

EMBRYOLOGY

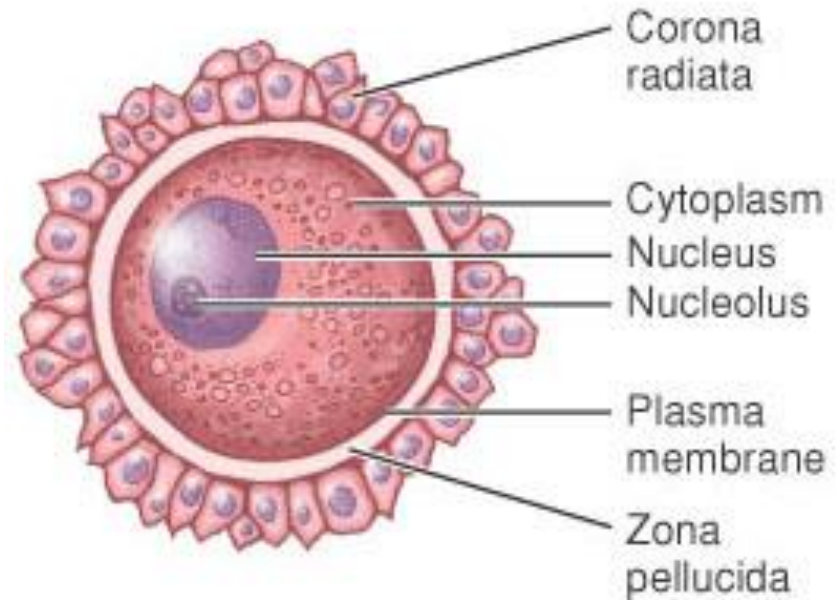
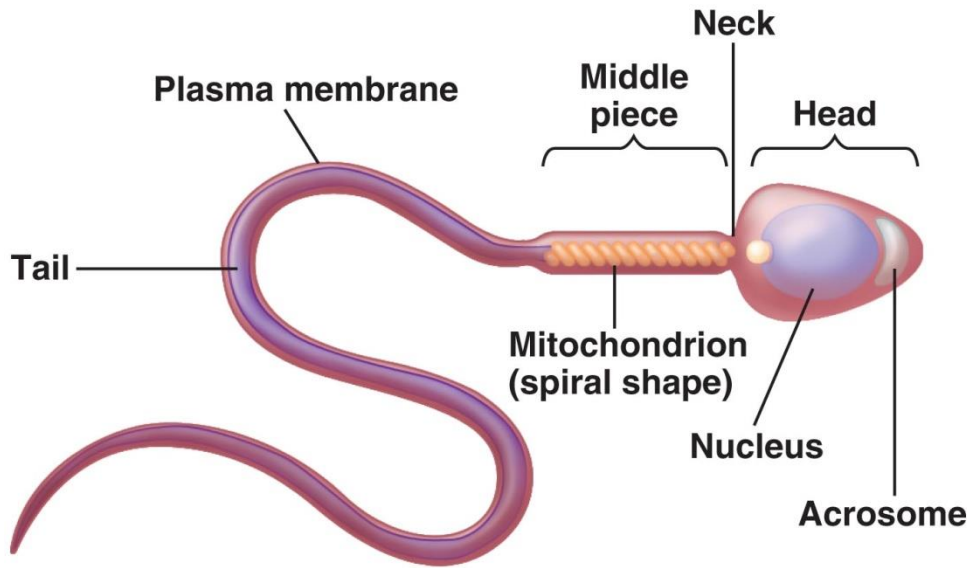
PRENATAL DEVELOPMENT

