Fertilization to Implantation

BOOKLET 2

Learner outcomes…
What you need to know!

- trace the processes of fertilization, implantation and extra-embryonic membrane formation, i.e., placenta, amnion, chorion, allantois, followed by embryonic and fetal development, parturition and lactation, and describe the control mechanisms of these events, i.e., progesterone, LH, human chorionic gonadotropin (hCG), prostaglandins, oxytocin, prolactin
- describe development from fertilization to parturition in the context of the main physiological events that occur in the development of organ systems during each major stage (trimester); i.e., zygote, blastocyst, gastrulation, general morphogenesis

Learner outcomes…
What you need to know!

- identify major tissues and organs that arise from differentiation and morphological development of the ectoderm, mesoderm and endoderm in the embryo; i.e., -ectoderm: nervous system, epidermis

  -mesoderm: skeleton, muscles, reproductive structures

  -endoderm: lining of the digestive and respiratory systems, endocrine glands

Terms you need to know

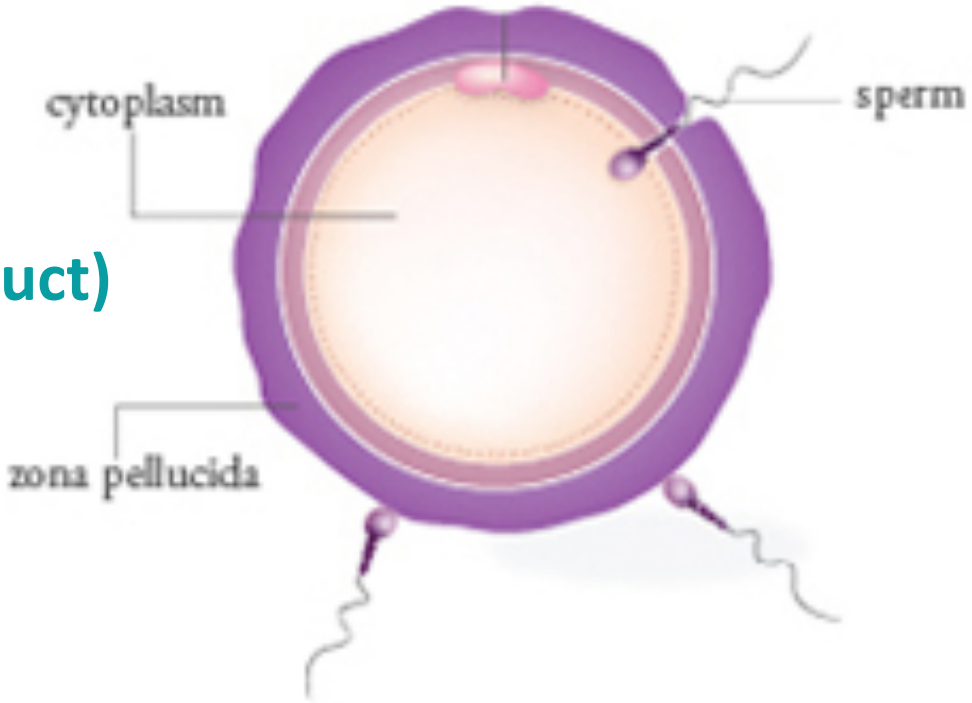
Oviduct
(2n) and (n)
Zygote
Cleavage
Morula
Blastocyst
Trophoblast (chorion)
Mitosis
Implantation
Undifferentiated Cell

Terms you need to know

Gastrulation
Ectoderm
Mesoderm
Endoderm
Gastrula
Ectopic
Neurulation
Chorion
Amnion
Allantois
Yolk Sac
Placenta
Umbilical Cord

First Stages of Development

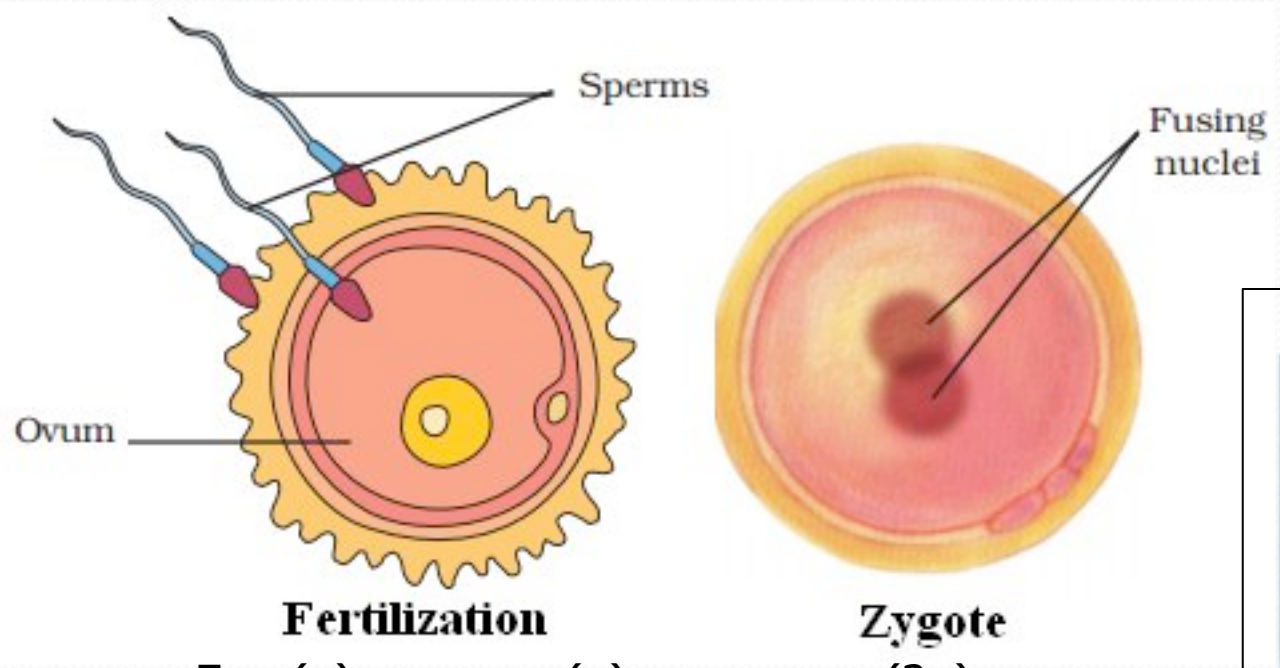
Fertilization:
Occurs: in **FALLOPIAN TUBE(oviduct)**
(within 24 h of ovulation)
Only a few dozen of the
best swimmers make it!!



- Sperm reaches egg & uses acrosome to digest through outer layer
- Sperm travels further eventually reaching the plasma membrane of the ovum.
- One sperm enters, causing cell membrane to depolarize preventing entrance of other sperm.
- Sperm and Ovum nuclei fuse (23+23 = 46)

Fertilization

- **Gametes** (n) fuse to form a **zygote** (2n)
- Zygote = **first SINGLE cell of new life**



Egg (n) + sperm (n)

(2n)

Actual Image

Early Stages of Development

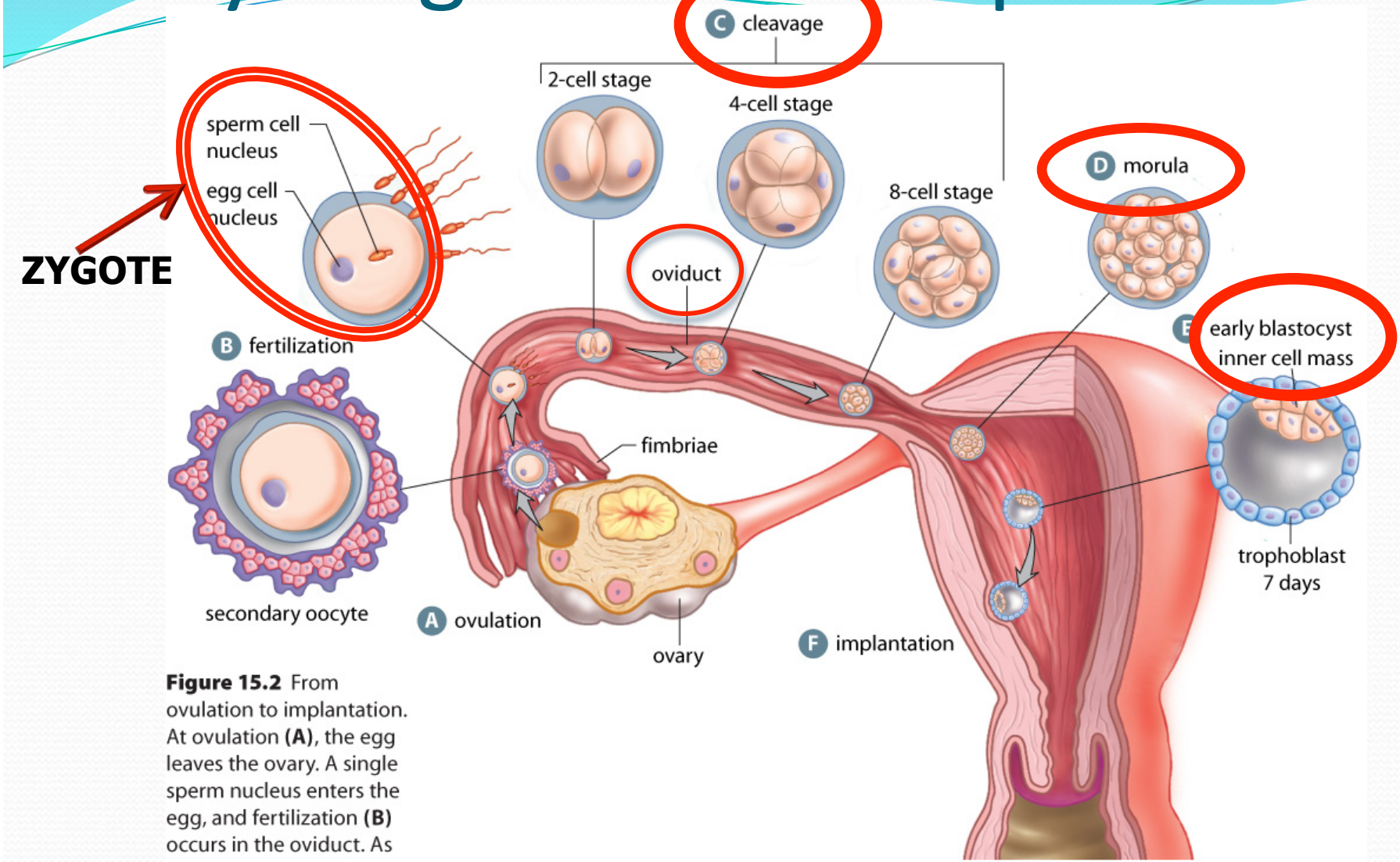


Figure 15.2 From ovulation to implantation. At ovulation **(A)**, the egg leaves the ovary. A single sperm nucleus enters the egg, and fertilization **(B)** occurs in the oviduct. As the zygote moves along, it undergoes cleavage **(C)** to produce a morula **(D)**. The blastocyst forms **(E)** and implants in the lining of the uterus **(F)**.

