
REPRODUCTIVE PHYSIOLOGY LECTURE 4

PHYSIOLOGY OF PREGNANCY

GUYTON & HALL, Chapter 83

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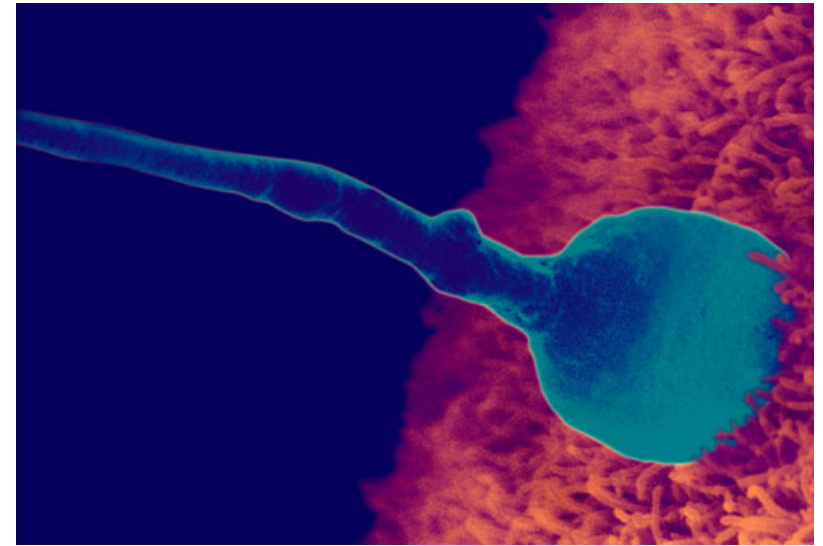
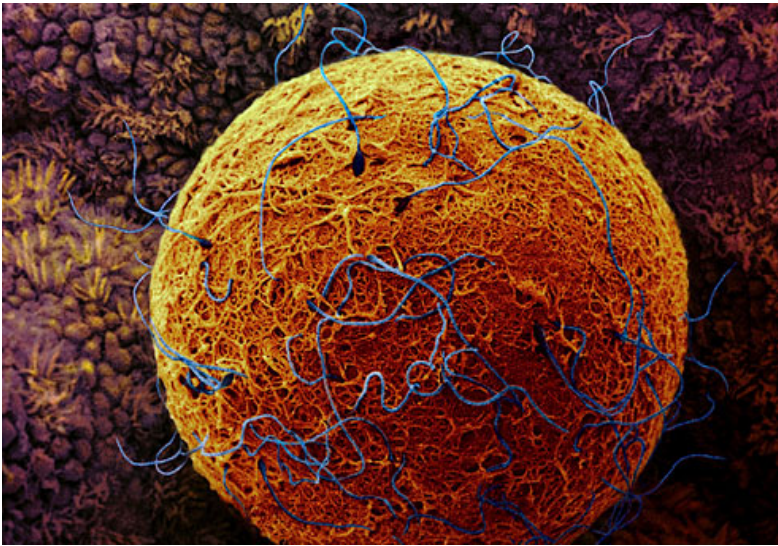
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OBJECTIVES

By the end of this lecture, you should be able to:

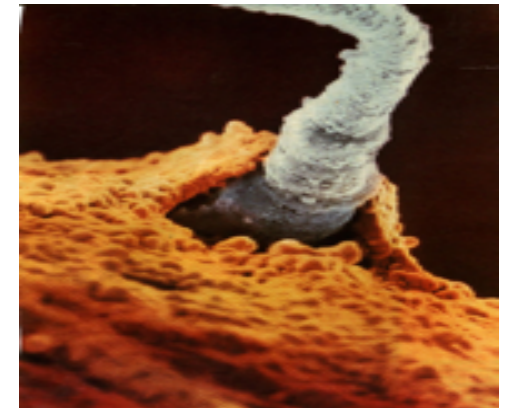
- Describe fertilization
- Recognize the development and the function of the placenta
- Recognize the placenta as an endocrine organ
- Describe the physiological functions of placental hormones
- Explain the mother's physiological response to pregnancy

FERTILIZATION



https://www.youtube.com/watch?v=_5OvgQW6FG4

Follow link to watch this video plz



FERTILIZATION

After ejaculation, sperms reach **ampulla** of fallopian tube within 30-60 min (PG and OT actions)

Ampulla of oviduct-opt. site of fert.