lecture and seminar from Human Morphology

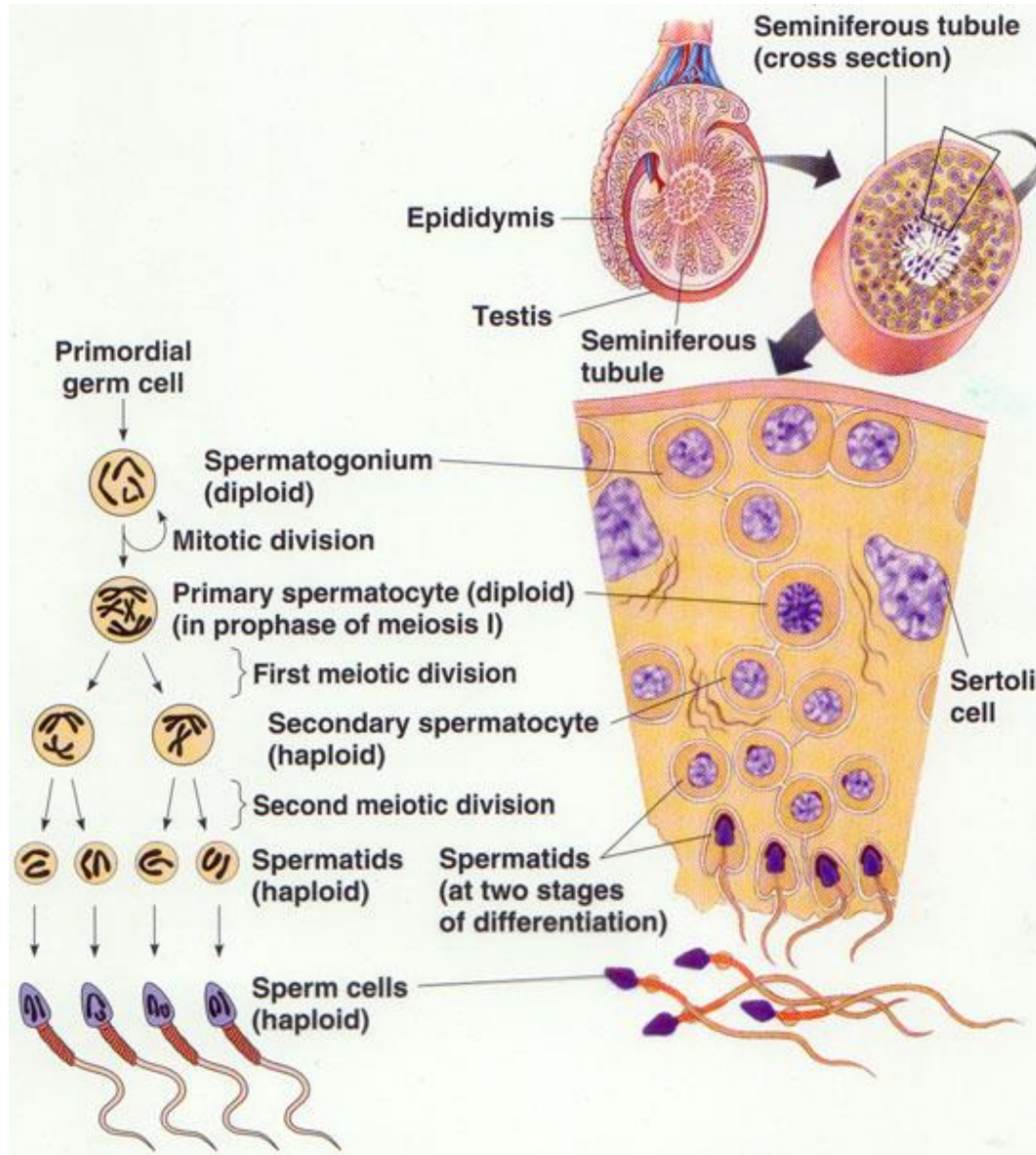
15. 10. 2020

M. Chalupová

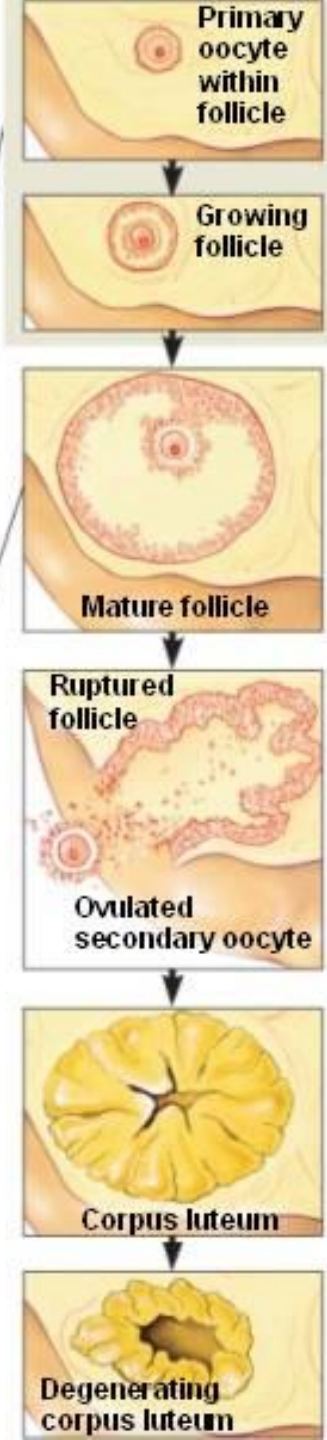
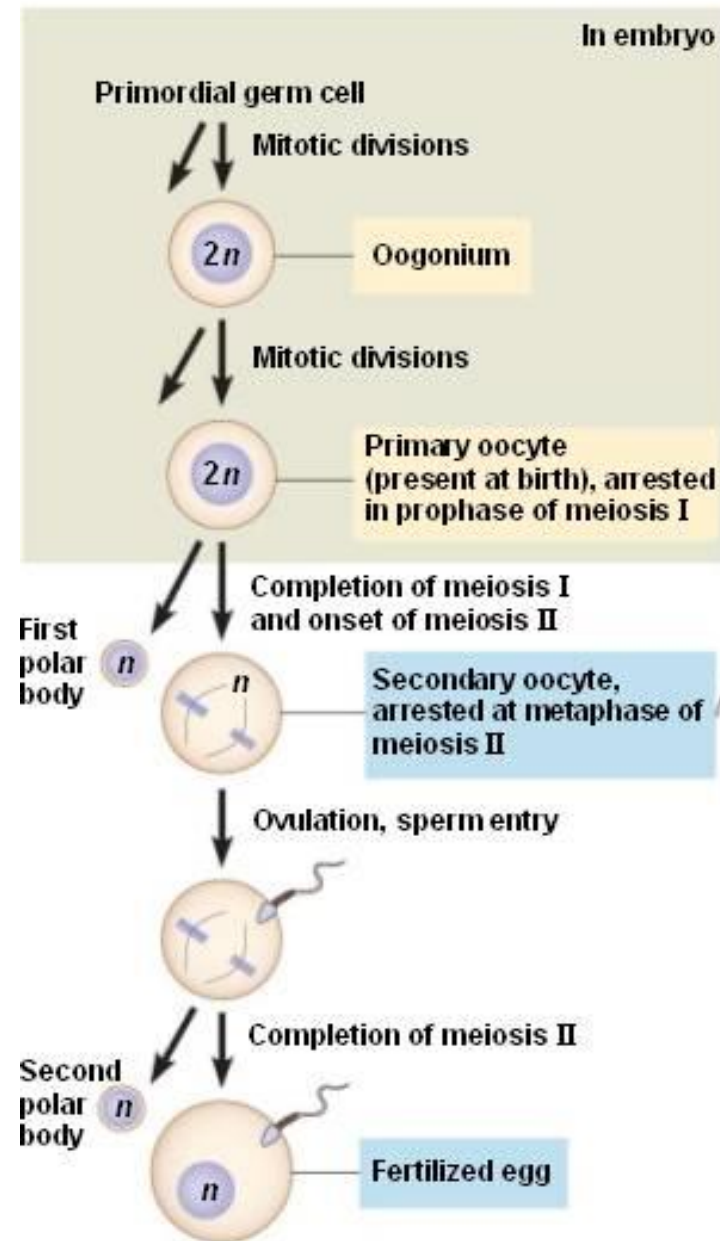
Gametes – Sperm, Oocyte



Spermatogenesis

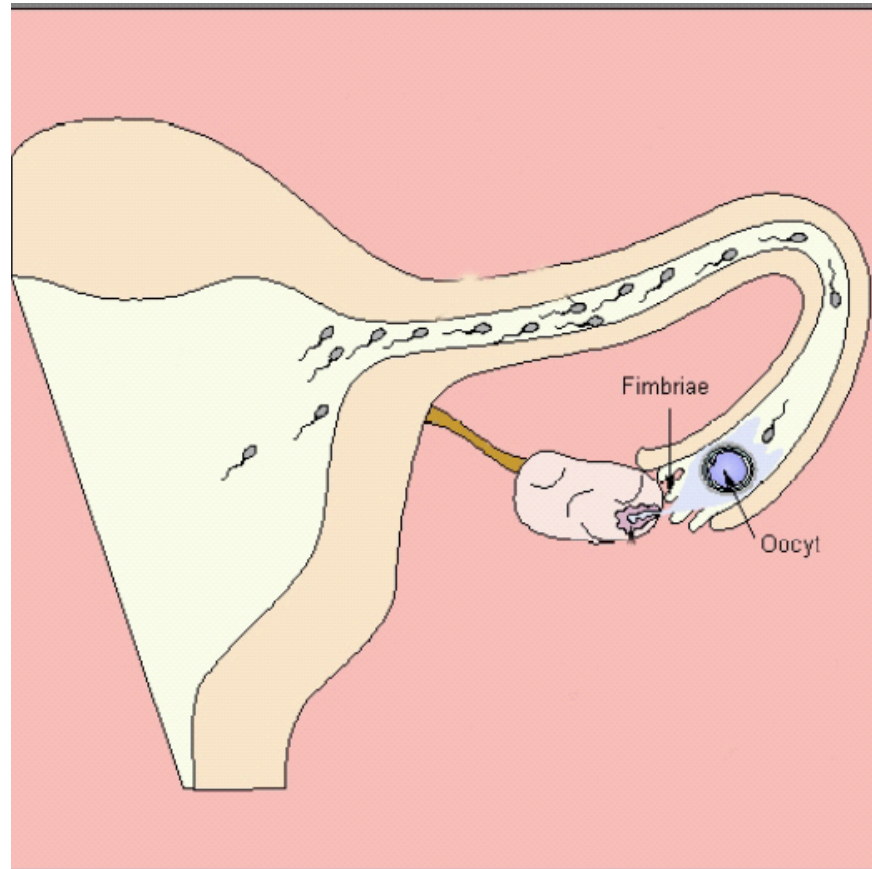


Oogenesis



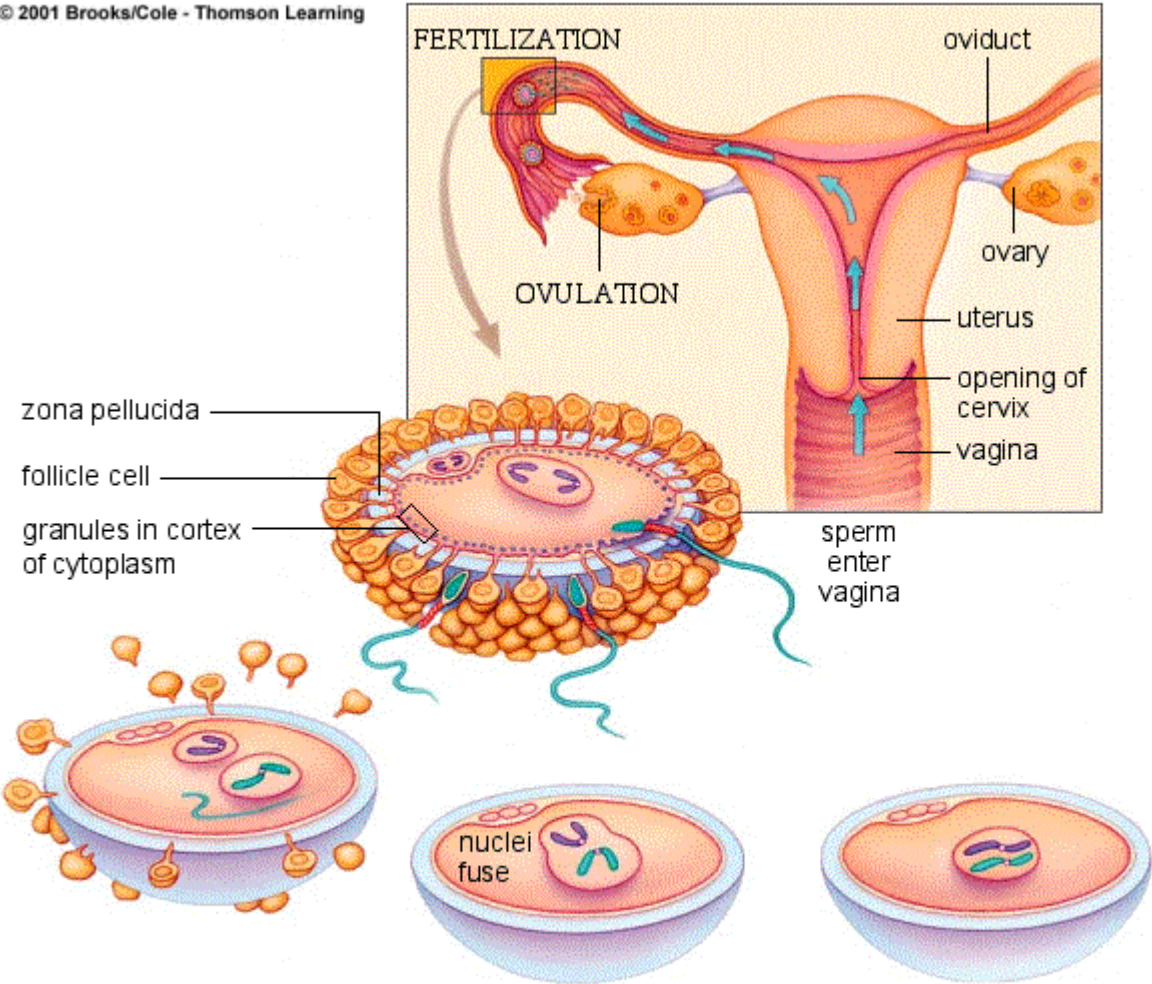
Fertilization

- the process by which the male and female gametes fuse to form a zygote and so start the development of an embryo
- occurs mostly in the ampullary region of the uterine tube




