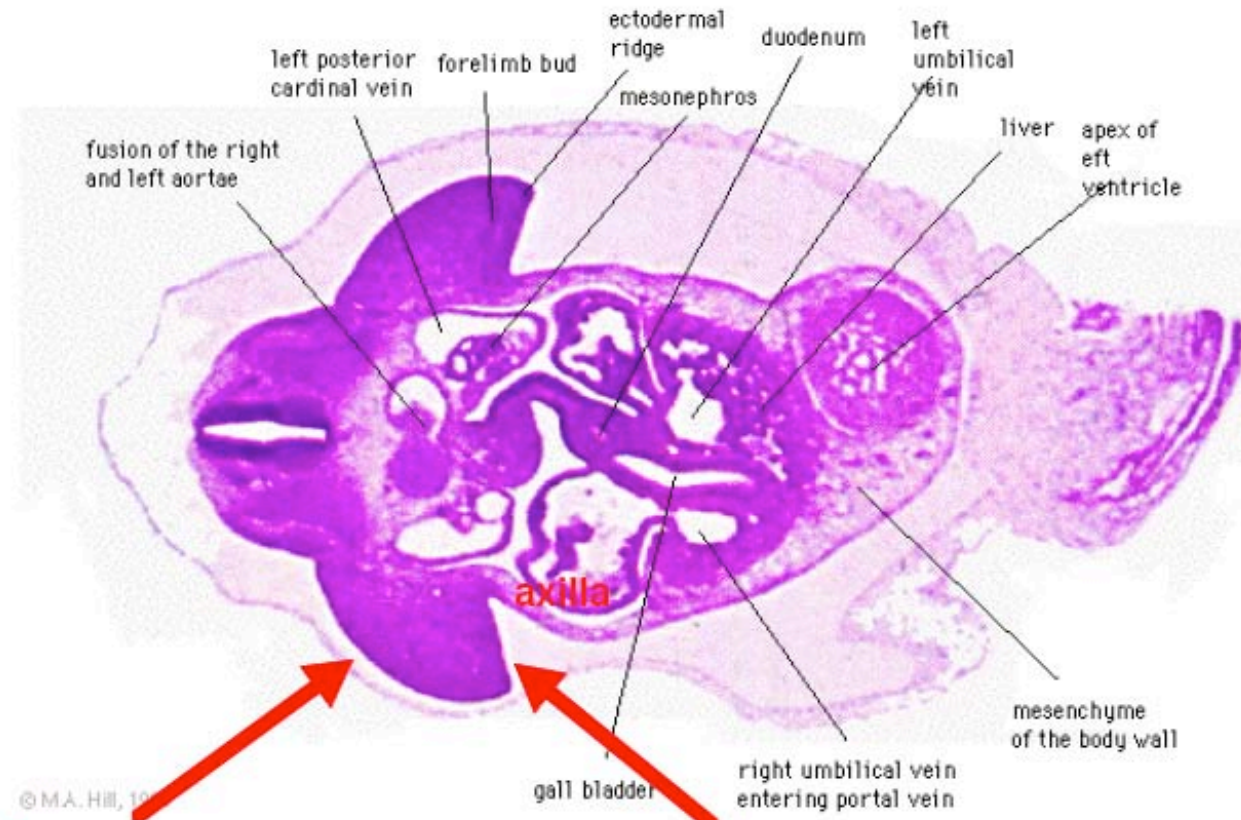
Body Musculature





BEGINNINGS GROWTH AND DEVELOPMENT

Forelimb Muscles



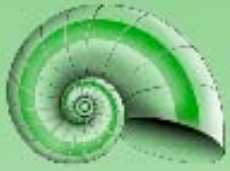
extensor muscles

flexor muscles



Week 5

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



Carnegie stage 16

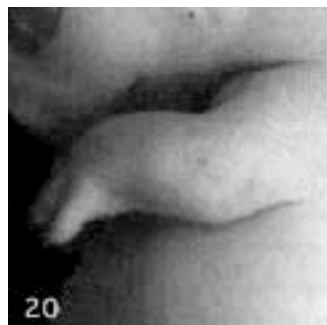
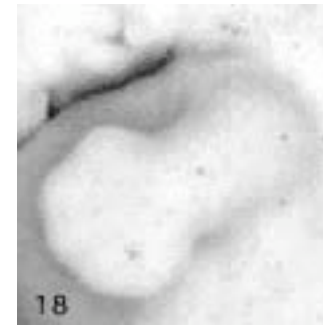
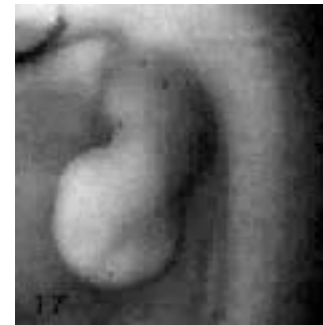
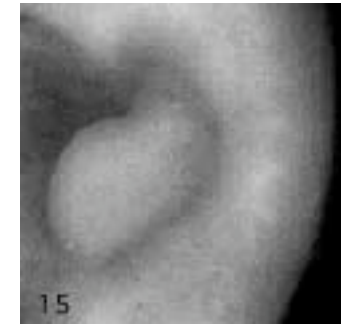
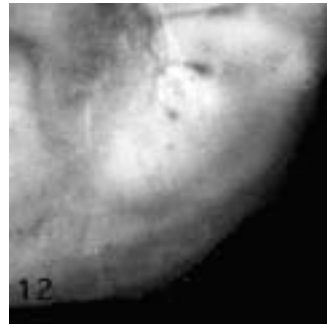