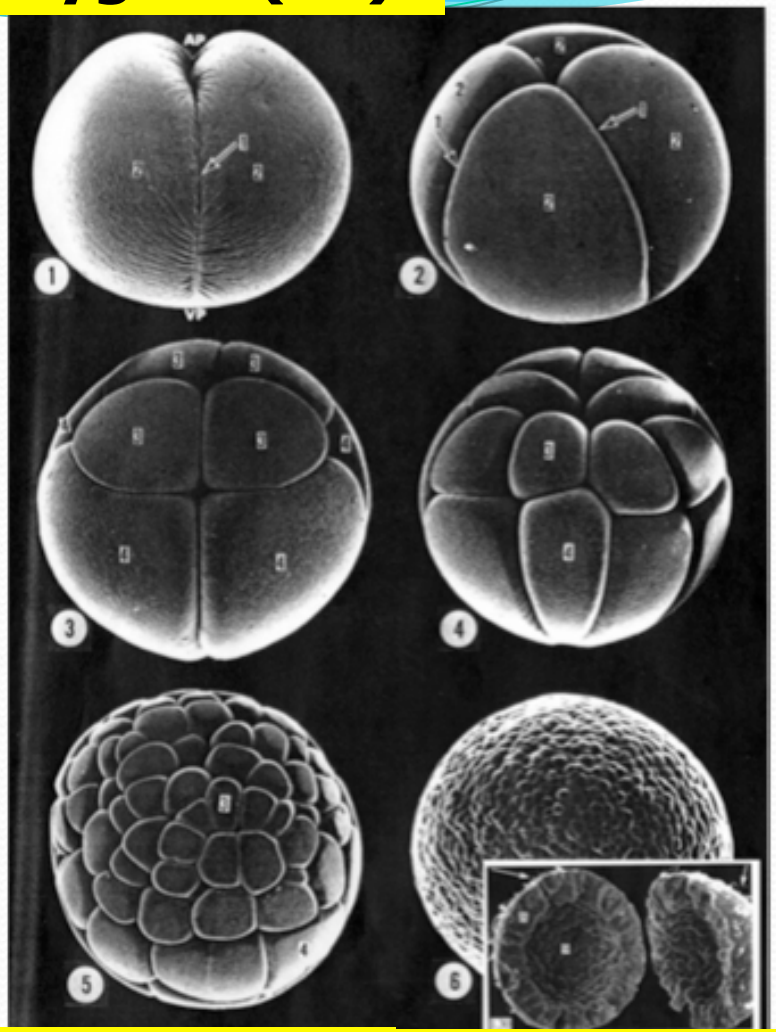
When can Conception Occur?

- Ova can survive at most for approx. 1-2 days post ovulation while sperm can survive for up to approx. 5 days given the right environment.
- *Given a normal menstrual cycle, when could pregnancy occur?*

Cell Cleavage

- Zygote undergoes **mitotic** divisions (***cleavage***) to form ball of cells called **morula** (16-32 cells by day 5)

- Morula develops into **blastocyst** (day 7)

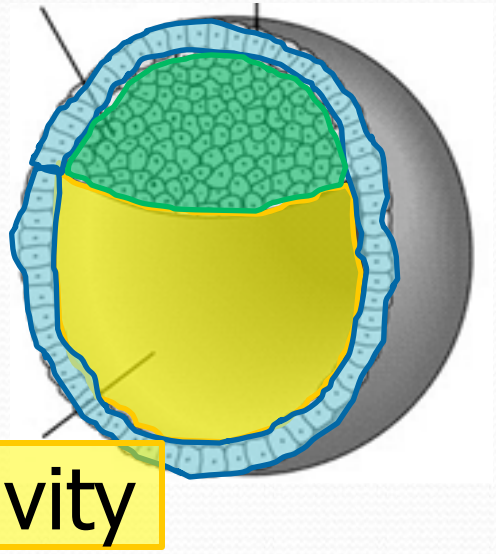


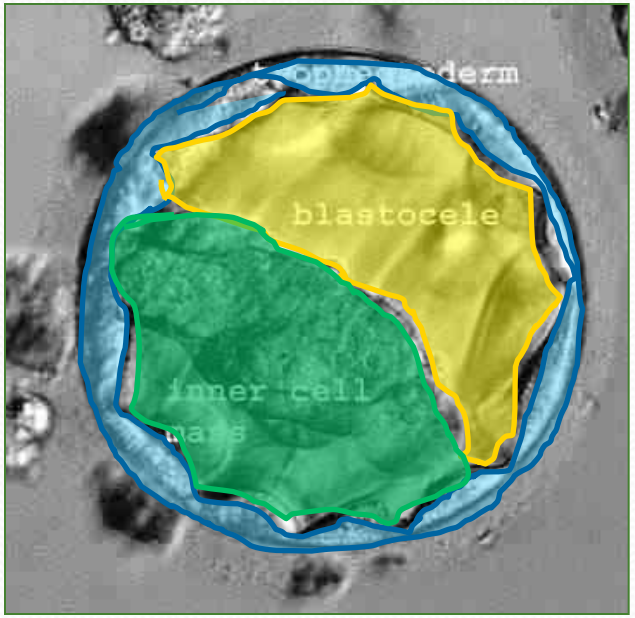
Blastocyst

a cavity (space) opens up in the morula

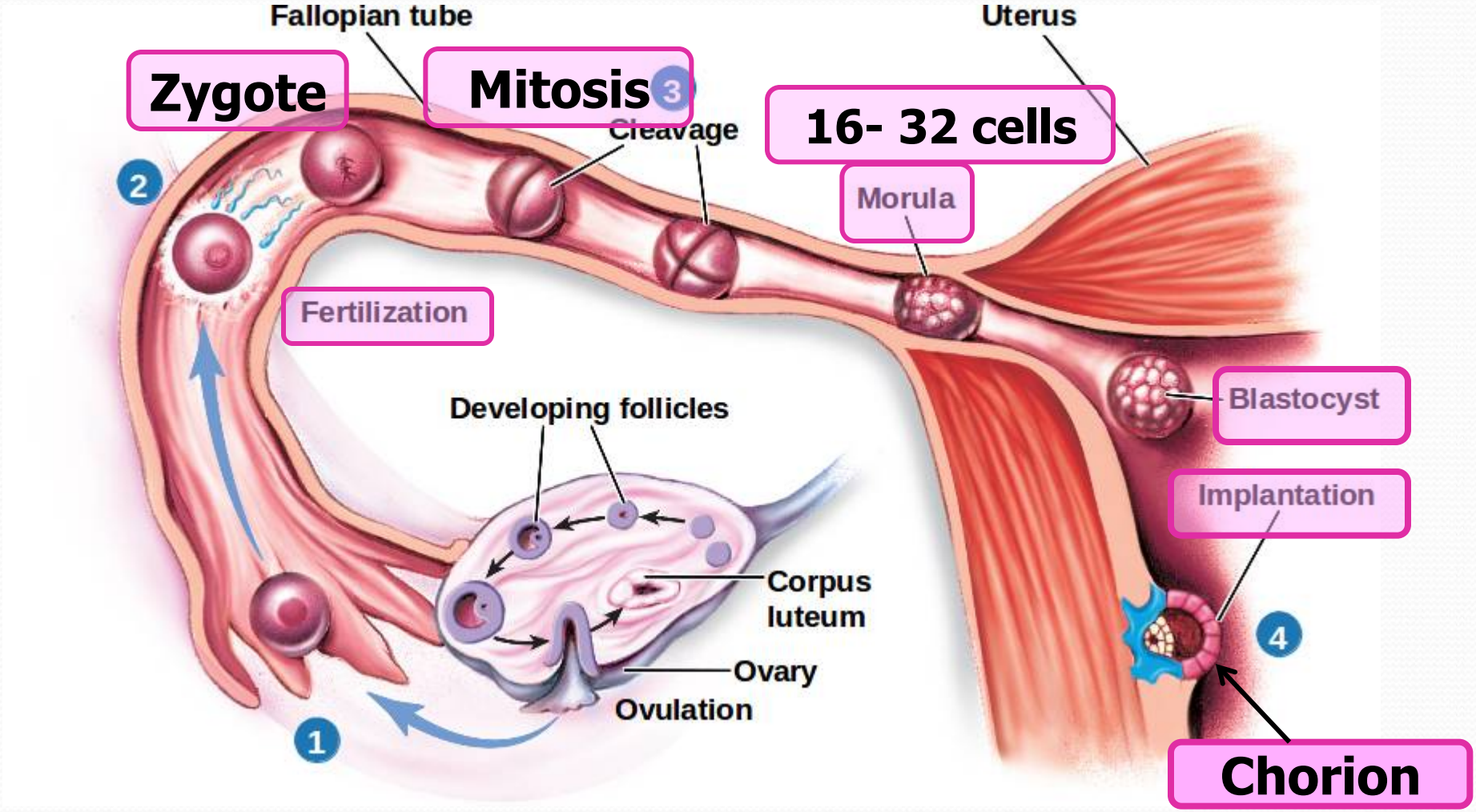
- **Chorion (trophoblast):** outer layer of blastocyst
  - **Chorion forms placenta and** the **amnion**