Fertilization

© 2001 Brooks/Cole - Thomson Learning



Fertilized Oocyte

- in cytoplasm forming of female and male pronuclei
- pronuclei fuse  diploid zygote

nuclei of gametes
before fusion



Cleavage

1. week of development

2 blastomers



4 cell-stage, 4 blastomers

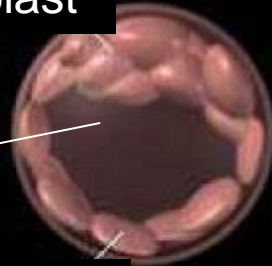


blastocyst

embryoblast

blastocyst cavity

trophoblast



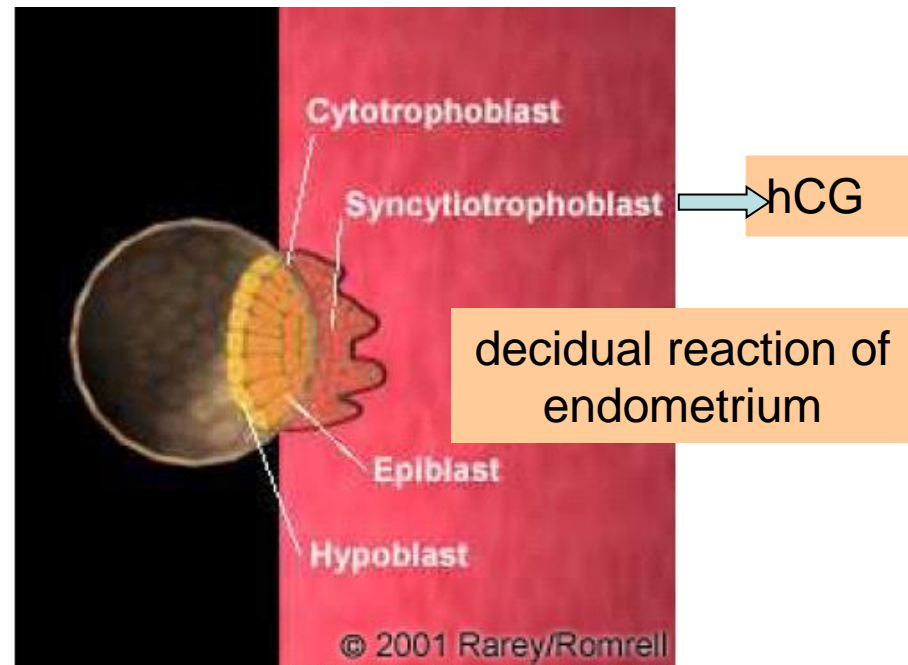
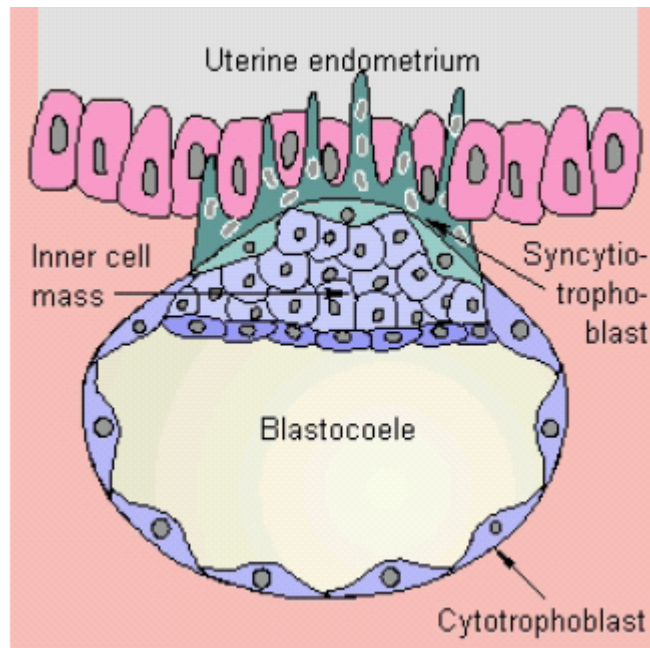
morulla



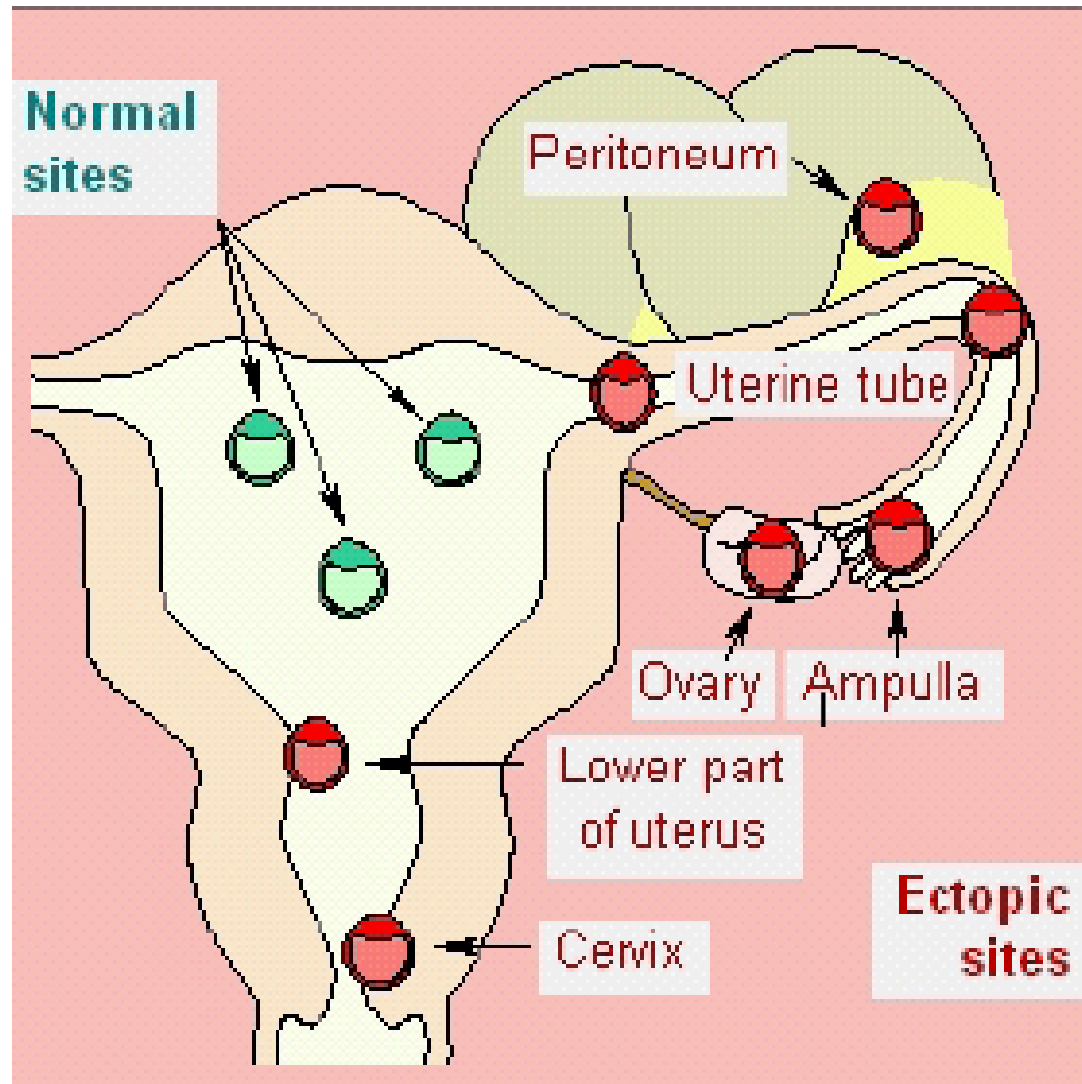
Implantation

1. week

- **TROPHOBLAST** differentiates into
 - inner **CYTOTROPHOBLAST**
 - outer **SYNCYTIOTROPHOBLAST** (invading into the endometrium)
- from **EMBRYOBLAST** are separated
 - **HYPOBLAST** (primary endoderm) *sometimes written like entoderm*
 - **EPIBLAST** (primary ectoderm)



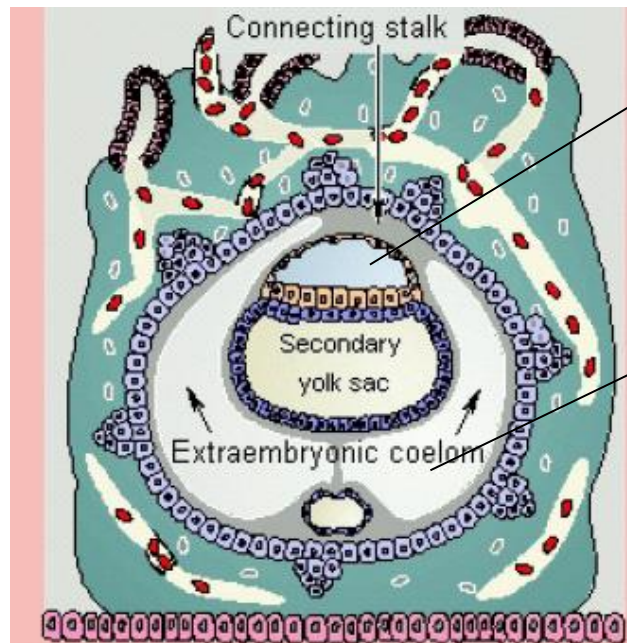
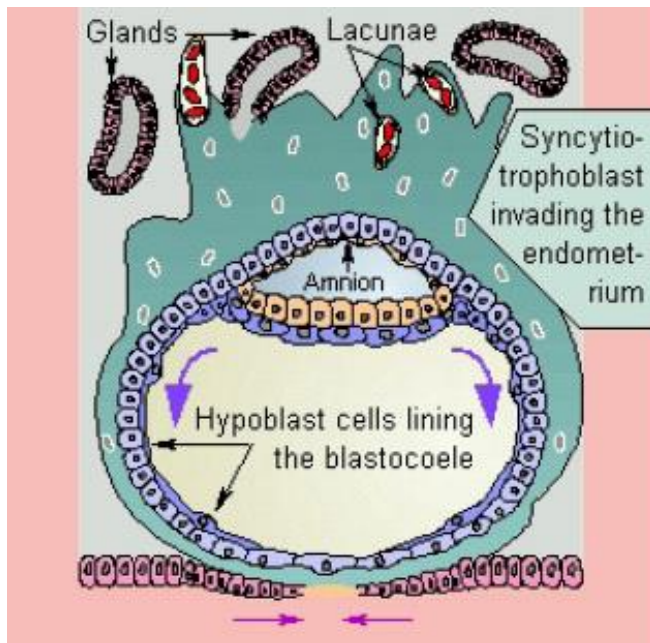
Implantation