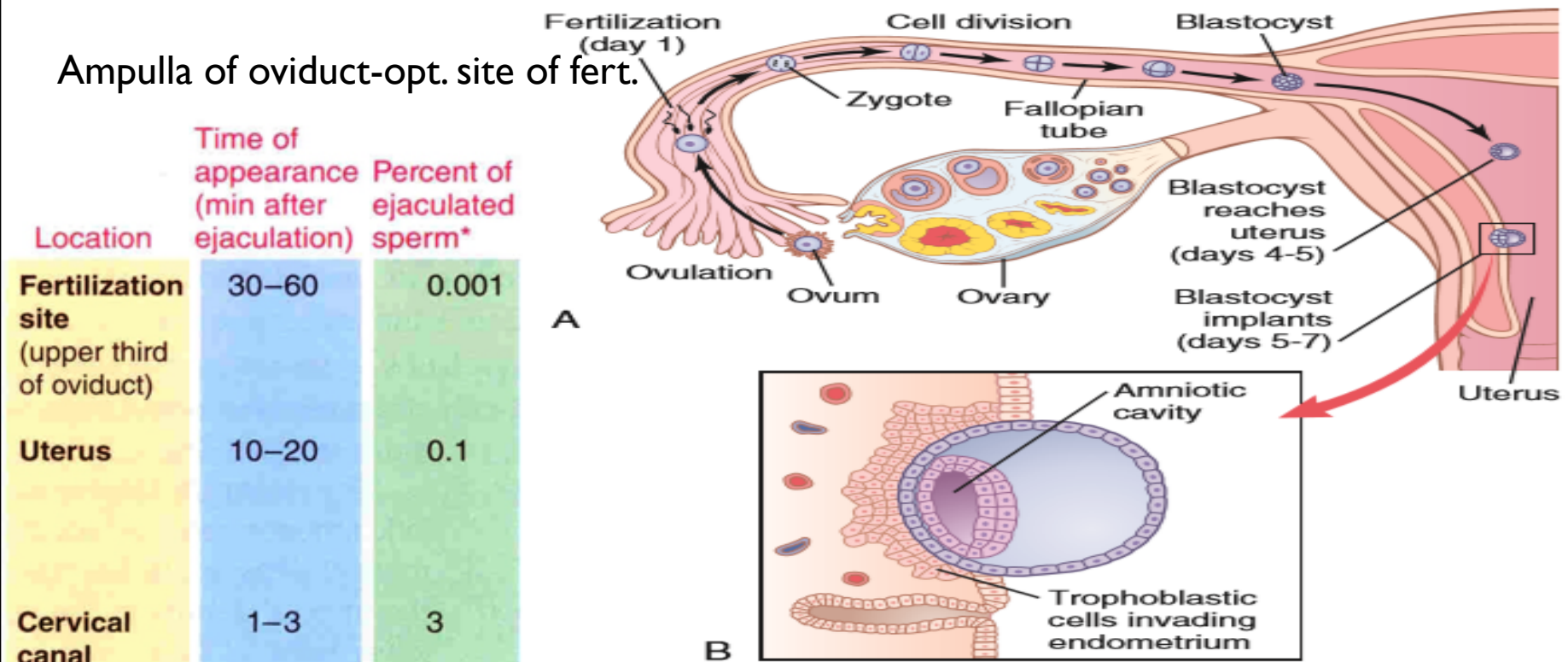


Figure 83-2. A, Ovulation, fertilization of the ovum in the fallopian

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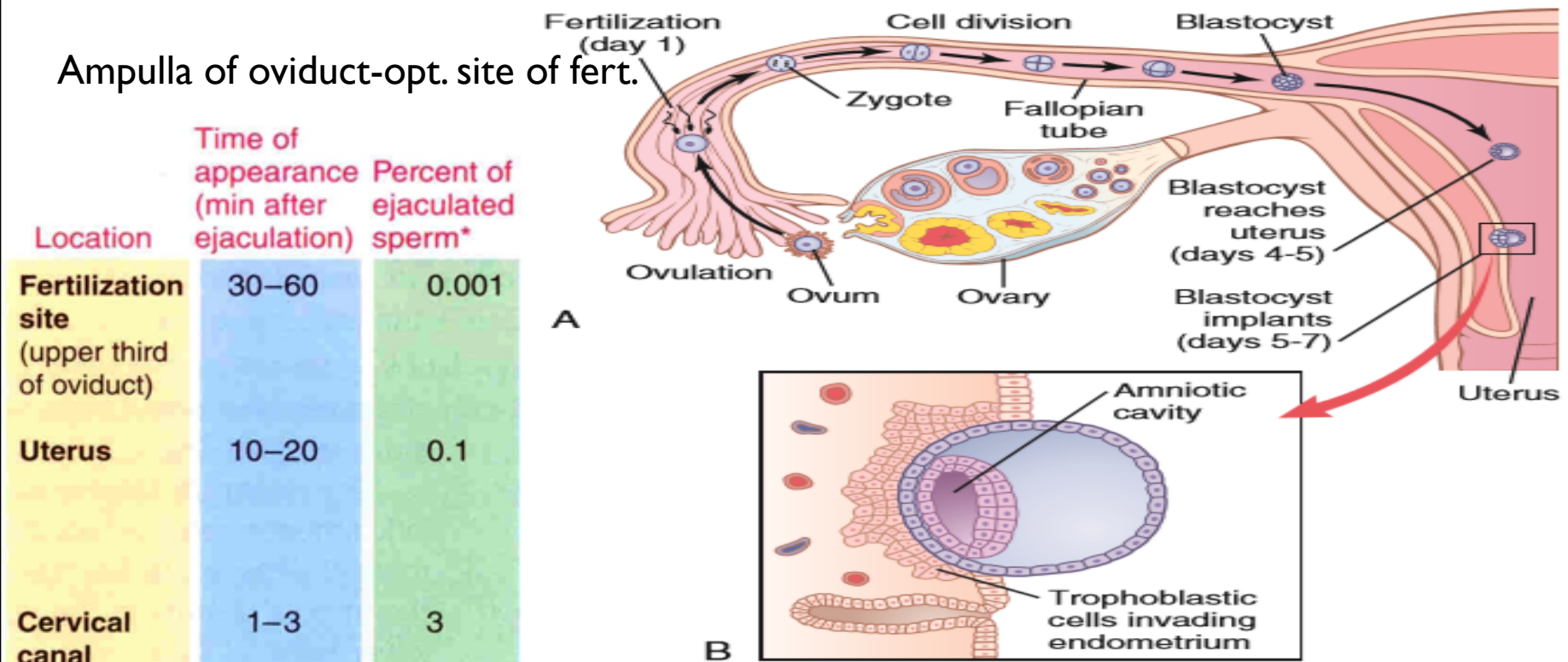


Figure 83-2. A, Ovulation, fertilization of the ovum in the fallopian

FERTILIZATION

1 The fertilizing sperm penetrates the corona radiata via membrane-bound enzymes in the plasma membrane of its head and binds to ZP3 receptors on the zona pellucida.