- **inner cell mass:** will develop into **embryo**





From Ovulation to Implantation



From Ovulation to Implantation

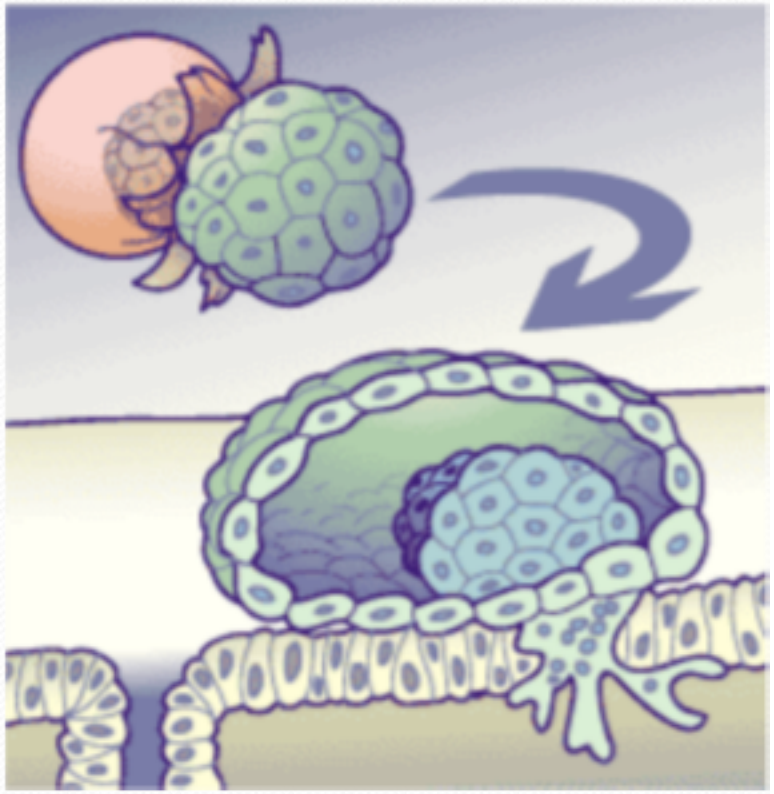
- **Day 1:** First Cleavage – cell divides by **mitosis**
- **Day 4:** 16 – 32 cell stage. Ball of cells is called a **morula.**
- **Day 5:** the cells of the morula begin to move around to form an inner and outer layer of cells. The outer layer of flattened cells (chorion) are important for **implantation in the uterine lining.**
- **Day 7:** The two layers of cells arrange themselves around a hollow fluid filled cavity called the blastocoel, the actual cell mass is called a **blastocyst.**

From Ovulation to Implantation

Day 8: Implantation

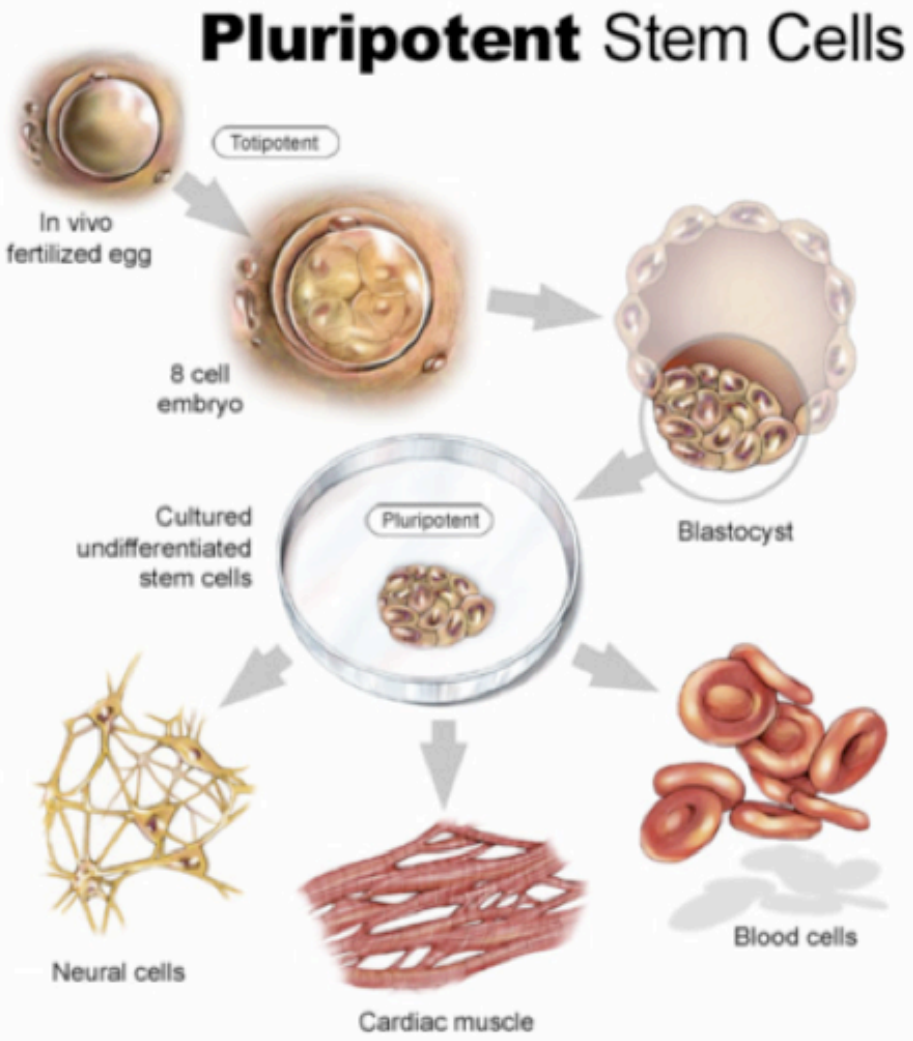
1. The blastocyst, by means of villi and enzymes secreted by the **chorion** (the membrane that forms around it), **implants** itself in the endometrium thus resulting in ***pregnancy*** (**gestation**).

2. The **chorion** secretes **hCG,** (**Human chorionic gonadotropin**) **a hormone** which stimulates the corpus luteum to produce progesterone and estrogen for the first 3 months**.**



STEM CELLS

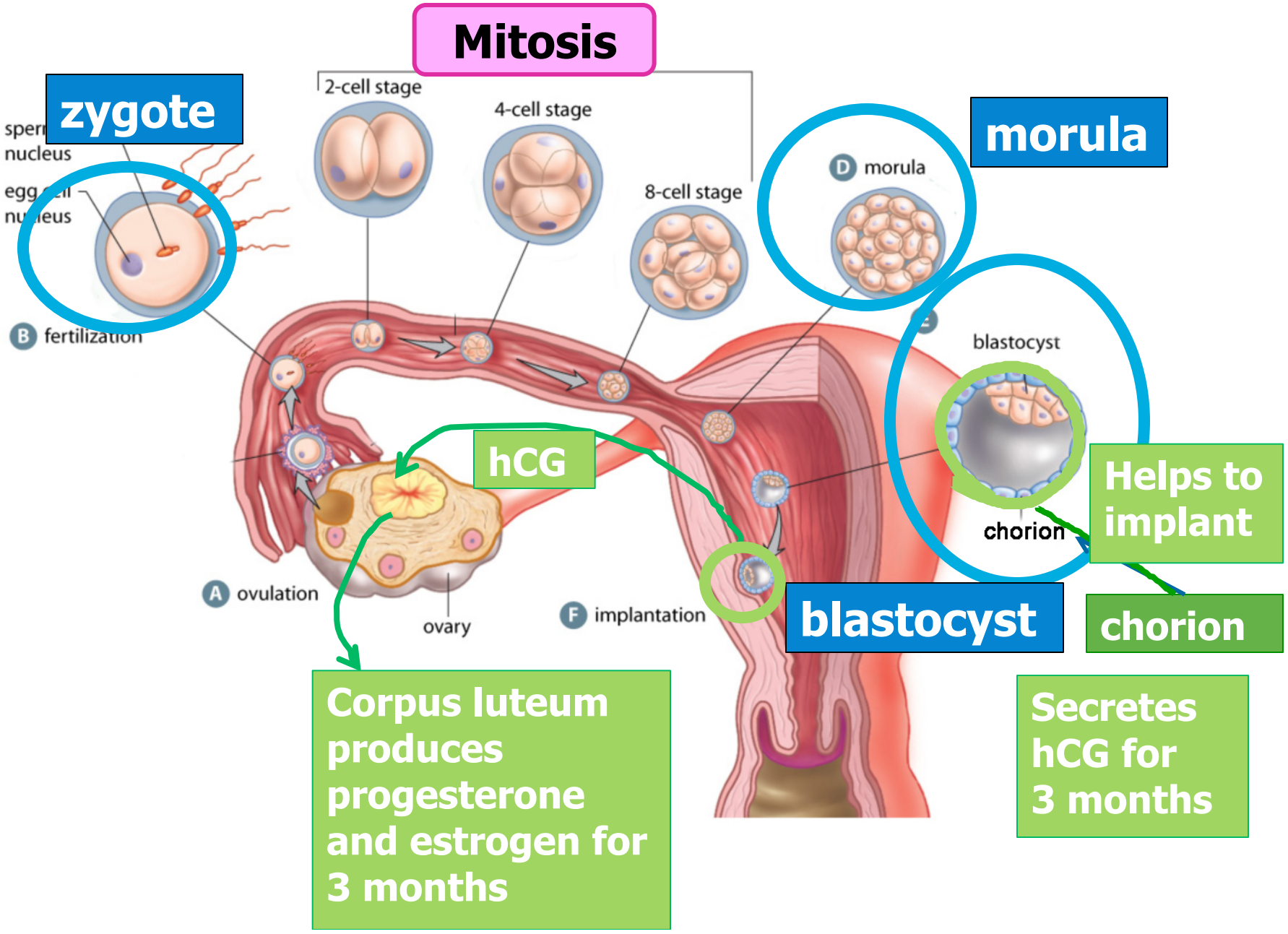
Stem cells from the blastocyst are undifferentiated …can develop into any cell in the body and can be used for stem cell research.