Bilaminar Germ/Embryonic Disc

2. week

- amnion – amniotic cavity
- primary and secondary (definitive) yolk sac
- chorion (chorionic cavity) – is constituted from the extraembryonic somatic mesoderm and trophoblast



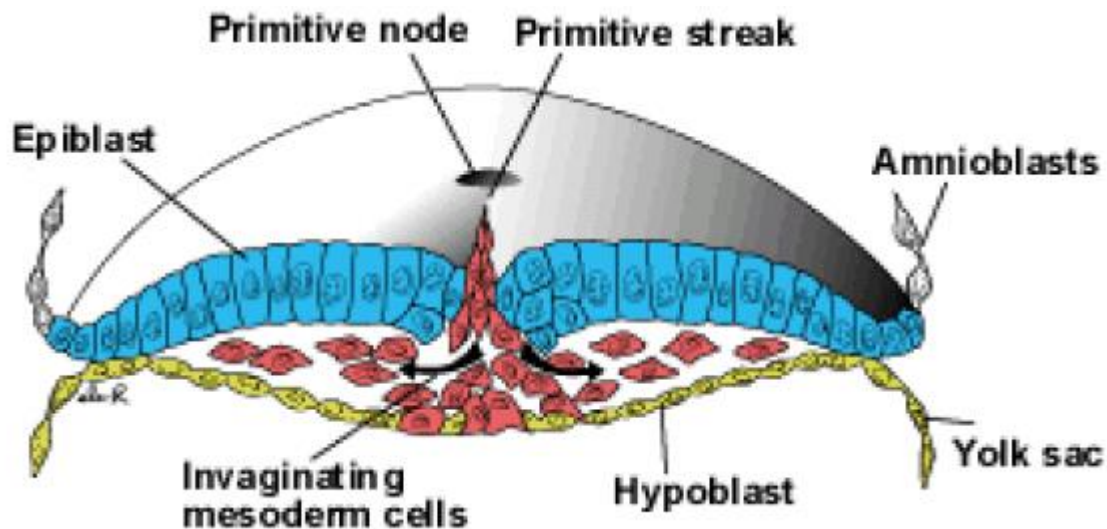
amniotic cavity

chorionic cavity

Trilaminar Germ Disc

3. week

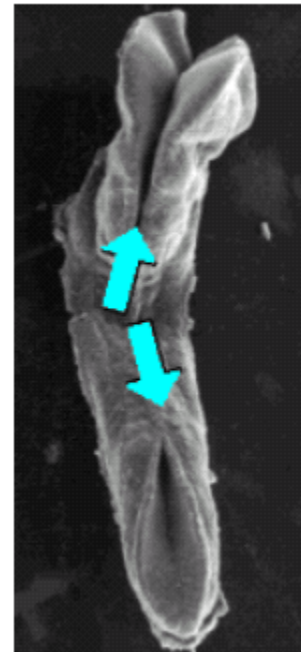
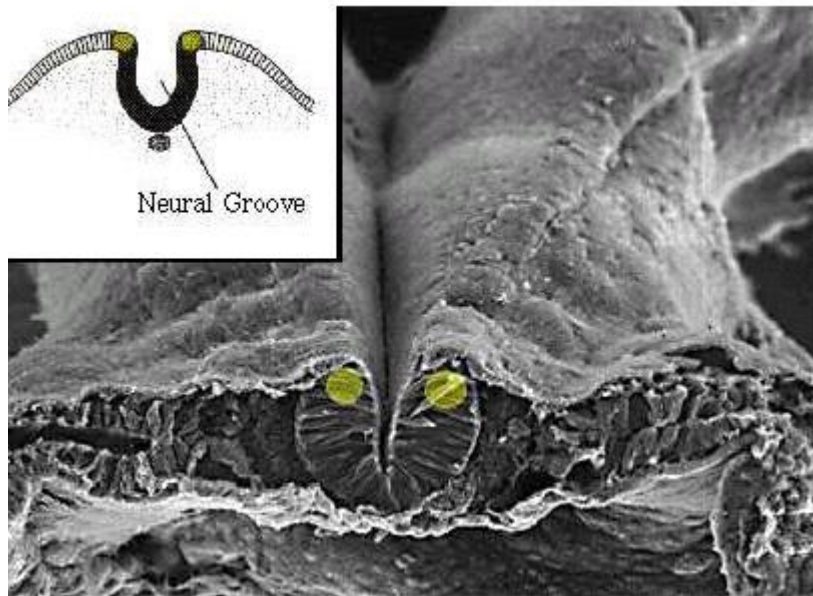
- formation of three primary germ layers (gastrulation)
 - ectoderm – mesoderm – endoderm
- primitive streak, primitive node



Neurulation

3. – 4. week

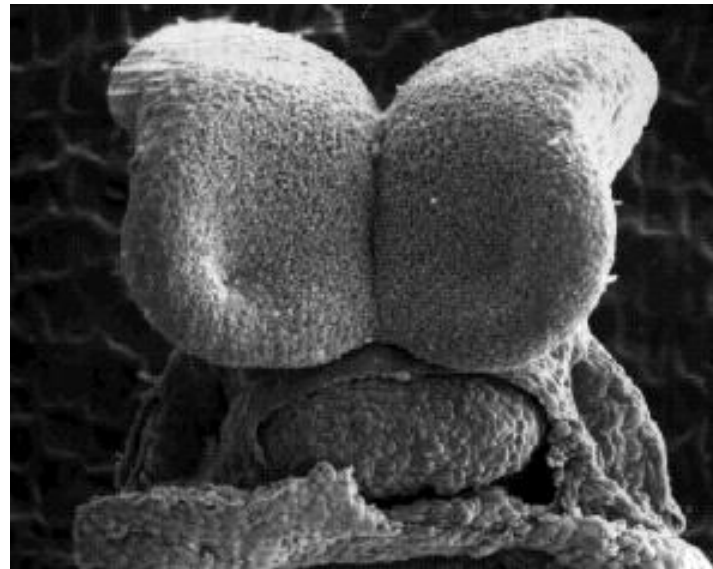
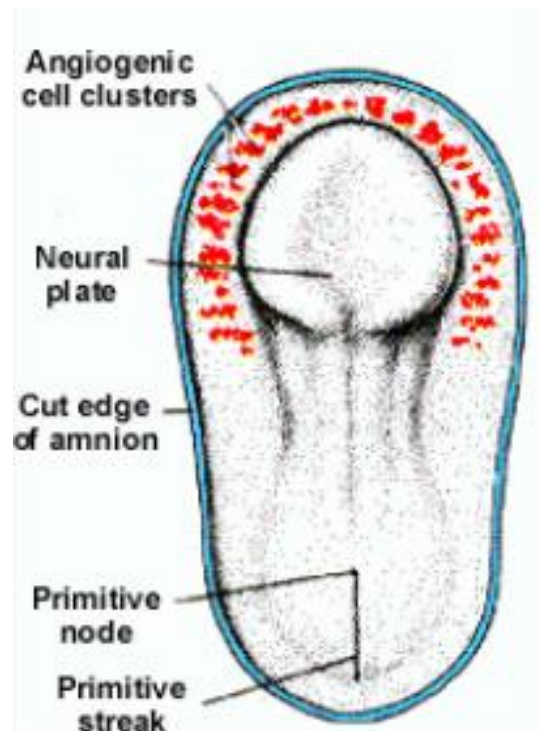
- notochord and primitive node induce the development of neural plate
- neural plate → neural tube