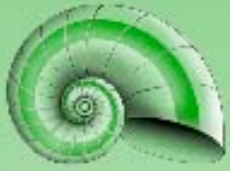
37-42 days



BEGINNINGS GROWTH AND DEVELOPMENT

Upper Limb Carnegie Stages





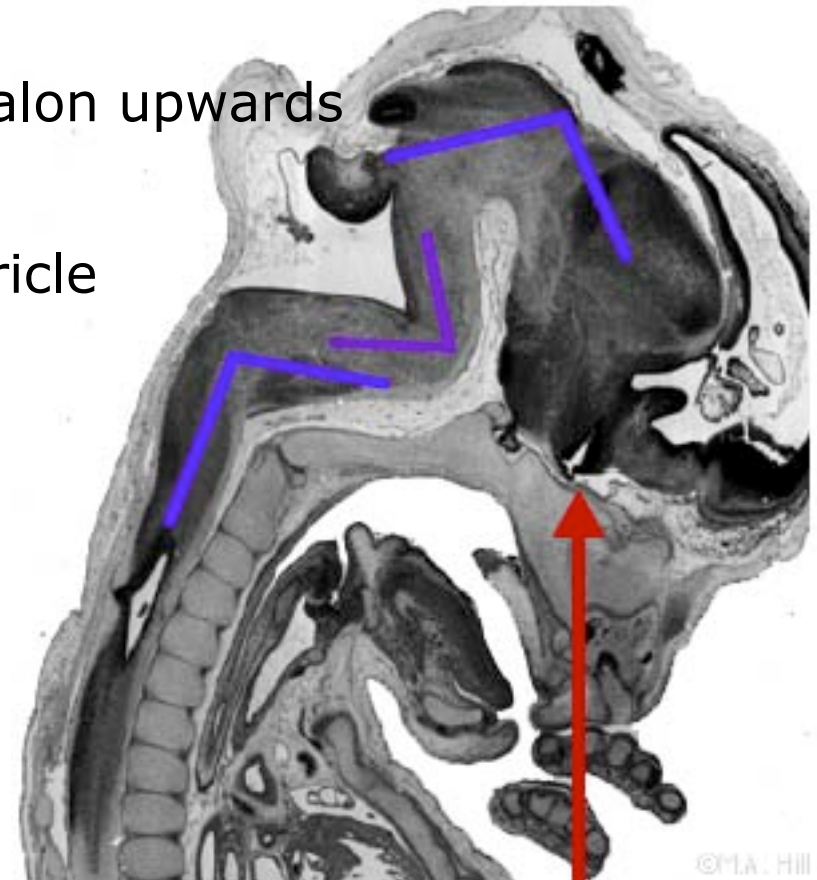
Week 6

- Head
 - growth
- Neural
 - Flexures, 4th ventricle
- Endocrine
 - Pituitary, thyroid
- Limb
 - Digital rays
- Sensory
 - nasal pit, eyes
- Heart
 - Heart chamber formation



Brain Flexures

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



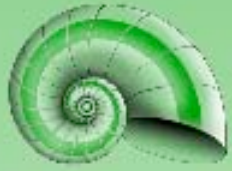


BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 17



42-44 days



BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 18



44-48 days



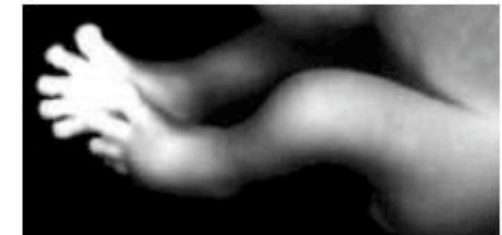
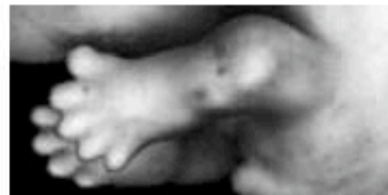
Week 7

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



BEGINNING

Limb External Appearance



Day 50

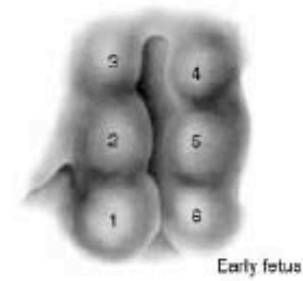
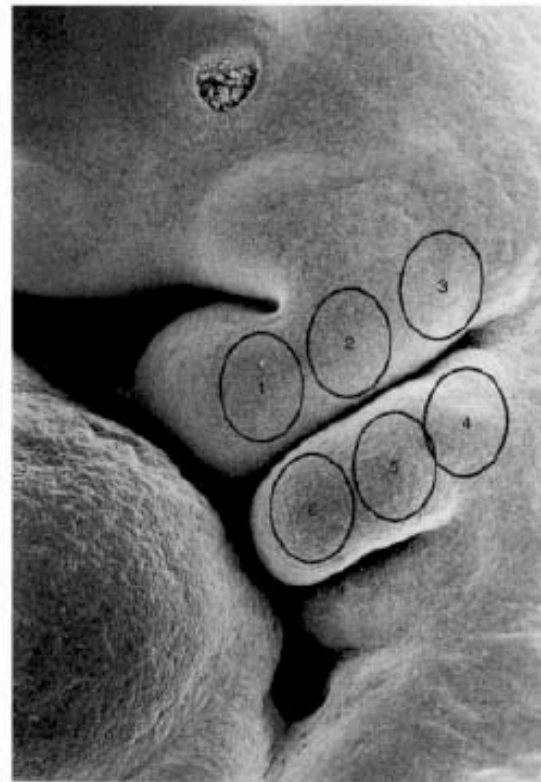
Day 56