First Spinal Cord Stem Cell Surgery (3 min)

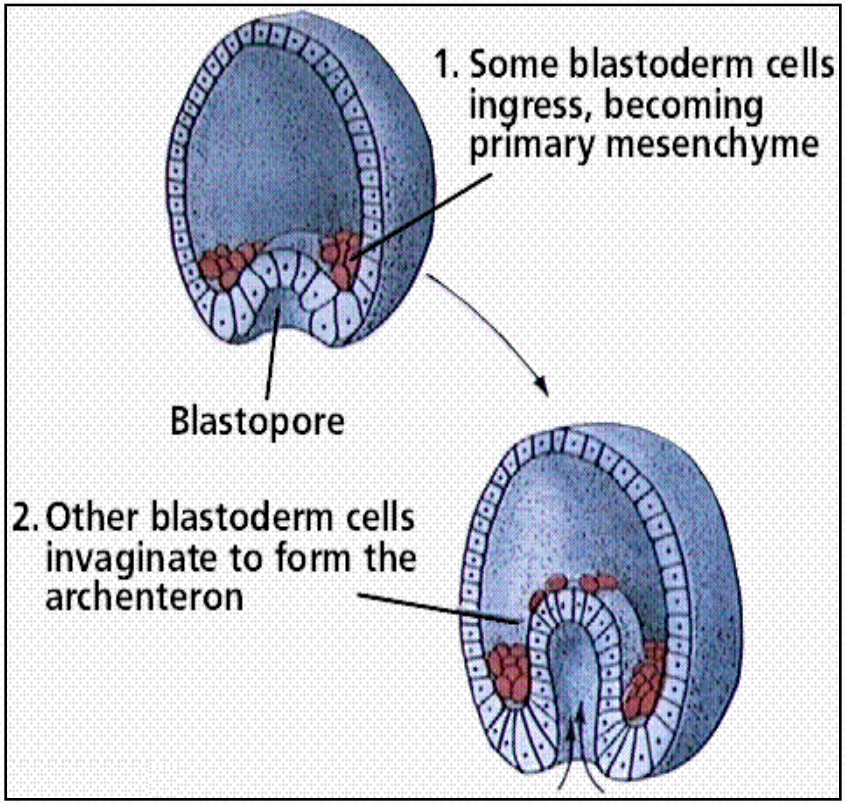
A stem cell Story (15 min)

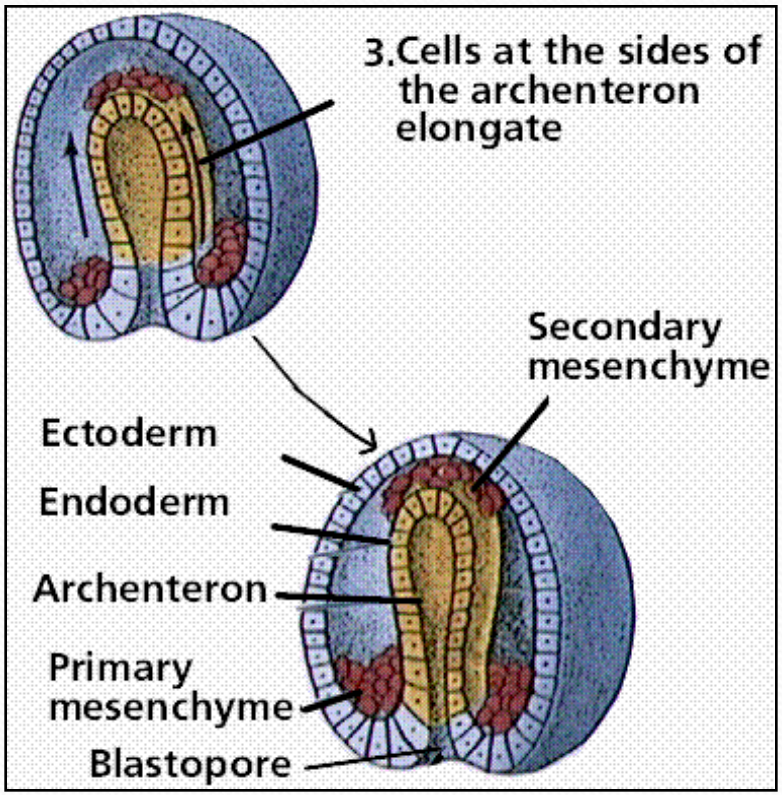
REVIEW THE STEPS:



Gastrulation (~Day 7)

- **Gastrulation** is the process in which the **inner cell mass of blastula** turns into **3 germ layers** (embryonic tissues) – the (**ectoderm, mesoderm, endoderm)**
- embryo now called **gastrula**

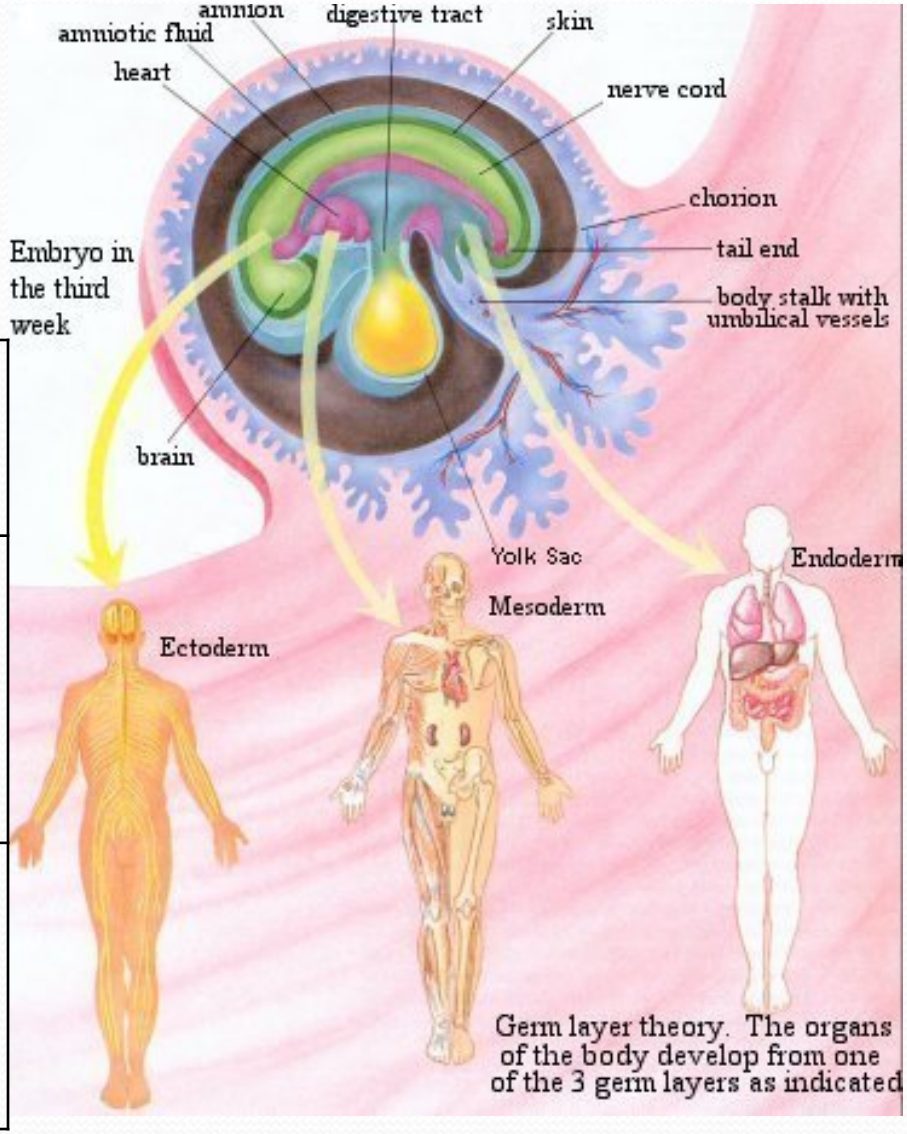




Gastrulation (~Day 7)

Cells begin to differentiate (change) to form specific organ systems!

Ectoderm	-nervous system -epidermis (skin)
Mesoderm	-**S**keleton -**M**uscles -**G**onads (reproductive structures) **S**o **M**any **G**onads
Endoderm	-Respiratory system -Digestive a -**E**ndocrine glands **R.E.D.**

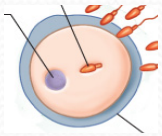


Bozeman 6:50- 8:59

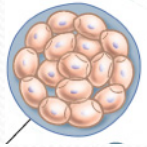
How to remember the stages?

Zebras Make Better Guacamole Every Friday

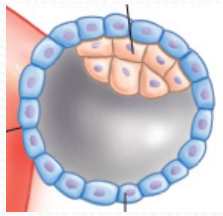
Zygote – Day 0 (Sperm + egg)



Morula – Day 4 (16 – 32 cells)



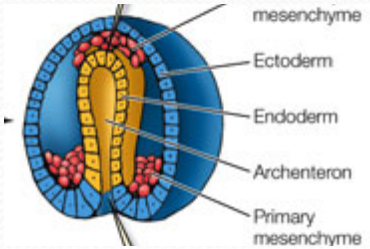
Blastocyst – Day 6 **Implantation Outer layer (chorion) helps the implantation process, secretes hCG and forms placenta

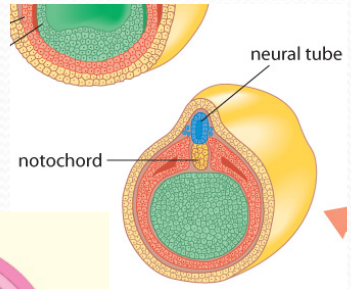


How to remember the stages con't…

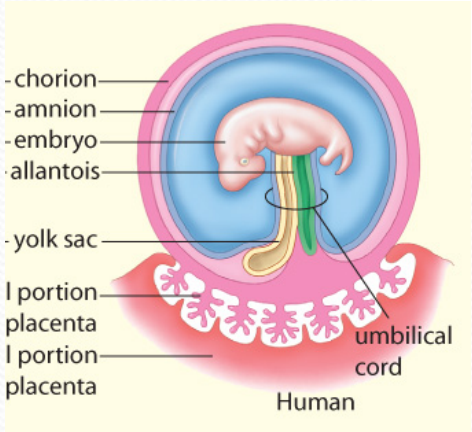
Zebras Make Better Guacamole Every Friday

Gastrula – Day 7 - 3 germ layers – ectoderm, mesoderm, endoderm.
Neurulation – formation of neural tube which will form CNS.