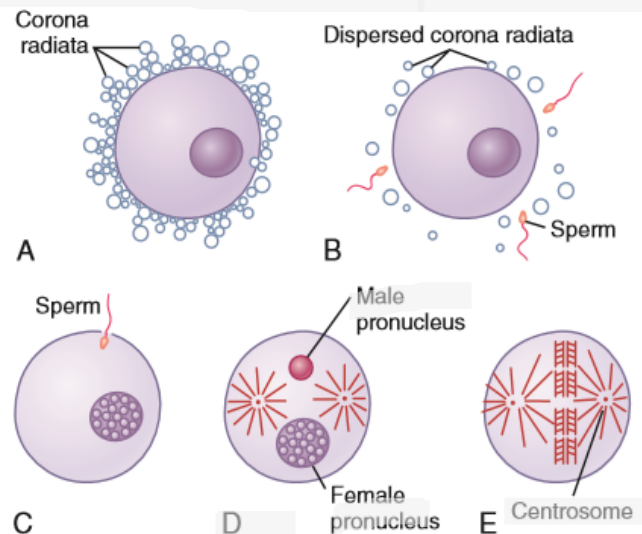
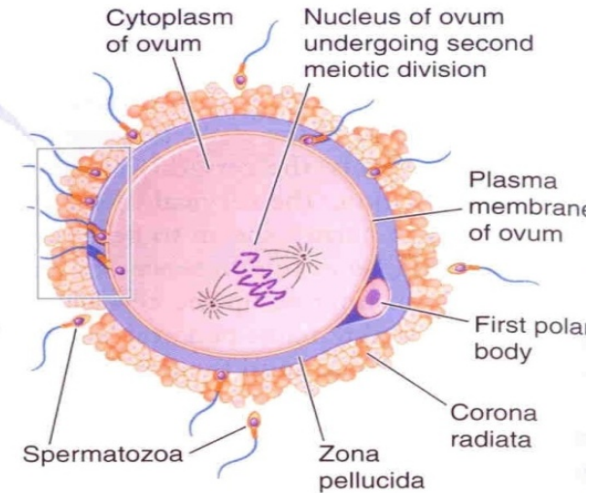
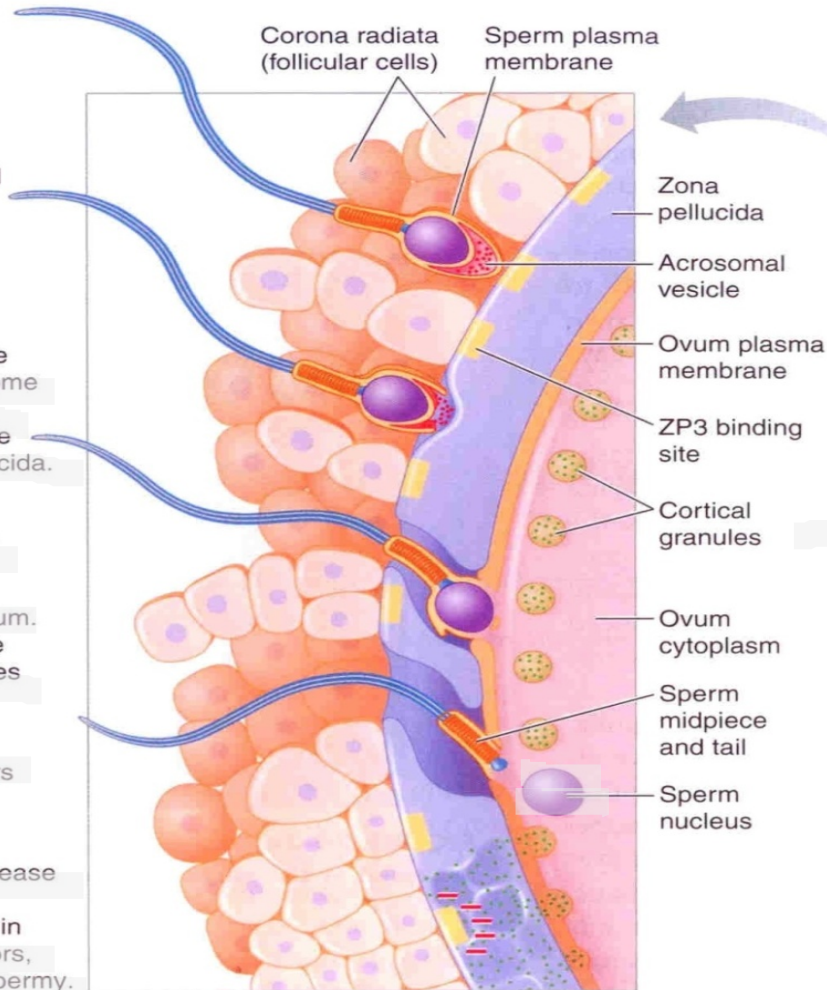
2 Binding of sperm to these receptors triggers the acrosome reaction, in which hydrolytic enzymes in the acrosome are released onto the zona pellucida.