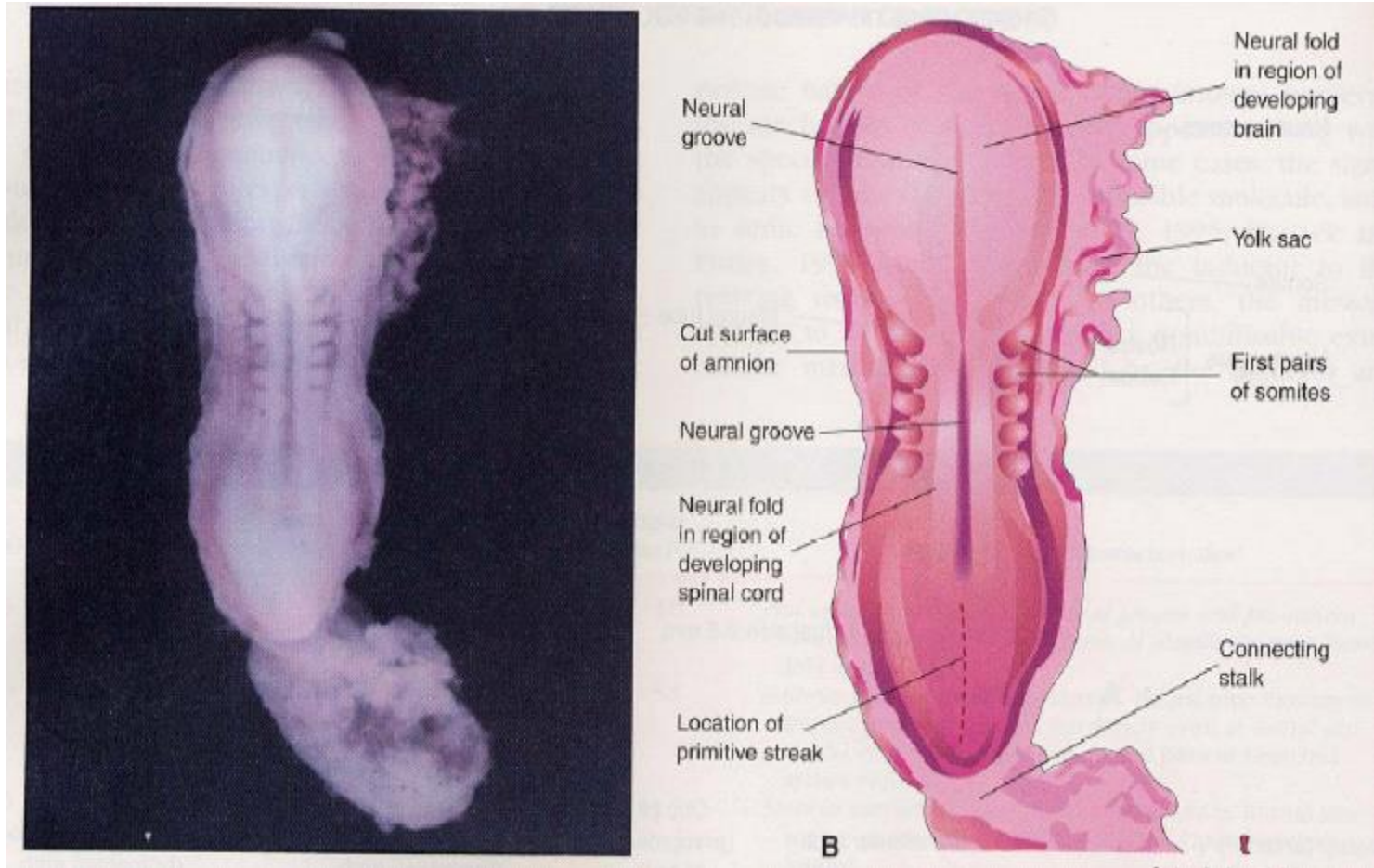
Cardiovascular System

3. week

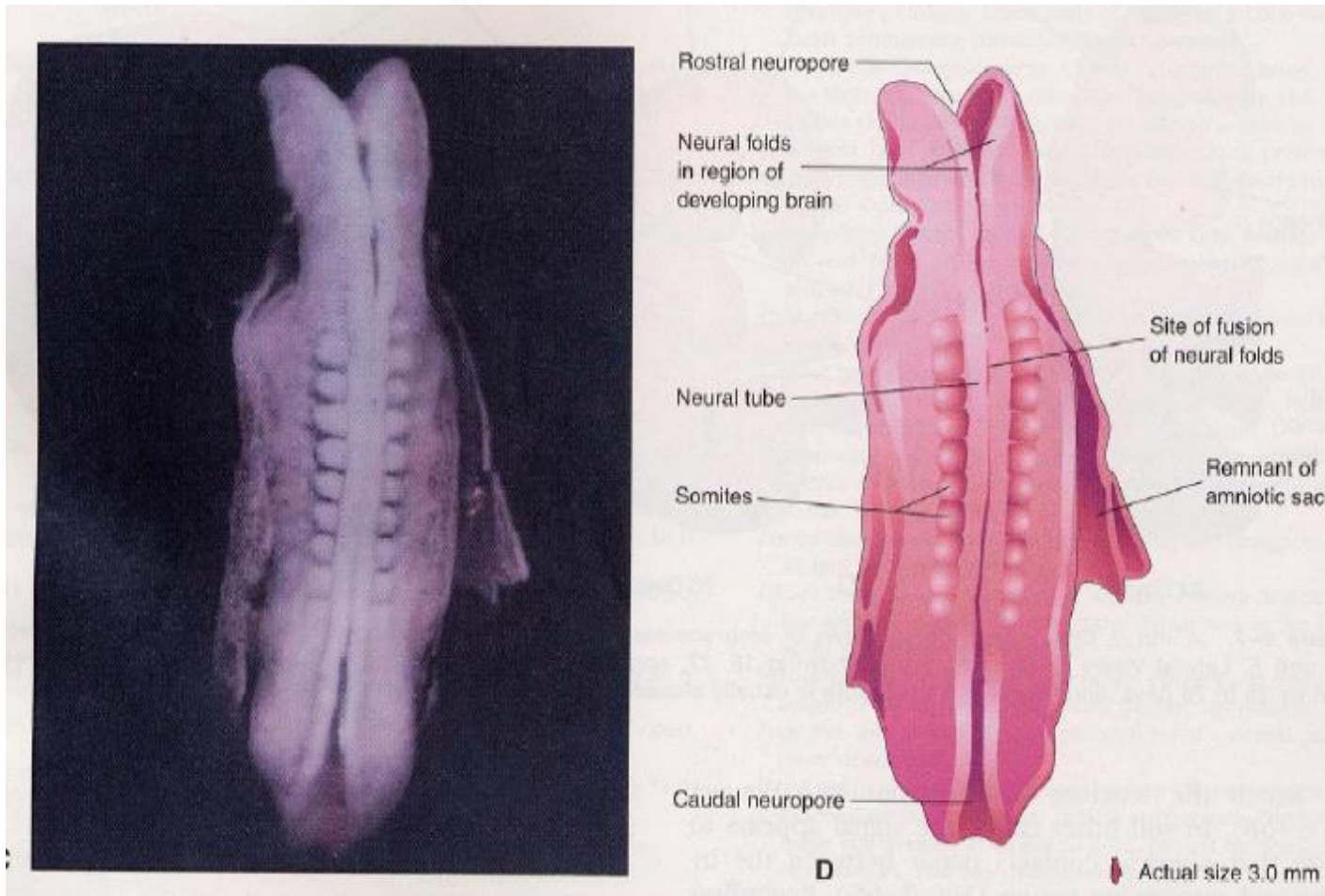
- heart and vessels arise in **cardiogenic zone** from mesenchyme
- heart sounds – from 21. – 22. day



22 days (2,5 mm)



23 days (3 mm)

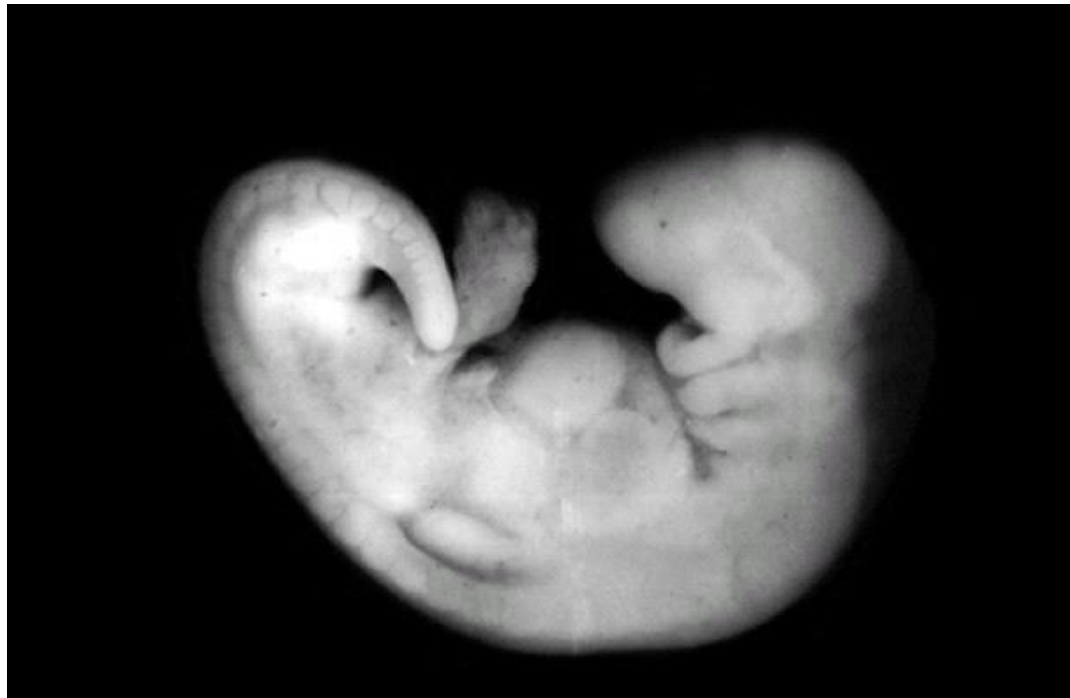


24 - 25 days (2,5 - 4,5 mm)