Embryo – Day 10 - chorion starts to form the **placenta**

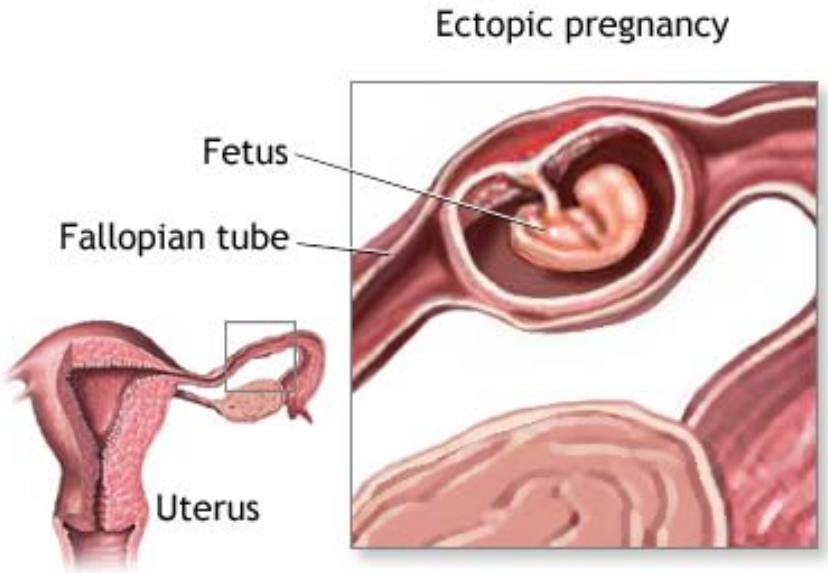


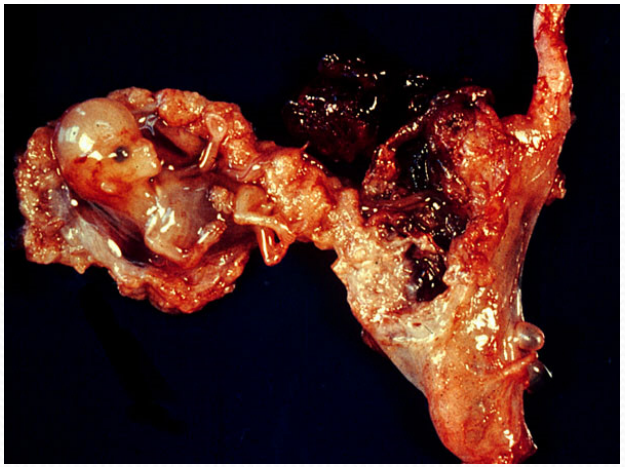
Fetus – week 8 – called fetus because all major organ systems have started to develop

Ectopic Pregnancy: Faulty Implantation

- In an ectopic pregnancy, a fertilized egg has implanted **outside the uterus**, usually in the **fallopian tube.**

- **Severe bleeding** and possible death of the mother can result from this type of pregnancy





A.D.A.M.

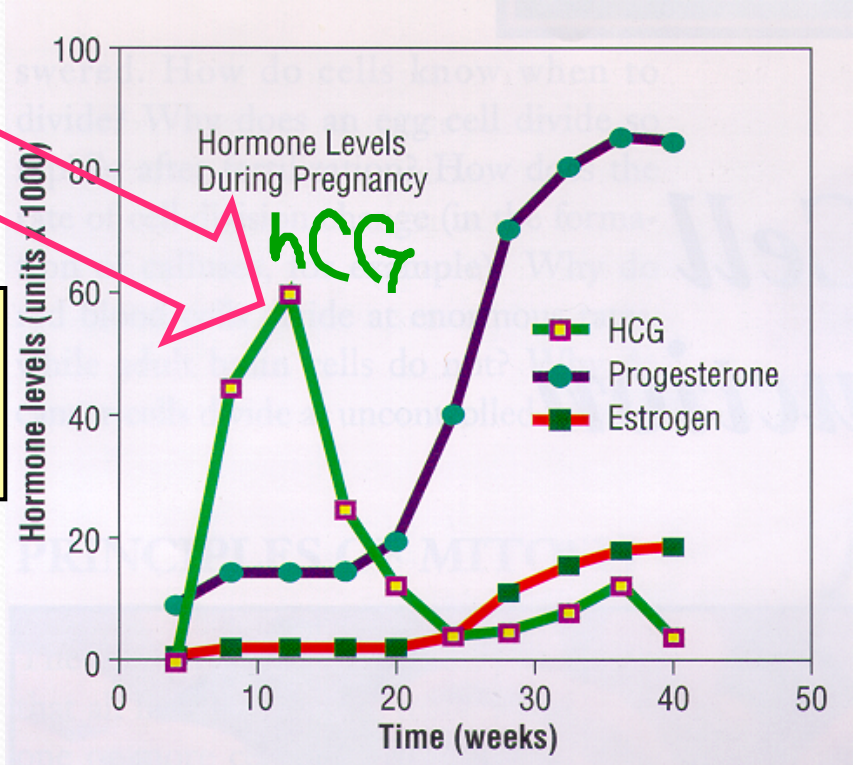
Pregnancy Tests

Outer layer of the blastocyst (the **chorion**) starts to secrete **hCG** when it implants in the endometrium on ~day 7. This causes morning sickness & is the hormone measured in a pregnancy test!

Pregnancy test: tests for the presence of hCG in the urine (sometimes the blood).

Remember hCG: similar to LH – keeps corpus luteum secreting **progesterone & estrogen for 3 months!!**

Later on, the placenta secretes sufficient estrogen and progesterone

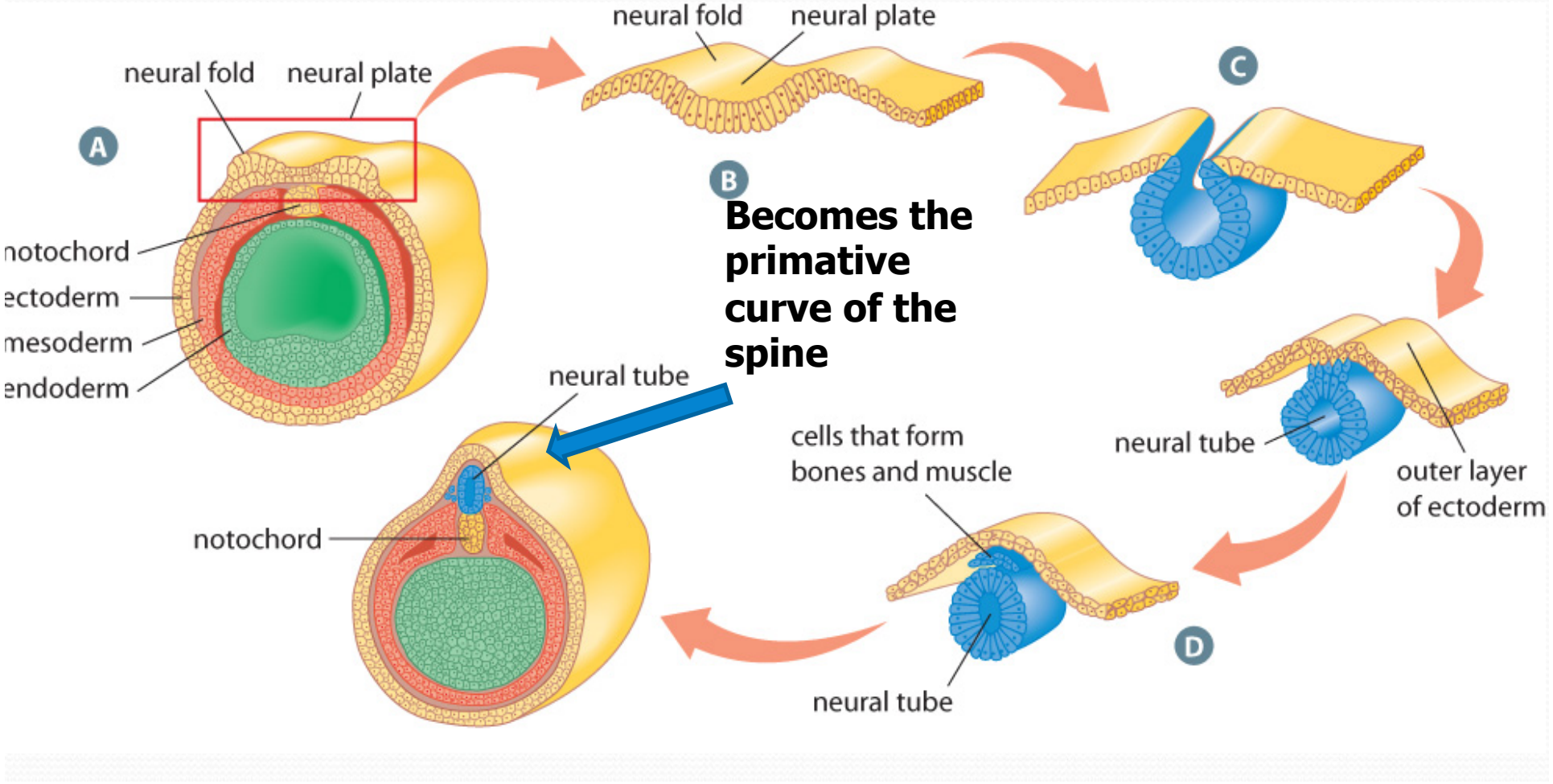


How can a miscarriage occur?