3 The acrosomal enzymes digest the zona pellucida, creating a pathway to the plasma membrane of the ovum. When the sperm reaches the ovum, the plasma membranes of the two cells fuse.

4 The sperm nucleus enters the ovum cytoplasm.

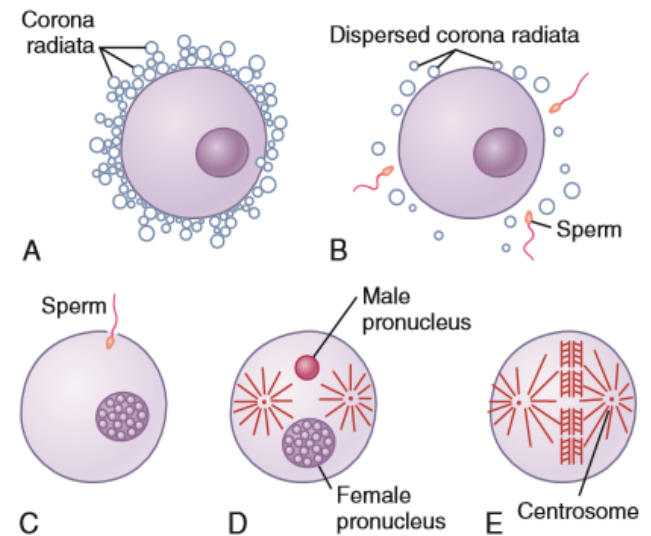
5 The sperm stimulates release of Ca^{2+} stored in cortical granules in the ovum, which in turn, inactivates ZP3 receptors, leading to the block to polyspermy.

(a) Sperm tunneling through the barriers surrounding an ovum



FERTILIZATION

- Sperm penetrates *corona radiata* and *zona pellucida* (hyaluronidase)
- Oocyte divides to form **mature ovum**
(female pronucleus 23 unpaired chr)
- Head of sperm swells
(male pronucleus 23 unpaired chr)
- release of cortical granules preventing further sperm penetration
- Fertilized ovum (zygote) contains 23 paired chr