28 – 32 days (4 – 6 mm)

- closed neural tube
- development of cardiovascular system
- forming of branchial arches
- eye, ear and nasal cavity development
- limb buds
- bending of an embryo



6. – 7. week



7. week (14 mm)



8. week (18 mm)



8. week (29 mm)

- formed extremities, divided fingers
- eyelids closed
- sex is not differentiated



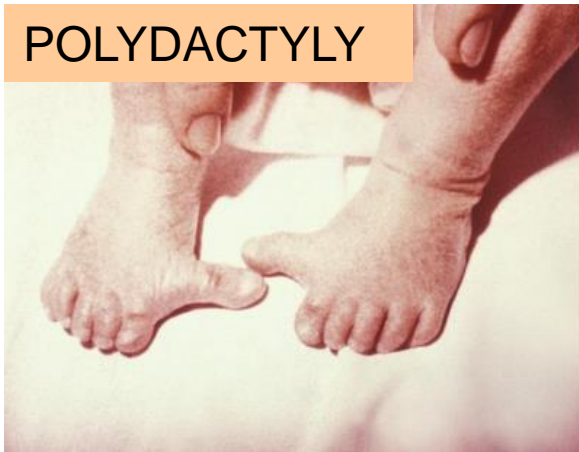
Limb Development Disorders (7.-8. week)

SYNDACTYLY



TRIPHALANGEAL THUMB

POLYDACTYLY



AMELIA



ECTRODACTYLY



Etiology of Congenital Anomalies

- *genetic factors*: responsible for approximately 10–15% CA, are associated with chromosomal aberrations or originate in gene mutations
- *environmental factors*: so-called teratogens, cause another 10–15% CA
- *multifactorial causes and factors not yet known* (70–80% CA)

Teratogens and genetic factors can interfere with normal morphogenesis of the fetus **on several levels**

For example: cell migration, proliferation, interaction, apoptosis etc.

Genetic Causes of Congenital Malformations

- **chromosomal abnormalities** (including triploidy)
 - Down syndrome (21. chromosome trisomy), Klinefelter syndrome (karyotyp 47,XXY and its variants), Turner syndrome
- **single gene disorders**
- **polygenic disorders**

Environmental Factors of Congenital Anomalies

Physical agents:

One of the most serious is *ionizing radiation*, which causes growth retardation and defects of the central nervous system. Also it is necessary to mention the negative effects of vibrations.

Chemical agents:

drugs (cytostatics, antibiotics, hormones, antiepileptics, anticoagulants etc.), alcohol, smoking

Biologic agents:

viruses (CMV, herpes simplex, EBV, influenza, mumps), bacteria (*Treponema pallidum*), parasites (toxoplasmosis)

10. week (62 mm)



13. week (97 mm)



Congenital Disorders of CNS

13. week



ENCEPHALOCELE



NEURAL TUBE CLEFT /
SPINA BIFIDA



13. week

anencephalus



neural tube cleft



16. week

Dicephalus Masculinus



17. week (147 mm)

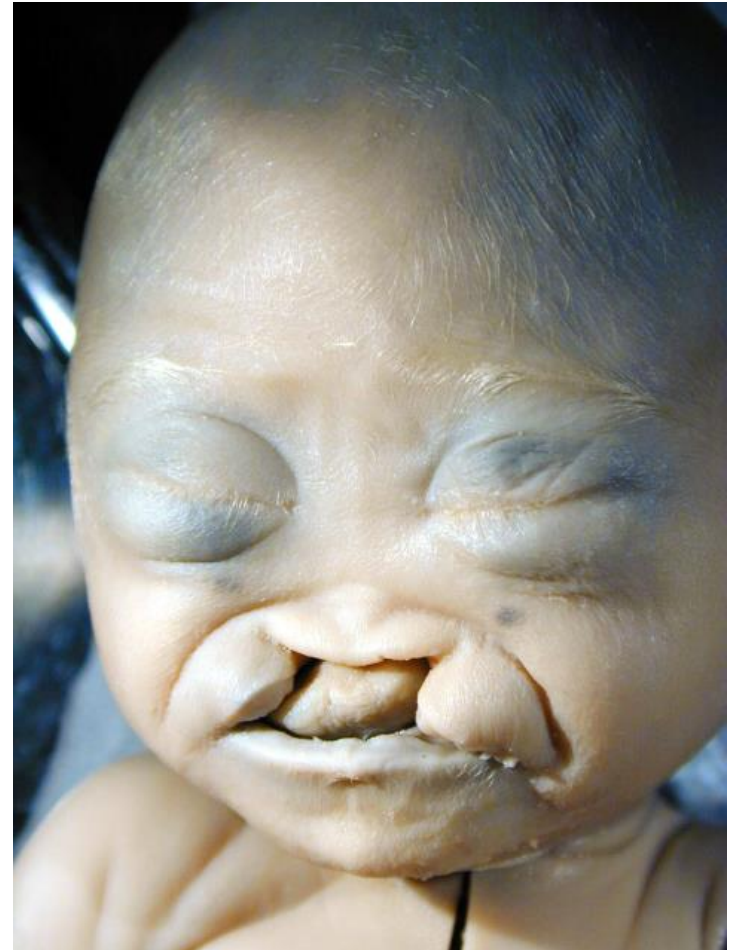


17. week Anencephalus



18. week (160 mm)

cheilognatopalatoschisis



Congenital Disorders of the Abdominal Wall

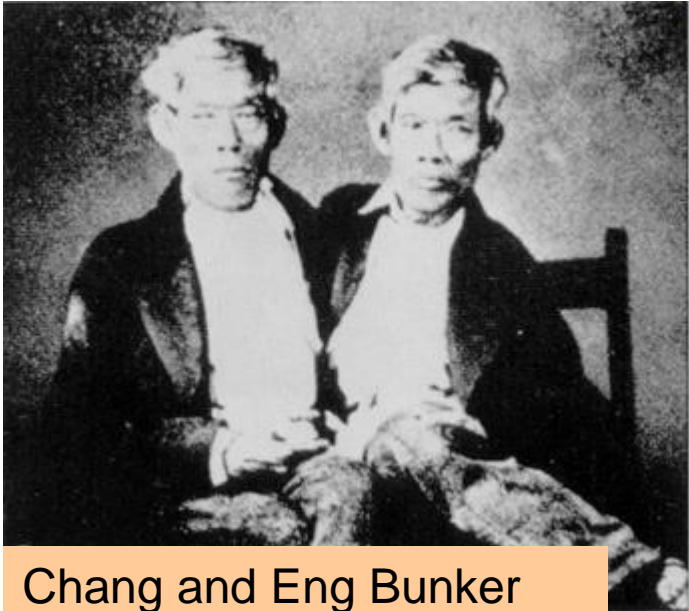
GASTROSCHISIS



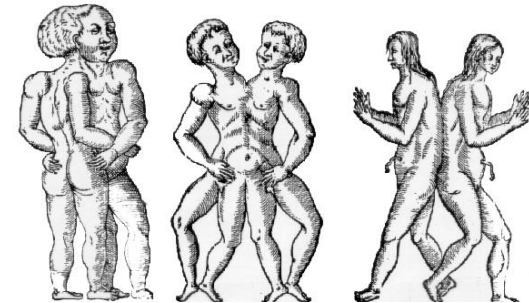
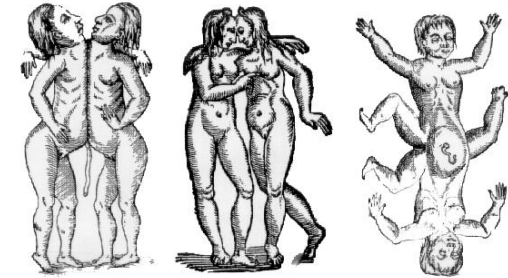
OMPHALOCELE