- For first 3 months **progesterone** comes from mother
- Fetus starts making it's own after **3 months**
- If mom stops progesterone and fetus does not start…
  - **Miscarriage** occurs

Neurulation: formation of neural tube → develops into **brain and spinal cord.**

Happens during the **gastrula** stage



Practice: State the layer (ecto, meso, endo) that the part originates from

1. **Lungs _____Endo_____**
2. **Eye _____Ecto_____**
3. **Skin _____Ecto_____**
4. **Heart _____Mes_____**
5. **Stomach _____Endo_____**
6. **Brain _____Ecto_____**
7. **Testes _____Meso_____**
8. **Small Intestine ___Endo_____**
9. **Teeth _____Ecto_____**
10. **Spinal cord _____Ecto_____**
11. **Hair _____Ecto_____**
12. **Muscles _____Meso_____**
13. **Pancreas ___Endo_____**
14. **Hypothalamus ___Ecto_____**
15. **Thyroid gland _____Endo___**
16. **Large intestine _____Endo__**
17. **Bones _____Meso_____**
18. **Finger nails ___Ecto_____**
19. **Ovaries _____Meso_____**

Summary of Events After Implantation

Days 7-10	Gastrulation begins – major cellular reorganization into the three germ layers "Gastrula" stage is when different genes will be turned on to express different organs in the later stages of the pregnancy
Days 10-14	Pregnancy fully established Amniotic cavity forms Yolk sac forms Embryo forms **Chorion starts to form the placenta**
Days 15-21	Emergence of the body plan "Primitive streak" starts to form (at site of Gastrulation) becomes mesoderm Neural Groove forms (future brain and spinal cord)
Day 21	**Heart begins to beat**
Week 4	Eyes, ears and lower limbs begin to develop
Weeks 5 – 8	**Teeth, palate, external genitalia begin to develop**

Extra-Embryonic Membranes

formed after implantation

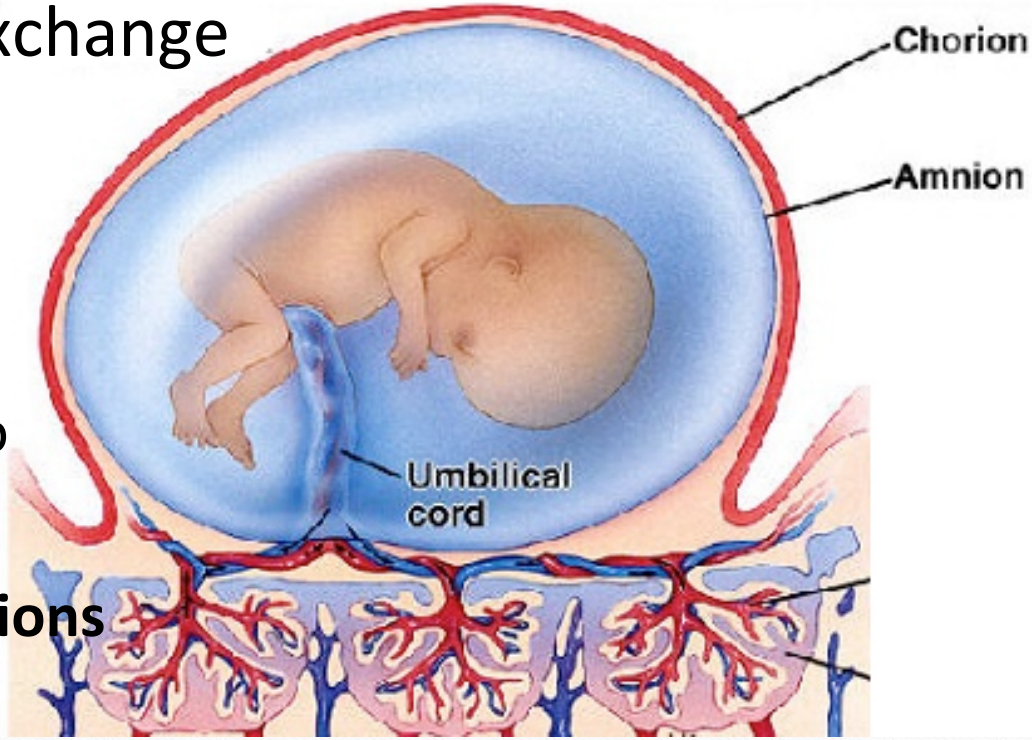
1. Chorion: outer membrane of **blastocyst**

- secretes **hCG** until 2nd trimester (first 3 months)
- **fetal** contribution to the **placenta**
- gas/nutrient/waste exchange

2. Amnion: inner membrane

of outer layer of blastula

- becomes **fluid-filled**
- sac that **protects** embryo
- from infection, impact and **temperature fluctuations**



Extra-Embryonic Membranes..CON'T

formed after implantation

3. Allantois: forms the foundation of the **umbilical cord**

- Becomes part of the **bladder**

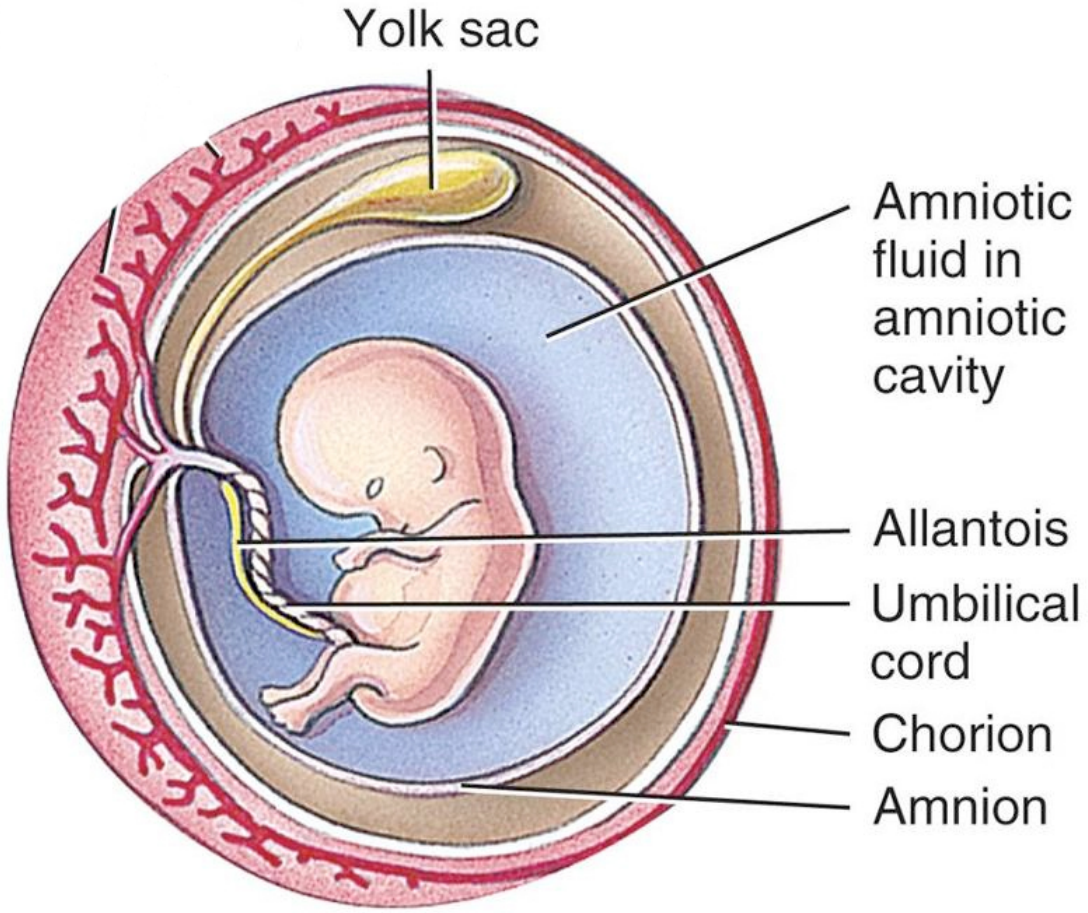
4. Yolk sack:

Small in humans

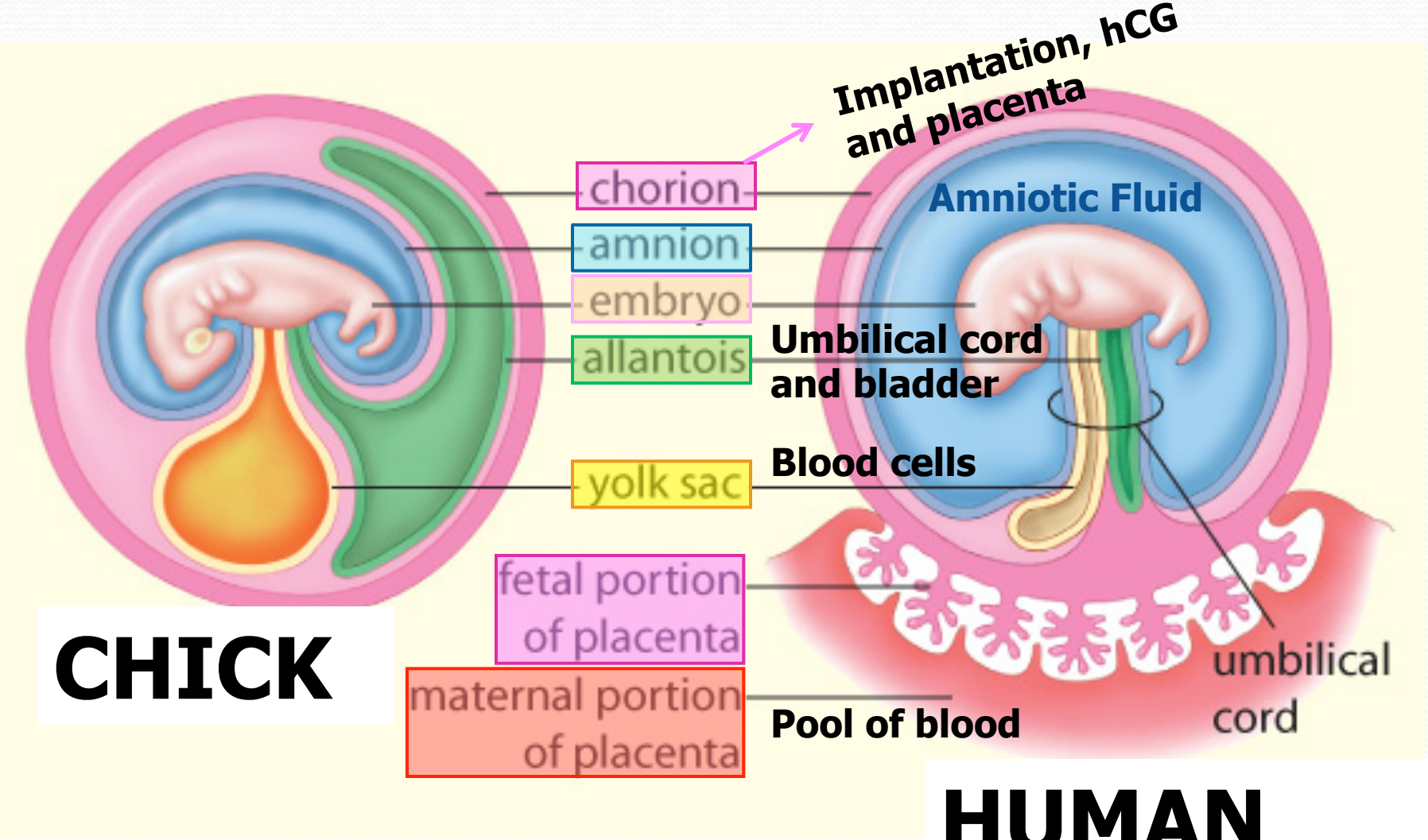
- (forms **blood cells**)