ZYGOTE



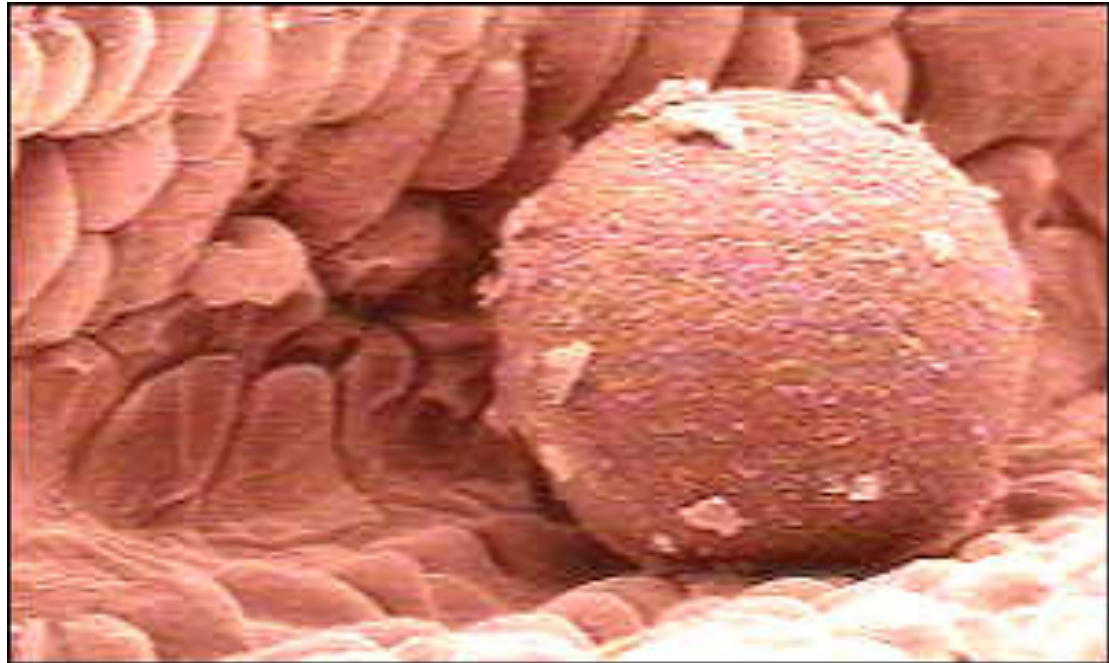
CLEAVAGE



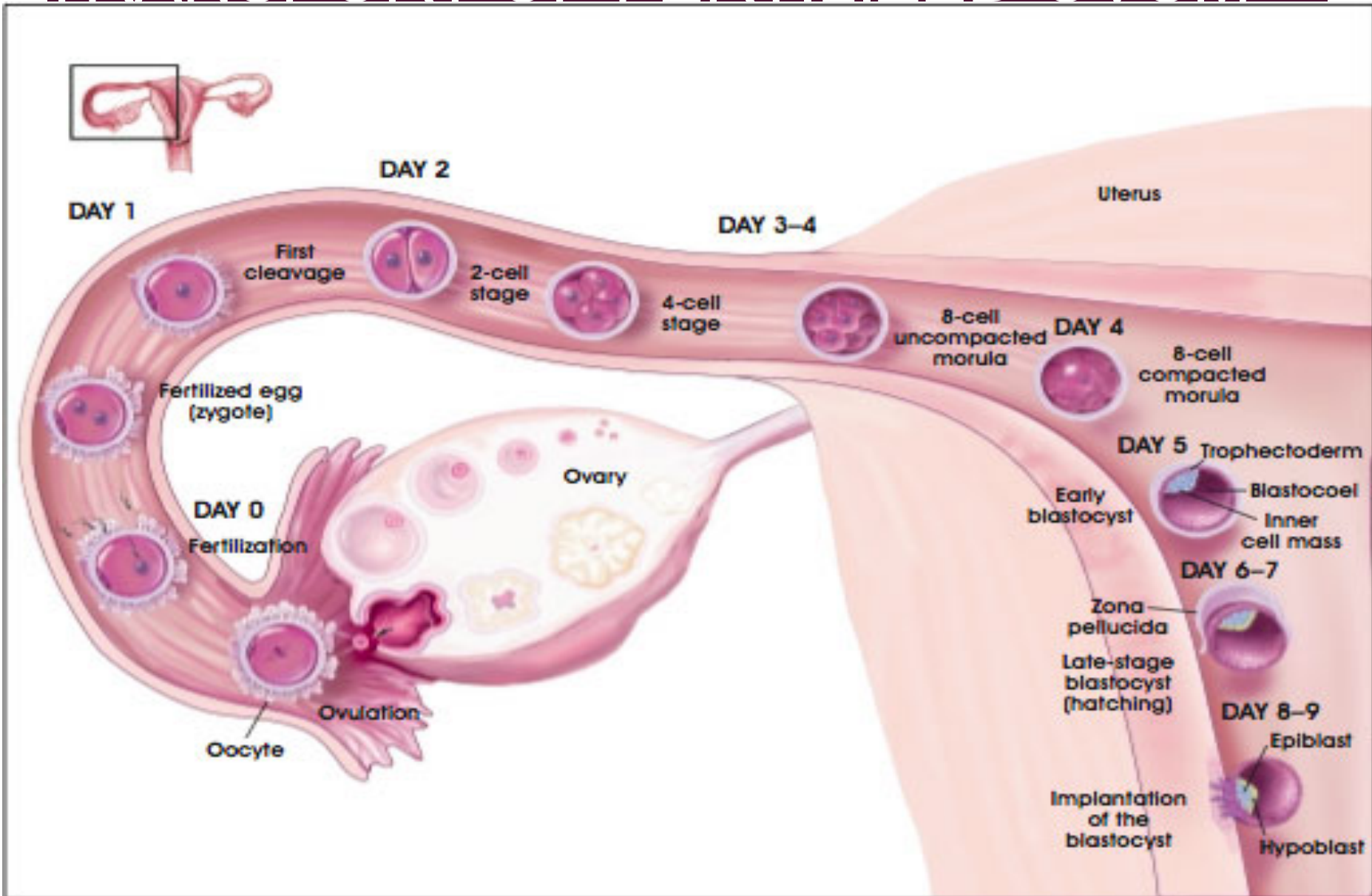
- Following fertilization, the zygote undergoes several mitotic divisions inside the zona pellucida (overall size does not change).
- 1st cleavage yields a 2 celled embryo,
 - each cell is called a **blastomere** and is *totipotent*
- Divisions continue rapidly until the 32 cell stage

TRAVELING

- Zygote begins to divide as it travels through oviduct
- Implants into lining of uterus