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



BEGINNINGS GROWTH AND DEVELOPMENT

External Ear



Early fetus



Late fetus



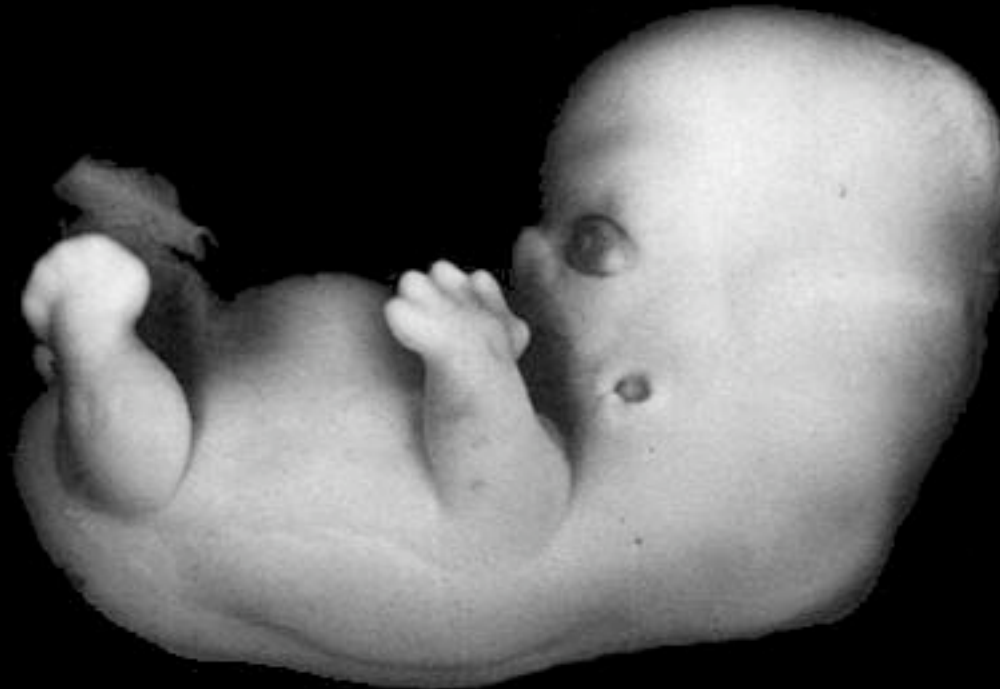
Newborn

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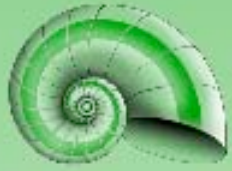


BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 19

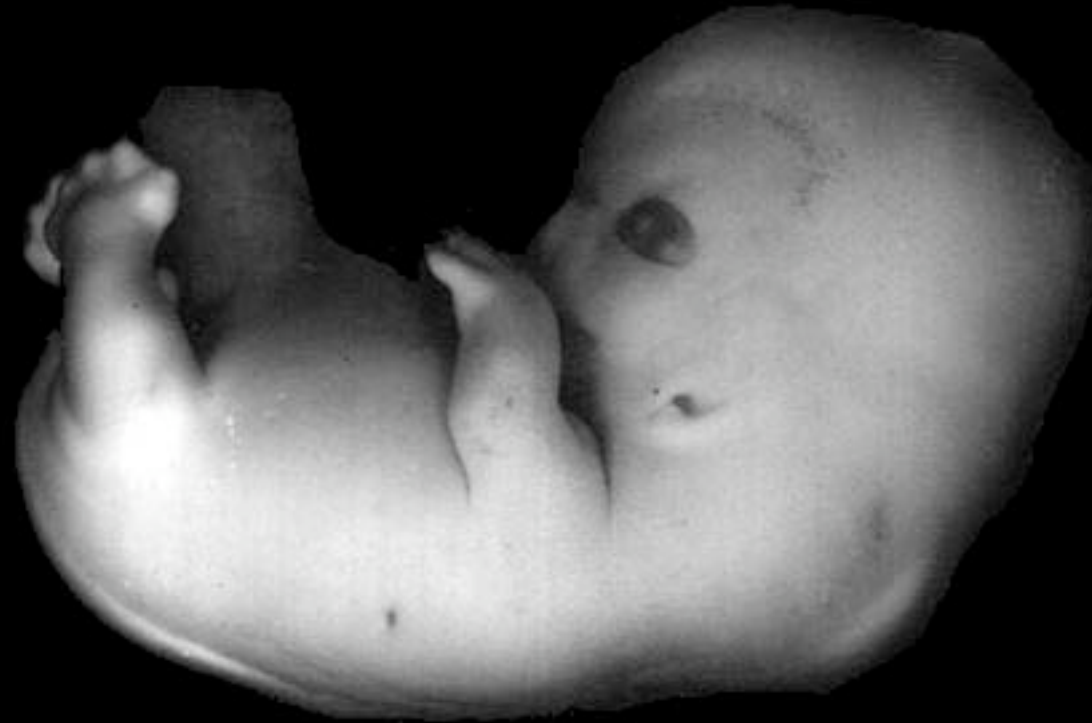


48-51 days



BEGINNINGS GROWTH AND DEVELOPMENT

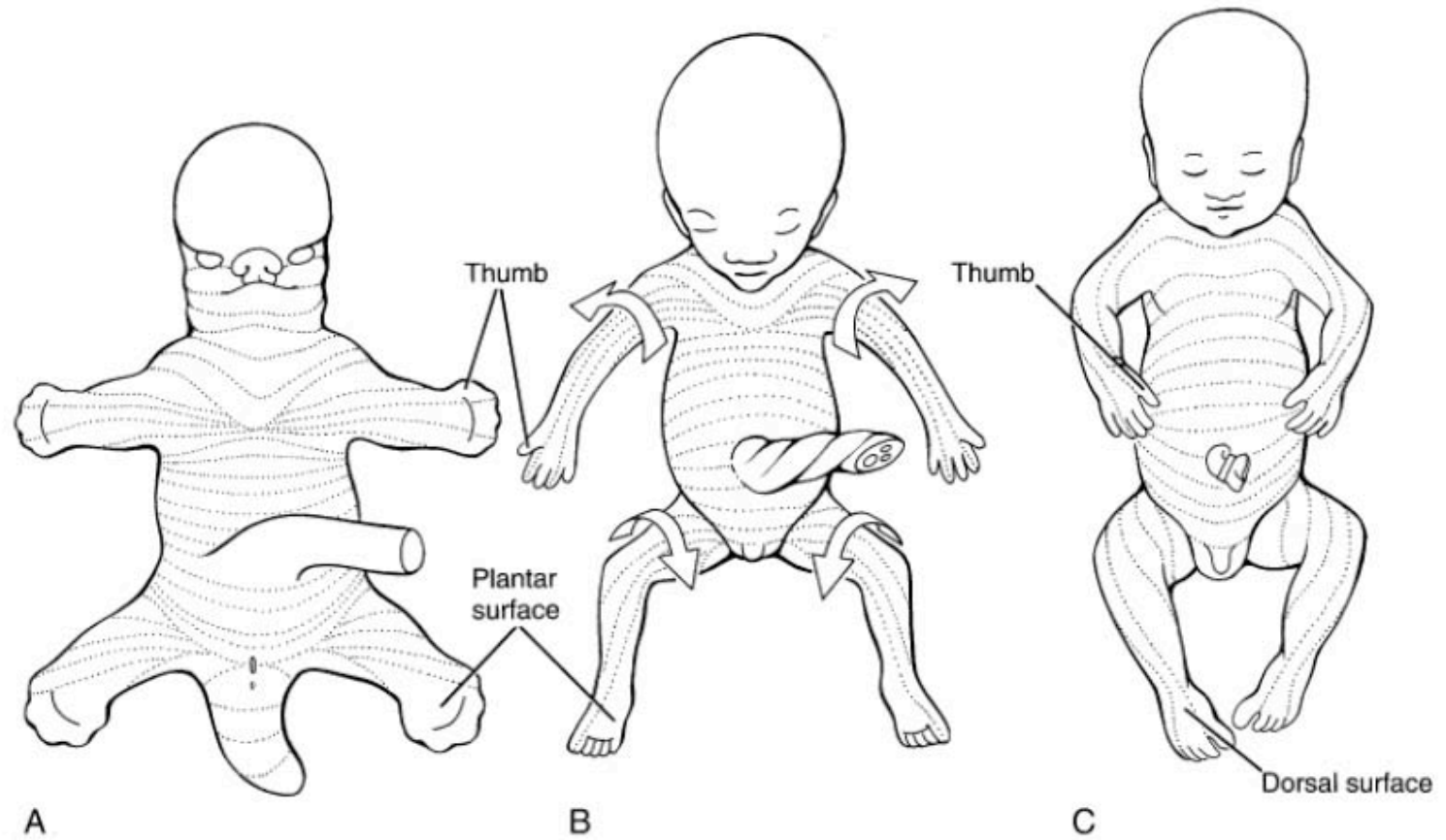
Carnegie stage 20



51-53 days



Limb Rotation



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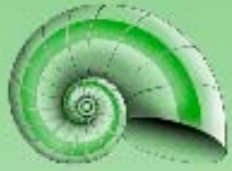


BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 21



53-54 days

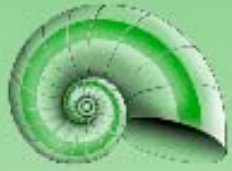


BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 22



54-58 days



BEGINNINGS GROWTH AND DEVELOPMENT

Carnegie stage 23



56-60 days



BEGINNINGS GROWTH AND DEVELOPMENT

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

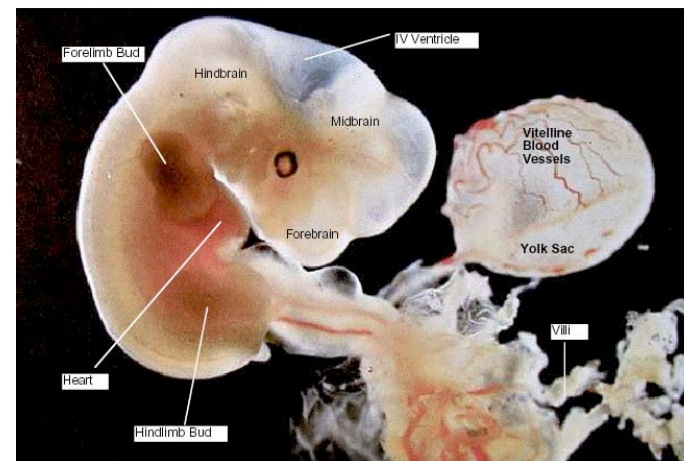
- Spinal cord
 - extends to coccygeal level
 - Basal and alar plates
- Brain
 - 5 secondary vesicles
 - Olfactory bulb
 - Cranial nerves