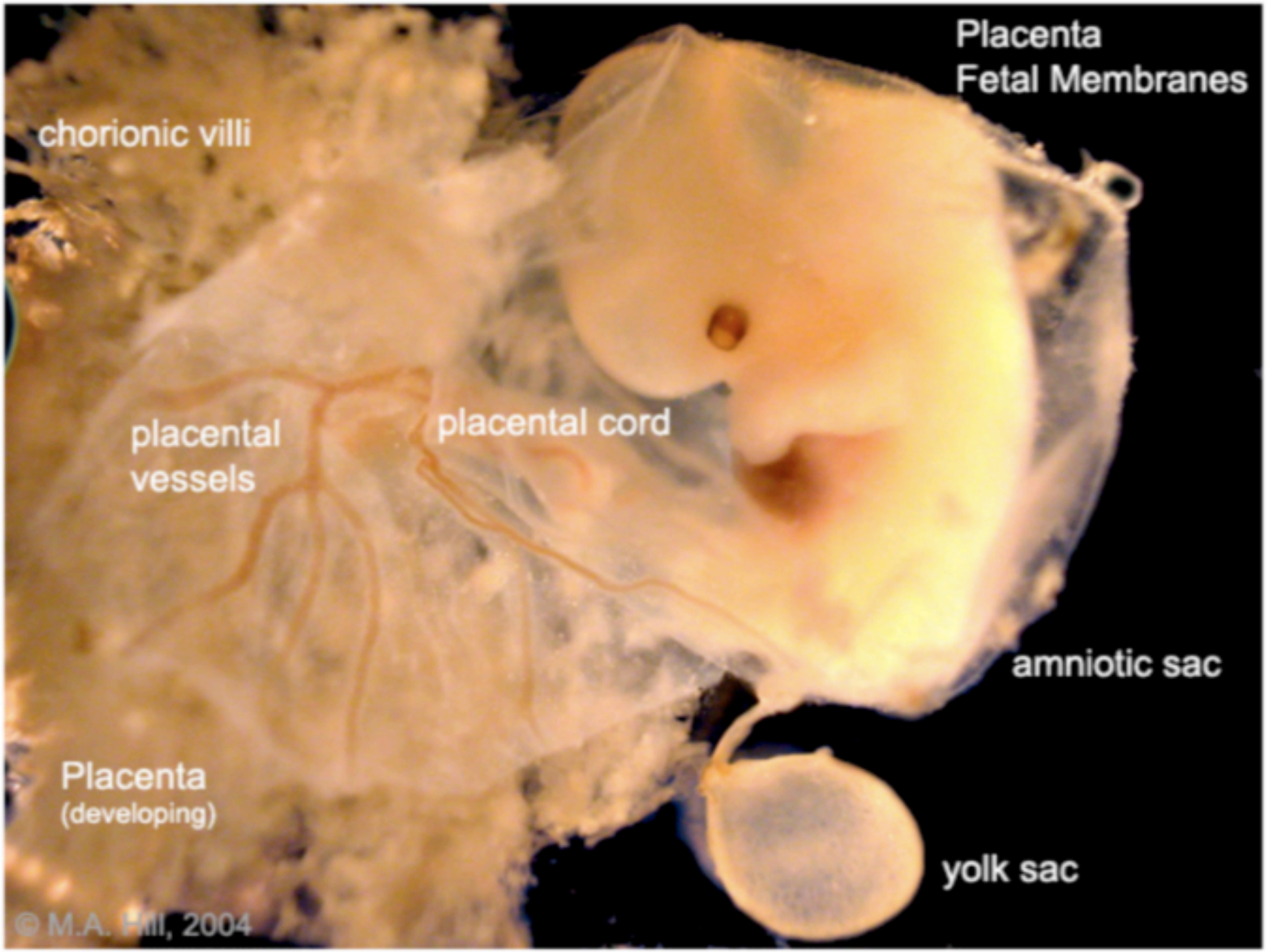
In other animals

-provides nutrients



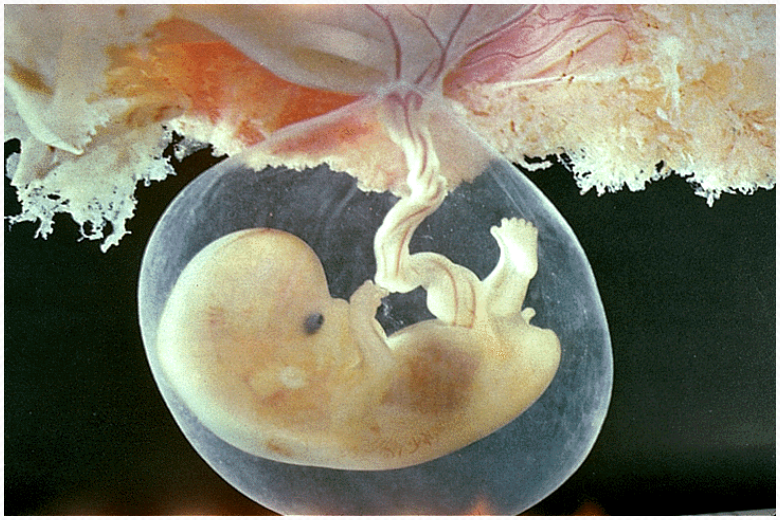
Extra-Embryonic Membranes




Placenta
Fetal Membranes
chorionic villi
placental
vessels
placental cord
amniotic sac
Placenta
(developing)
yolk sac
© M.A. Hill, 2004

Placenta

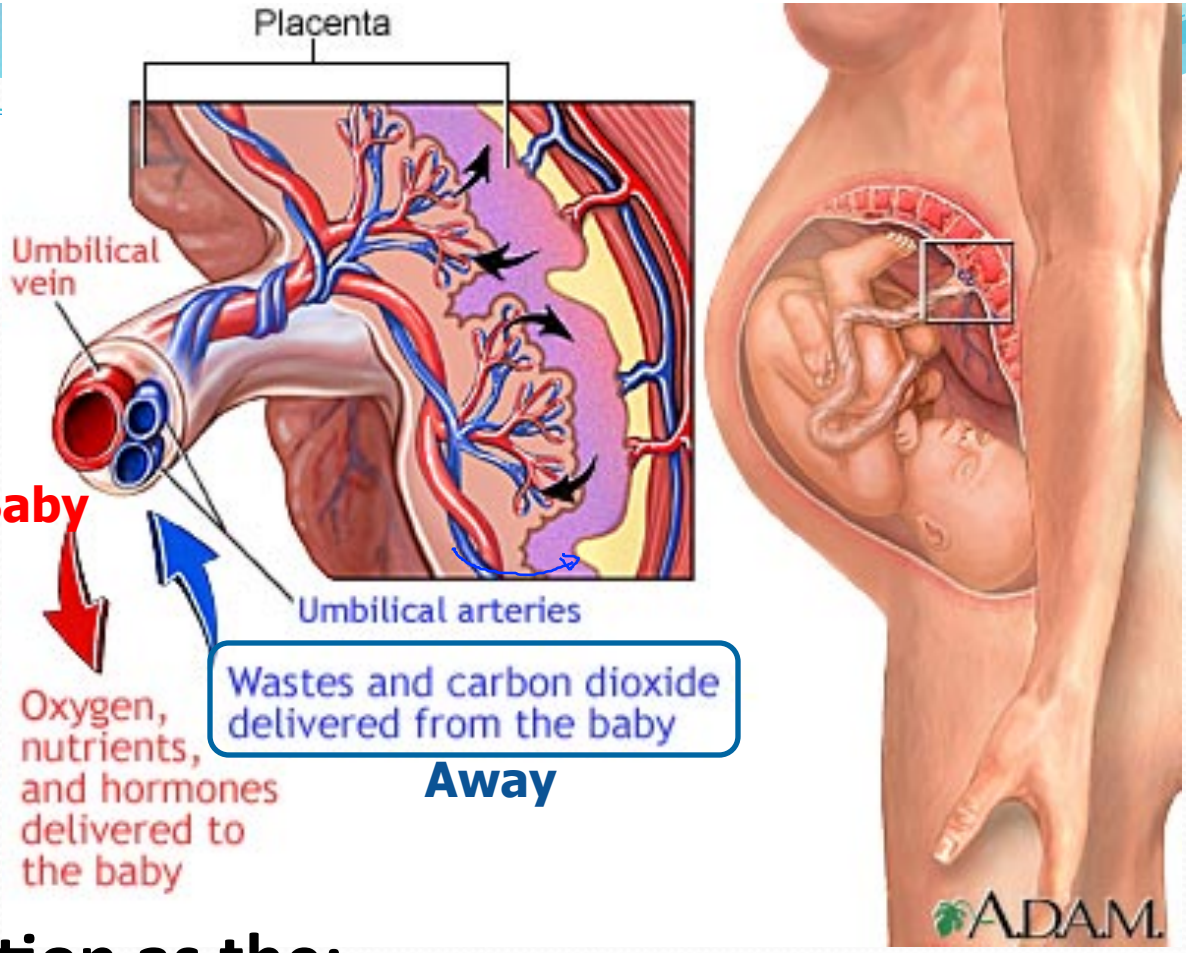
- **Placenta**: allows **exchange** of <u>some</u> substances between mother and fetus
  - from mother: **nutrients, oxygen, antibodies, viruses, drugs, alcohol**
  - from fetus: **metabolic wastes (CO_2, urea)**
  - **NO exchange of blood cells**