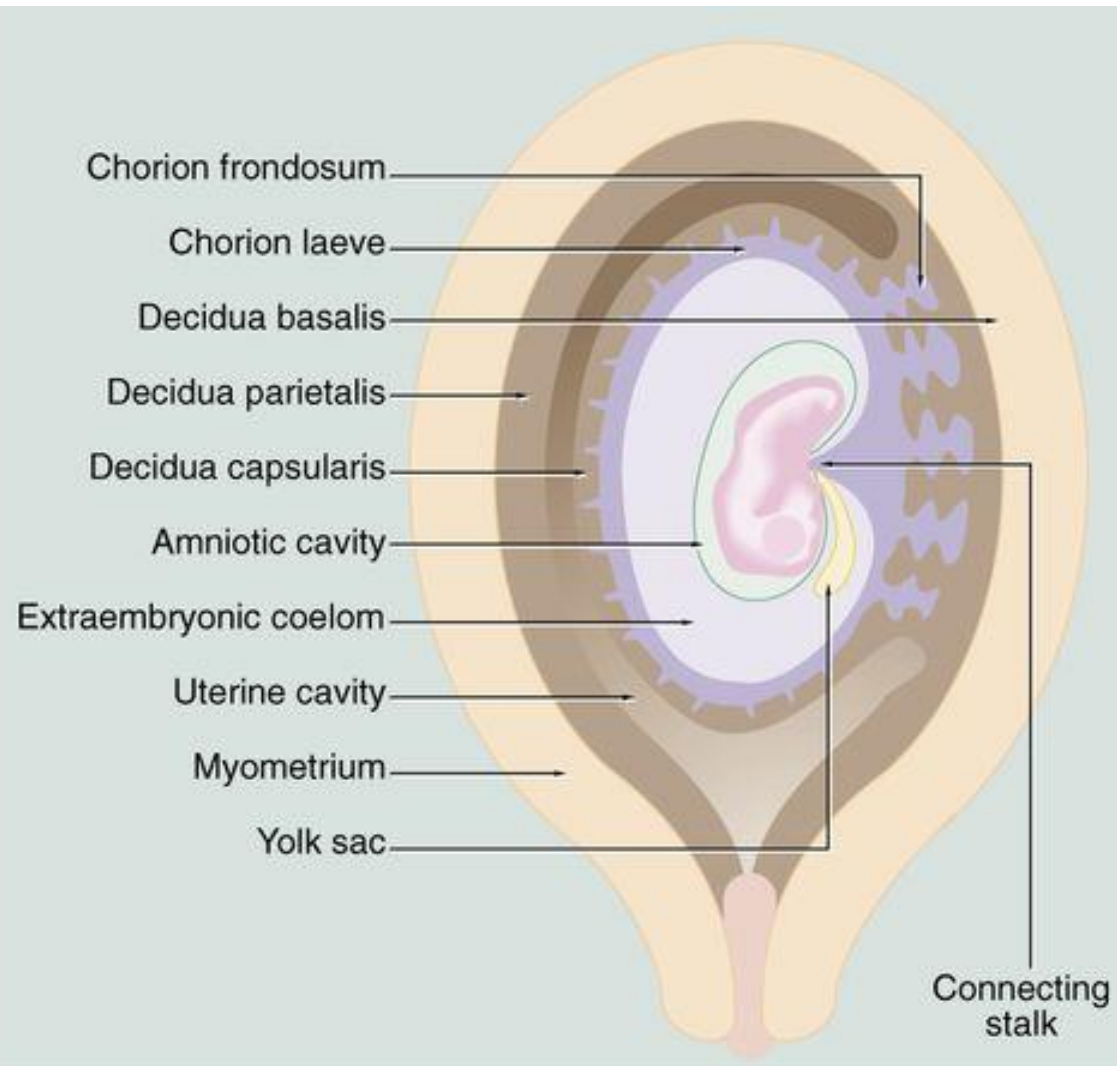
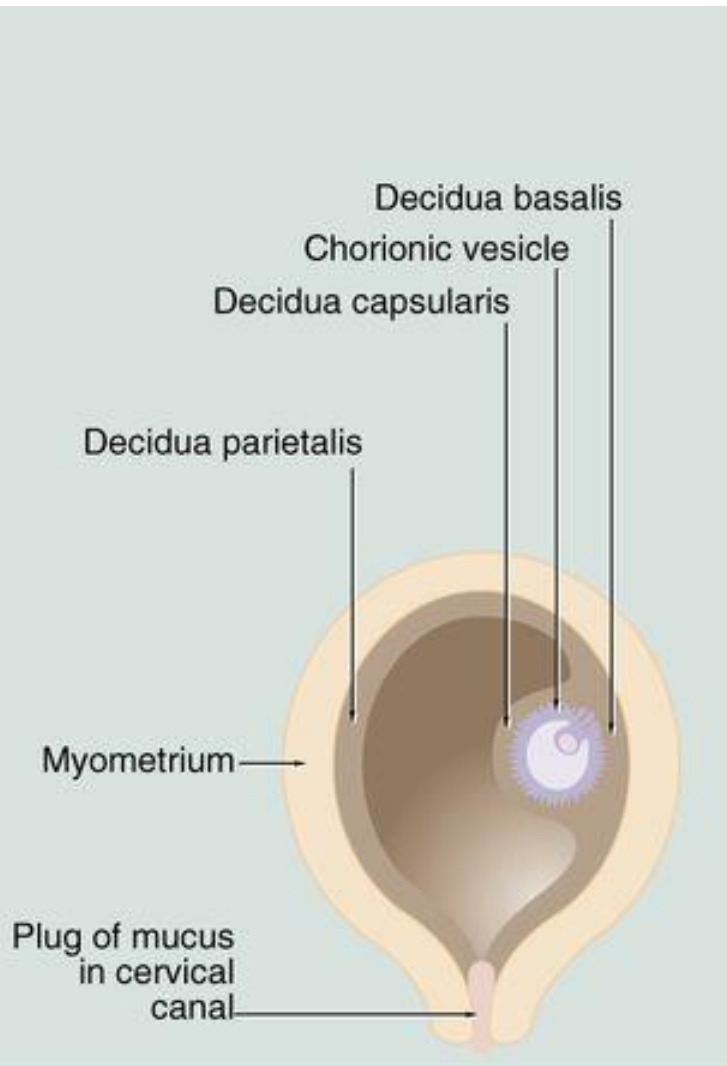
Conjoined /Siamese Twins



Chang and Eng Bunker
(1811–1874)



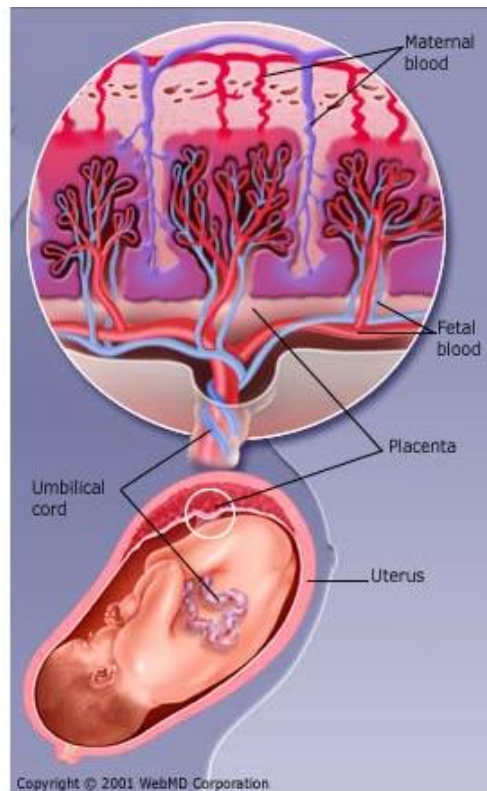
Embryo in the Uterine Cavity



Placenta of the Mature Fetus

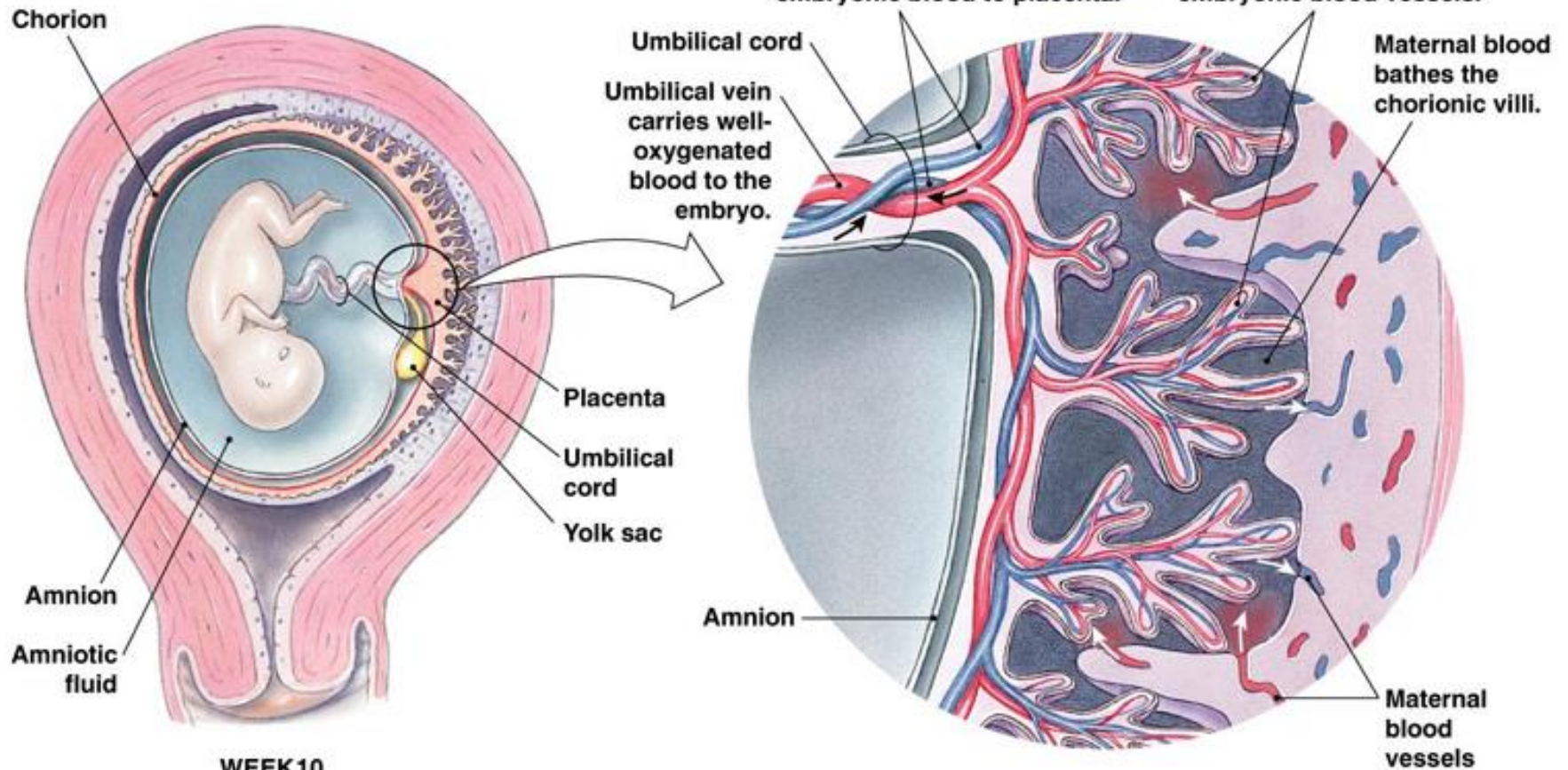
- placenta hemochorialis (mother blood washes chorionic villi), diameter of 15-25 cm, thickness 3 cm
- **fetal part (pars fetalis)** – chorionic plate, chorionic villi
 - **cotyledon** – one villus + all its branches
- **maternal part (pars materna)** – zona functionalis deciduae basalis, placental septa