BEGINNINGS GROWTH AND DEVELOPMENT

Cardiovascular System

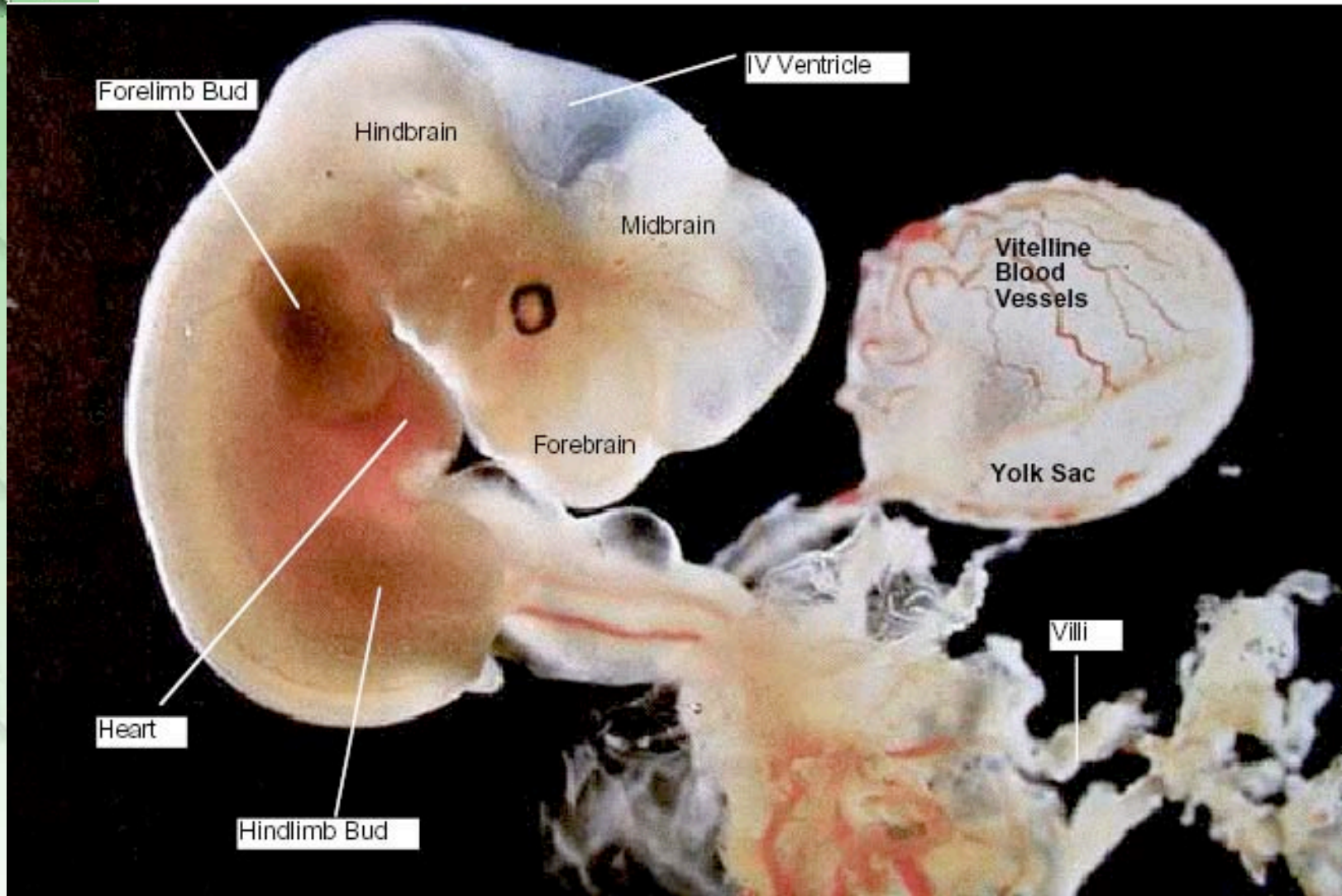
- Heart
 - 4 chambered heart
- Cardiac outflow
 - Transformed aortic arches
 - Pulmonary trunk
- Blood Vessels
 - Systemic, vitelline, placental
 - Vascular bed development in tissues