Placenta

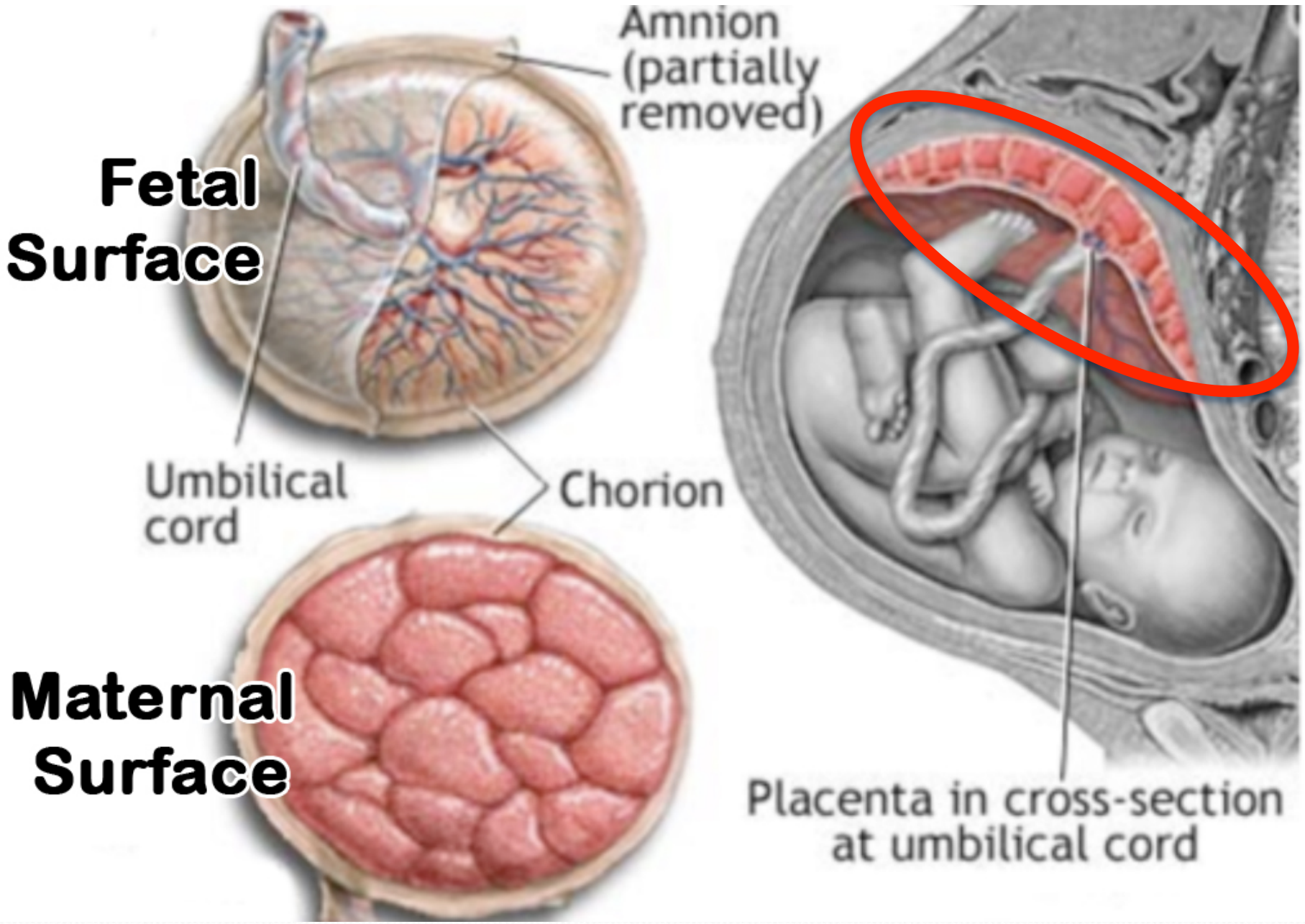
- formed when **chorion** extends into endometrium
  - not fully developed until the 2nd trimester
- secretes **estrogen & progesterone** during the 2nd & 3rd trimesters
- **Progesterone** prevents contractions
- **Progesterone and estrogen** cause growth of the endometrium

The Placenta



<u>The placenta will function as the</u>:

- **Lungs:** exchange O_2 and CO_2
- **Small Intestine:** provide nutrients
- **Kidneys:** remove nitrogenous wastes (urine)


Amnion
(partially
removed)
Fetal
Surface
Umbilical
cord
Chorion
Maternal
Surface
Placenta in cross-section
at umbilical cord

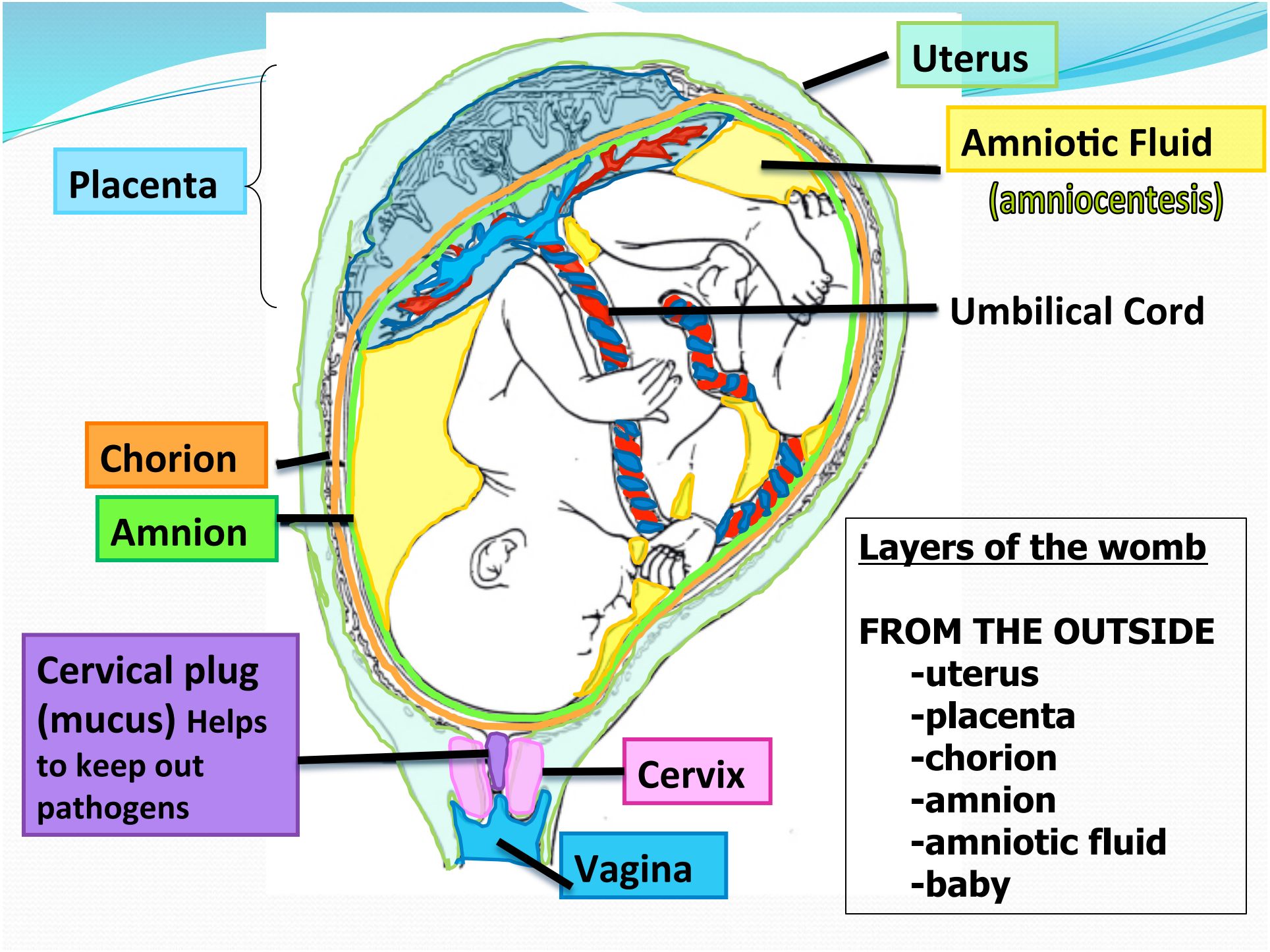
Umbilical Cord

- Rope-like structure that forms after 8 weeks
- Runs from the **belly button** of the fetus to the **placenta**

FYI

- Contains 2 **arteries** and 1 **vein**
  - 2 arteries carry **deoxygenated** blood… from fetus to mother
  - Vein carries **oxygenated** blood… from mother to fetus
- Normally arteries carry oxygenated blood

- Only 2 exceptions exist…pulmonary(heart) artery & umbilical artery!!!
- b/c an artery is defined as tubes that carry blood from the heart and not necessarily oxygenated blood


Uterus
Amniotic Fluid
(amniocentesis)
Placenta
Umbilical Cord
Chorion
Amnion
Cervical plug (mucus) Helps to keep out pathogens
Cervix
Vagina
Layers of the womb
FROM THE OUTSIDE
-uterus
-placenta
-chorion
-amnion
-amniotic fluid
-baby