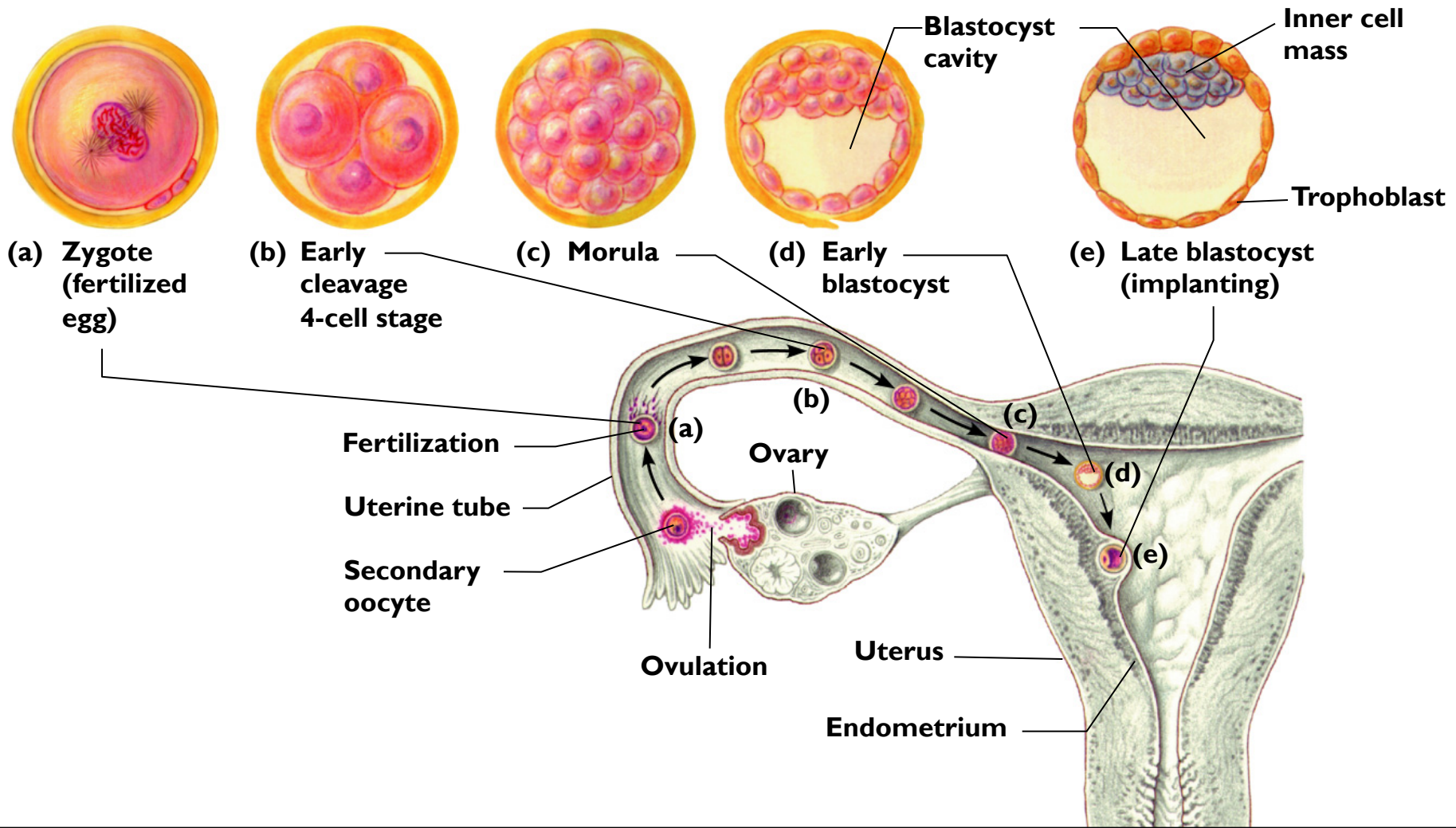
TRANSPORT OF FERTILIZED OVUM



TRANSPORT OF FERTILIZED OVUM

- 3-5 days after fertilization, the zygote reaches uterine cavity
- **Transport:** fluid current + action of cilia + weak contractions of the fallopian tube
- Isthmus (last 2cm) relaxes under effect of progesterone
- Delayed transport allows cell division
- Blastocyst (100 cells) enters the uterus