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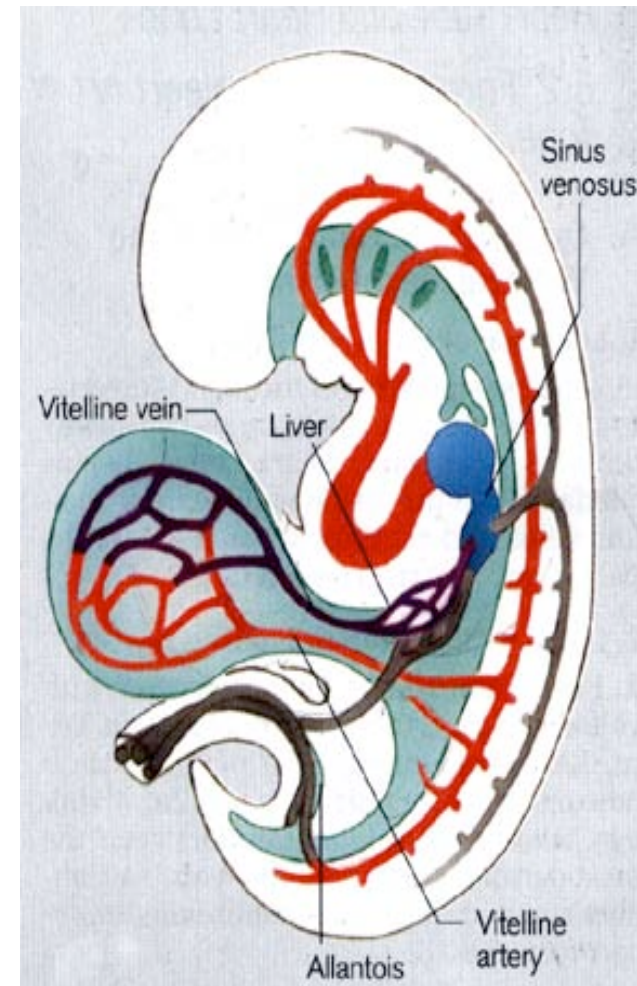
Embryonic Blood Vessels





Vitelline Blood vessels

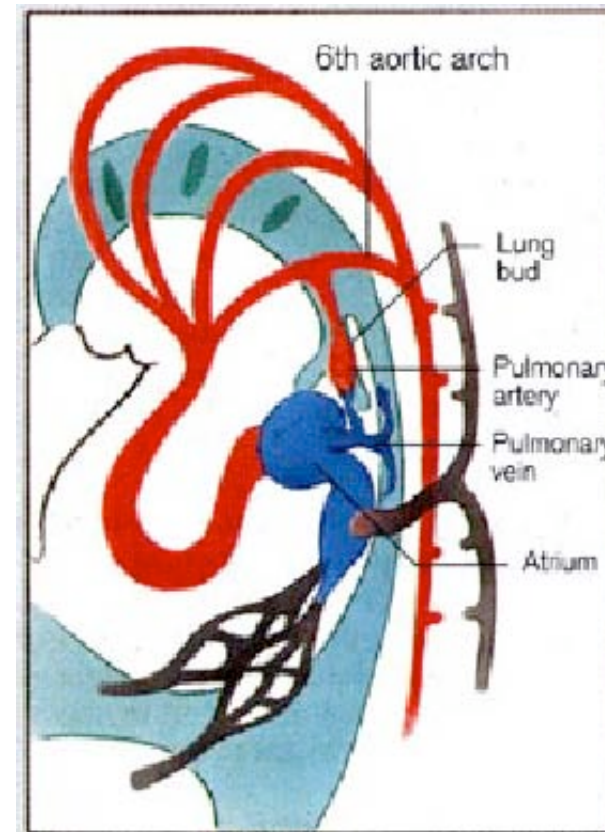
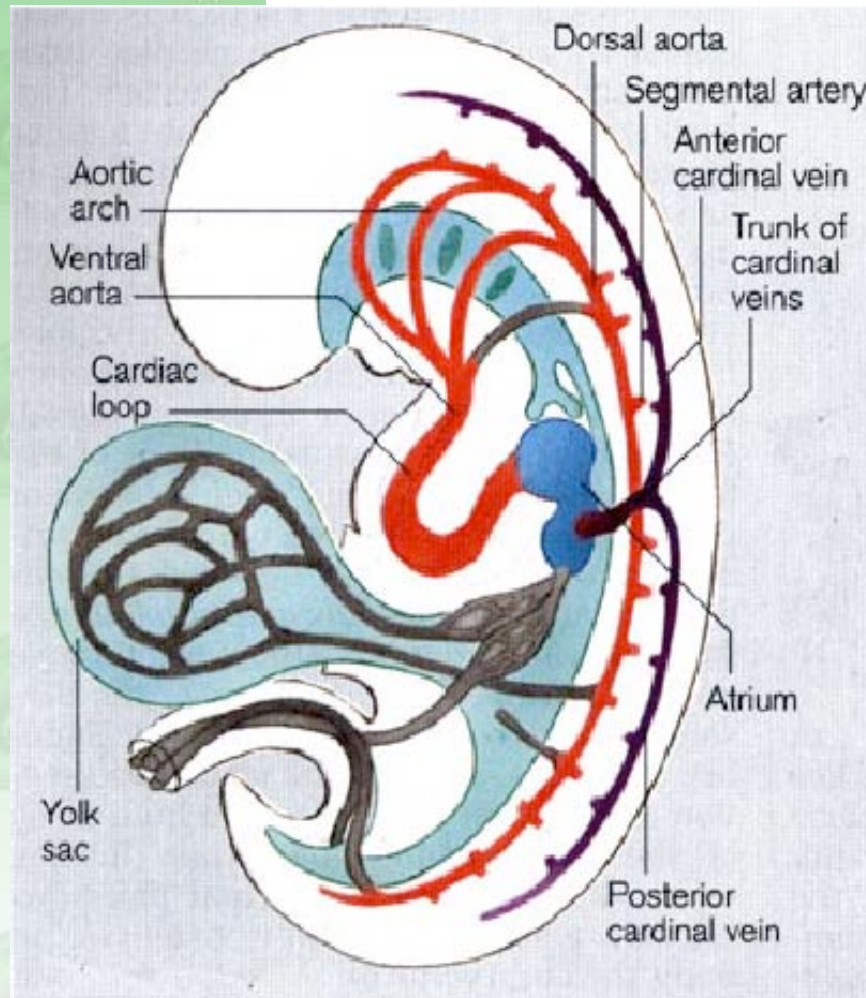
- cover entire surface of yolk sac
- connect to embryo through yolk stalk
- Arteries
 - arises from dorsal aorta
 - contribute to adult GIT arteries
- Veins
 - empties into sinus venosus
 - contribute to the adult portal system