decidua
chorionic villi
chorionic plate



Placenta

Some material is exchanged across placental membranes by diffusion, but other material must be transported.

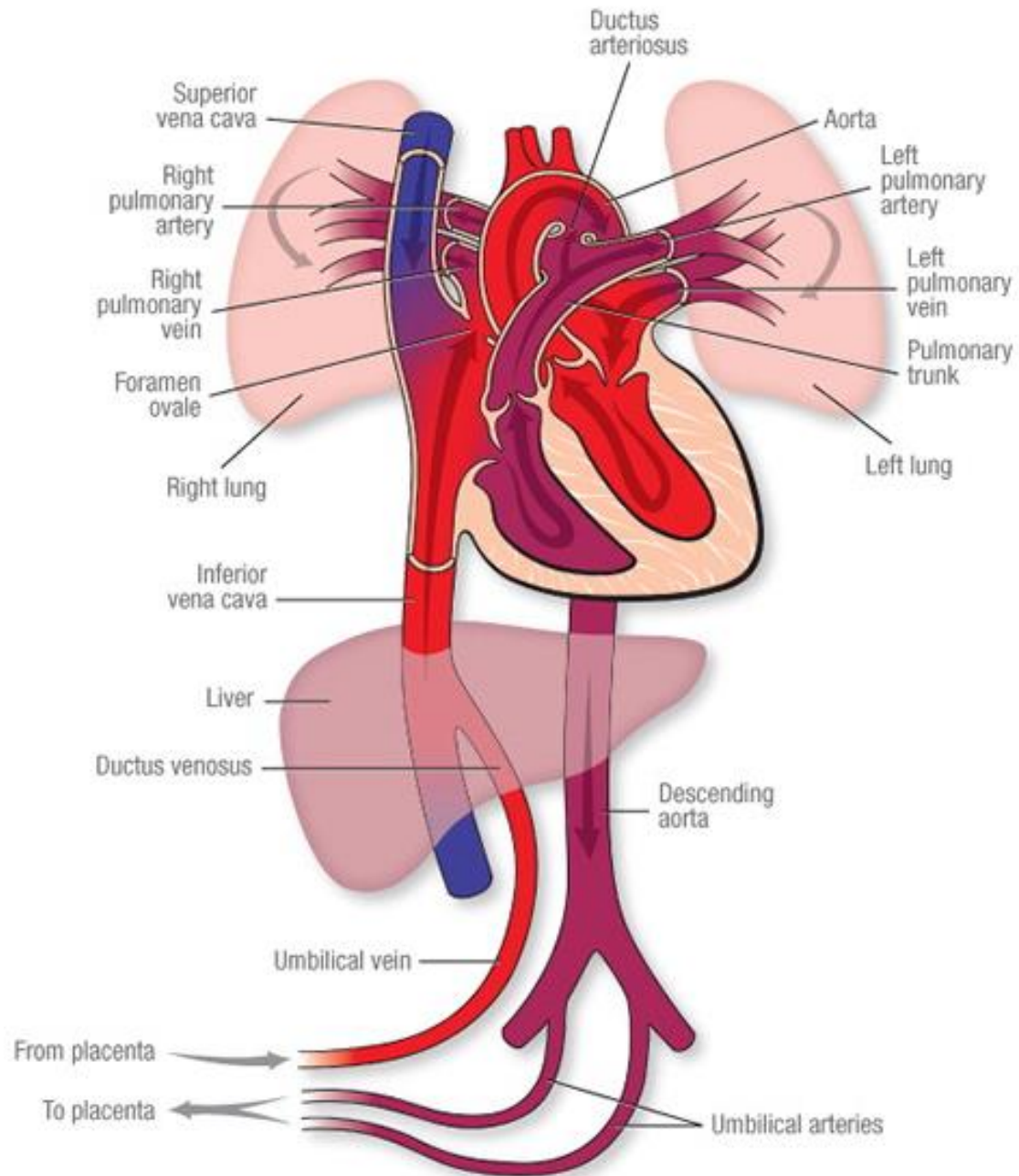


Fetal Circulation

ductus venosus Arantii

foramen ovale

ductus arteriosus Botalli



Carnegie Stages of Human Development

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



Stage 1 Zygote
(1 day, not to scale)



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Intrauterine Development Review

- the duration of normal gestation is *280 days* (which equals 40 weeks) counted from the first day of the last menstruation

Intrauterine development is divided into following stages:

- *embryonal*: 1st-8th week of the fetal development - equals 3rd-10th week of gestation (w.g.)
- *fetal*: from 9th week of the fetal development, i.e. from 11th week of gestation

Furthermore, fetal period can be theoretically divided into a *previable* (0 to 20 w.g.) and *viable* period (over 20th w.g.)

Infants born before 28th w.g. suffer from serious health complications caused by insufficient production of alveolar surfactant.

Intrauterine Development Review

- 1st lunar month:** fertilized oocyte quickly develops into a blastocyst, which will soon turn into an embryonic disc (3rd week) – formation of the cylindrical embryo body – the somite stage of development follows – formation of the head part, embryo body and caudal end, face and limb prominences begin to form (4mm)
- 2nd lunar month:** development of the facial structures – eyes, ears, nose; formation of the brain, limbs continue to develop, fingers become separate. Embryo slowly gains human features and becomes distinguishable from embryos of other mammals (28mm)
- 3rd lunar month:** quick growth, most of the internal organs are in their final positions, external genitalia are completely developed (90mm, 20g)
- 4th lunar month:** rapid growth, nails, skin covered with first hair (lanugo) (length 150mm, weight 120g)
- 5th lunar month:** growth slows down, the head becomes smaller compared to the rest of the body. **Heartbeat can be detected with a stethoscope!** (250mm, 300g)

Intrauterine Development Review

- 6th lunar month:** no subcutaneous fat – skin is soft, transparent, purple-red with blood vessels clearly visible, short hair, eye lashes and eyebrows begin to grow (300mm, 600g)
- 7th lunar month:** subcutaneous fat begins to form, eyes open, testes begin to descend into the scrotal pouch (350mm, 1200g)
- 8th lunar month:** subcutaneous fat increases, the fetus is plump, pink with hair on its head, nails reach to the ends of fingertips (400mm, 1800g)
- 9th lunar month:** changes which began in the 8th lunar month continue, descent of testes is finished (450mm, 2600g)
- 10th lunar month:** *by this time a full-term baby is ready to be born* – body is plump, skin is smooth without lanugo, nails reach over the ends of fingertips, hair is at least 10 mm long, bones on the head are hard, cartilage is firm and fontanelles are palpable; perimeter of the chest is slightly larger than perimeter of the head (500 mm, 3300 g)

Apgar Score

- **classification of the vitality of the newborn immediately after birth (baby is scored at 1, 5 and 10 minutes after birth) – a score of 7-10 is considered normal**
- **heart action**
 - none (0 points)
 - under 100/min (1 point)
 - over 100/min (2 points)
- **breathing**
 - none (0 points)
 - slow, irregular (1 point)
 - regular, cry (2 points)
- **muscle tone**
 - none (0 points)
 - weak (1 point)
 - normal (2 points)
- **reaction to irritation**
 - none (0 points)
 - grimace (1 point)
 - cry (2 points)
- **skin color**
 - general cyanosis and paleness (0 points)
 - acrocyanosis (1 point)
 - pink (2 points)

Physical Maturity

- average birth *weight* 3500g, birth *length* 50 cm
- *skin* – pink, few visible veins, subcutaneous fat is present, nails reach the fingertips
- *lanugo* – thinning of lanugo, balding areas
- *plantar creases* – covering at least the anterior 2/3 of foot
- *breast* – raised areola with 3-4mm breast bud
- *ear* – cartilage present with pinna with ability for natural recoil when folded
- *genitalia male* – pendulous scrotum with rugae, descended testes
- *genitalia female* – large labia majora covering labia minora
- *posture* – flexed position with good muscle tone