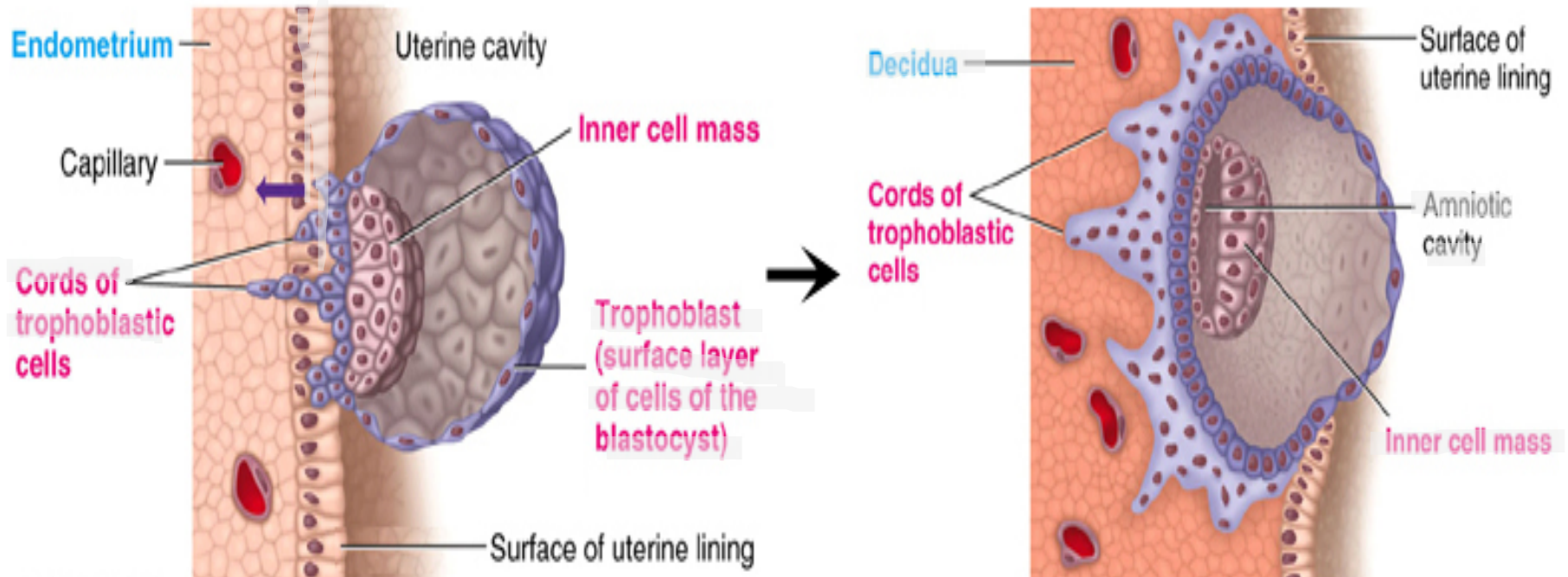
CLEAVAGE



IMPLANTATION

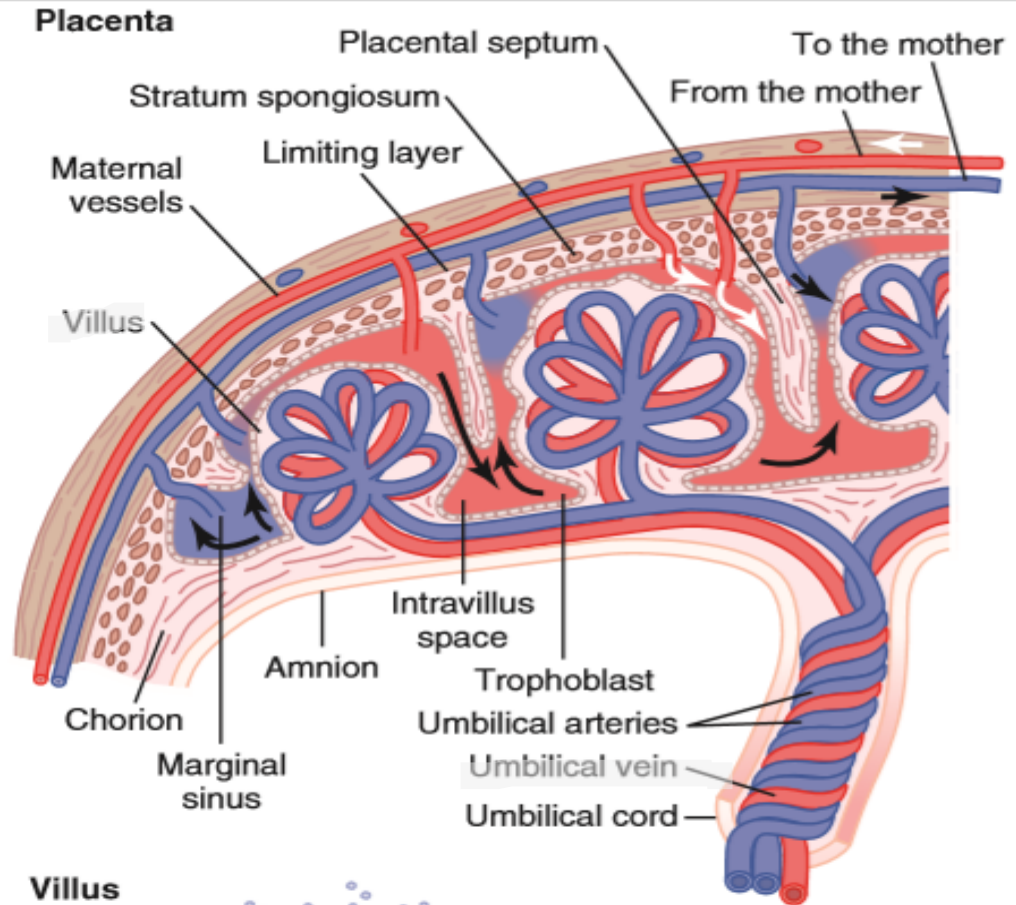
- Trophoblastic cords from **blastocyst**
- Blood capillaries grow in the cords
- 21 days after fertilization, blood starts to be pumped by fetal heart into the capillaries
- Maternal blood sinuses develop around the trophoblastic cords
- More and more trophoblast projections develop (placental villi)

IMPLANTATION

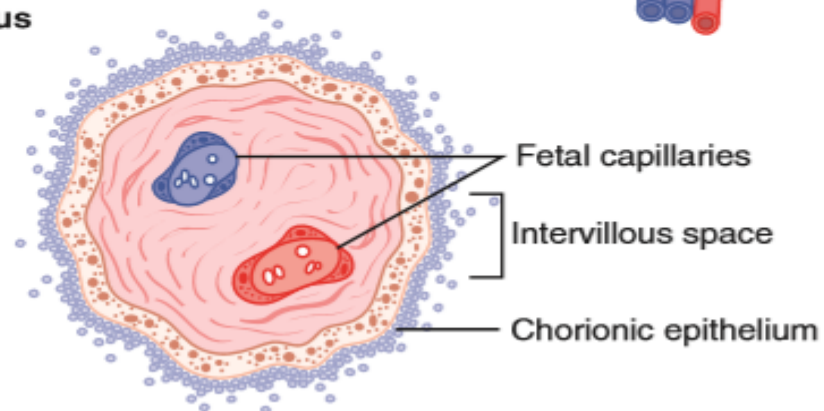


PLACENTA

Fetus's blood flows through two umbilical arteries, then into the capillaries of the villi, and finally back through a single umbilical vein into the fetus. At the same time, the mother's blood flows from her uterine arteries into large maternal sinuses that surround the villi and then back into the uterine veins of the mother.