BEGINNING

Systemic Circulation

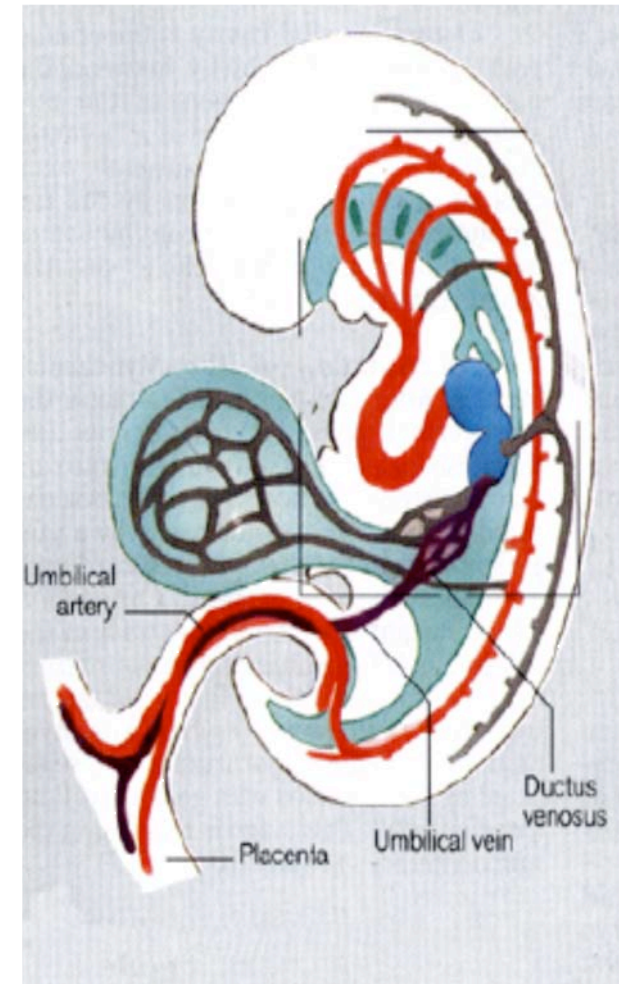


Pharyngeal arch arteries



Placental Blood vessels

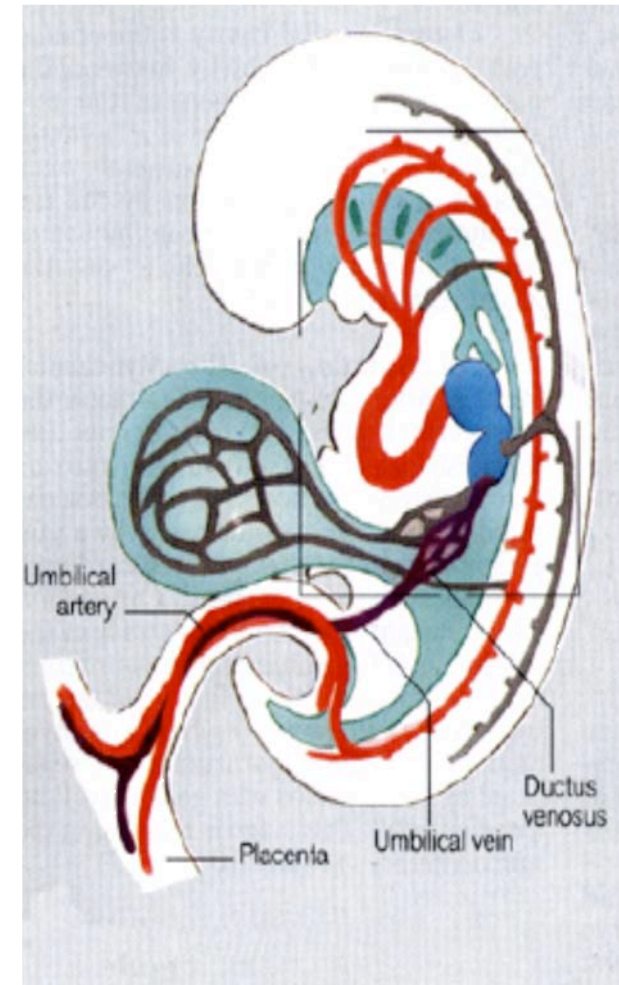
- Initially form in the connecting stalk
- Then umbilical cord
 - anastomose in chorion
 - extend maternally toward chorionic villi
 - extend embryonically to the sinus venosus and dorsal aorta

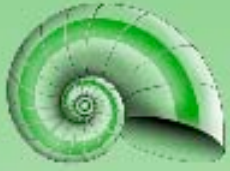




Placental Blood vessels

- 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



BEGINNINGS GROWTH AND DEVELOPMENT

Respiratory System

- Upper respiratory tract
 - Divided from oesophagus
 - Epiglottis, trachea
- Lung
 - Segmented bronchi



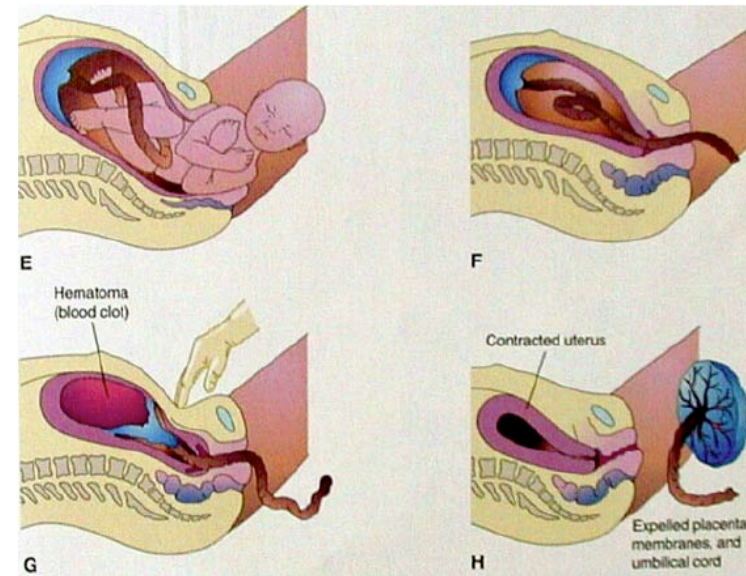
Week 9 - 38 Fetal

- Rapid body growth
 - Changing relative proportions
 - Head growth slower than body
 - 9-16 weeks most rapid
 - Large body weight gain in final weeks
- Continuing differentiation
 - Of organs formed in embryonic period



Birth

- Complex endocrine regulated
 - Initiated by fetus, uterine muscular development
- Neonatal changes
- Postnatal Development
 - Neural
 - Musculoskeletal
 - Reproductive





Newborn Homoeostasis

- Newborn has to establish
 - lung function
 - circulatory changes
 - thermoregulation
 - endocrine function
 - nutrition
 - gastrointestinal tract function
 - waste
 - kidney function

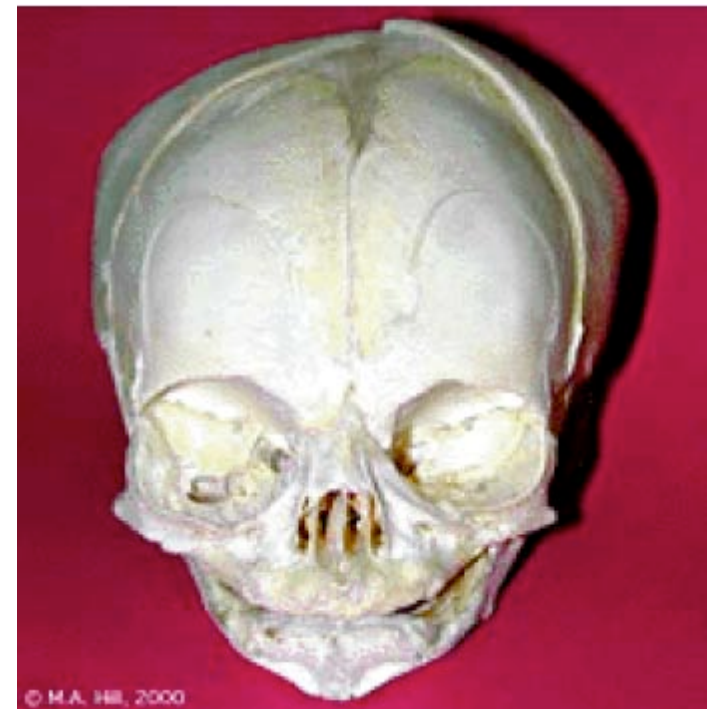


Head Growth

- continues postnatally
 - fontanelle allow head distortion on birth and early growth
- bone plates remain unfused to allow growth
- puberty growth of face



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Key References: UNSW Embryology

- This is a key educational resource developed for learning concepts in embryological development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/embryo.htm>
- Class Notes
 - A class resource page designed to link with lecture and practical support materials for new medical curriculum
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/class.htm#BGD>
- System Development
 - This page links to specific concepts associated with later system development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/synnote.htm>
- Abnormal Development
 - This page links to specific concepts associated with genetic and environmental effects on development
 - <http://anatomy.med.unsw.edu.au/cbl/embryo/Defect/page1.htm>



Key Ref: Developmental Biology

- 6th ed. Gilbert, Scott F. Sunderland (MA): Sinauer Associates, Inc.; c2000
- This is a searchable online 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
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 - <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
 - Database is a searchable catalogue of human genes and genetic disorders
 - <http://www.ncbi.nlm.nih.gov:80/entrez/query.fcgi?db=OMIM>