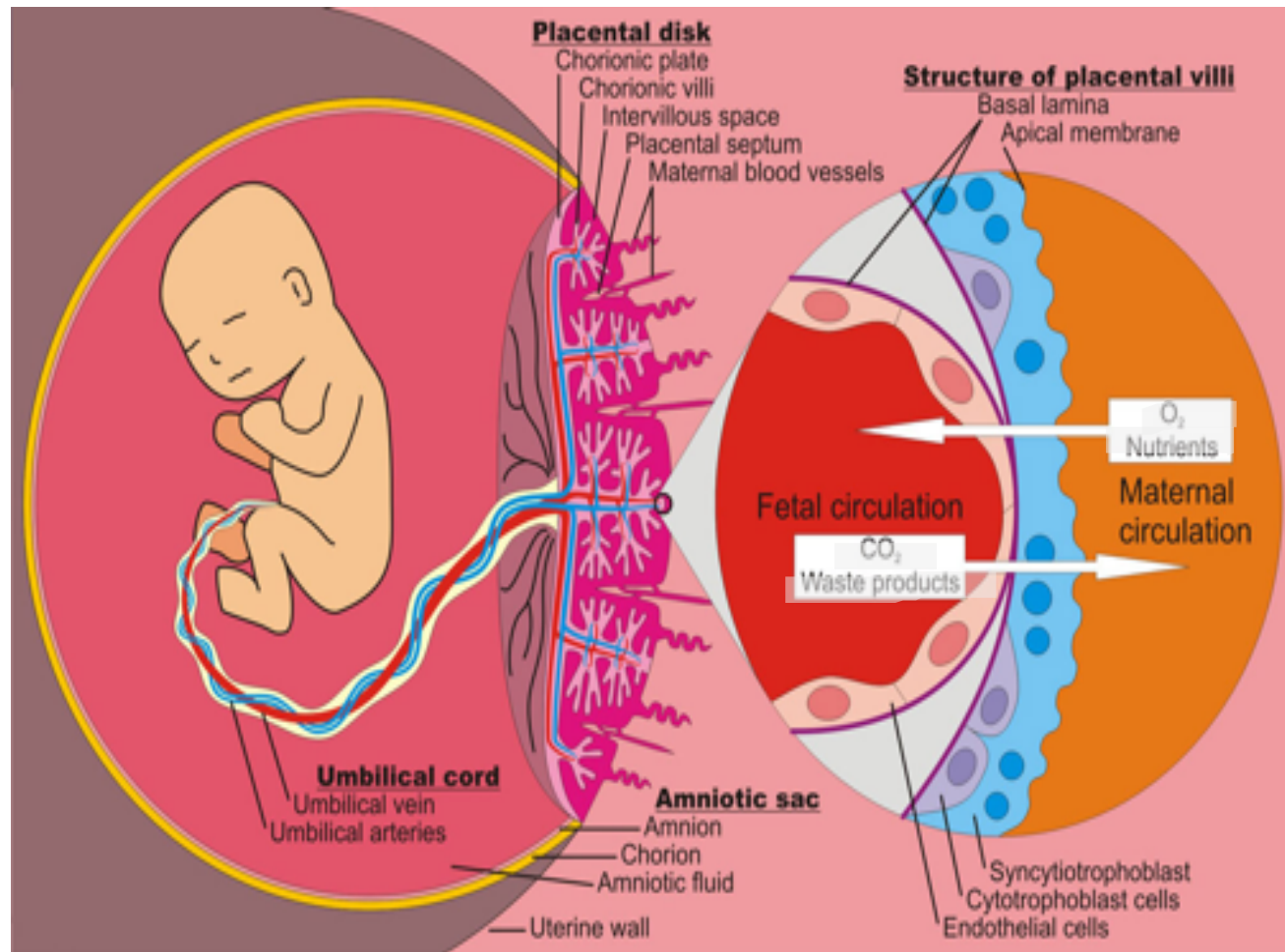
Villus



FUNCTION OF THE PLACENTA

Major function:

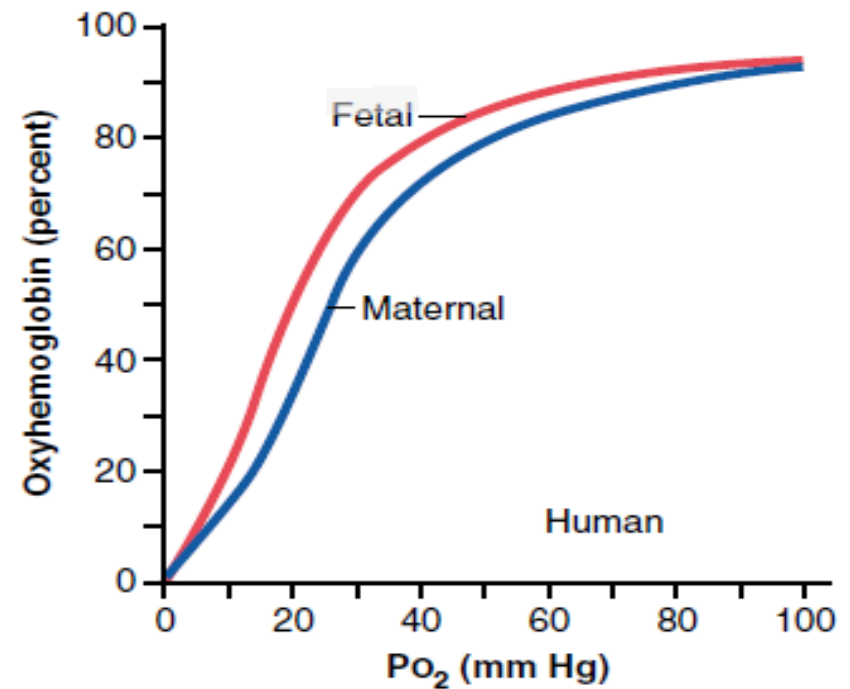
- Respiration
- Nutrition
- Excretion
- Endocrine
- Protection



IMPORTANT FACTORS FACILITATING DELIVERY OF OXYGEN TO THE FETAL TISSUES

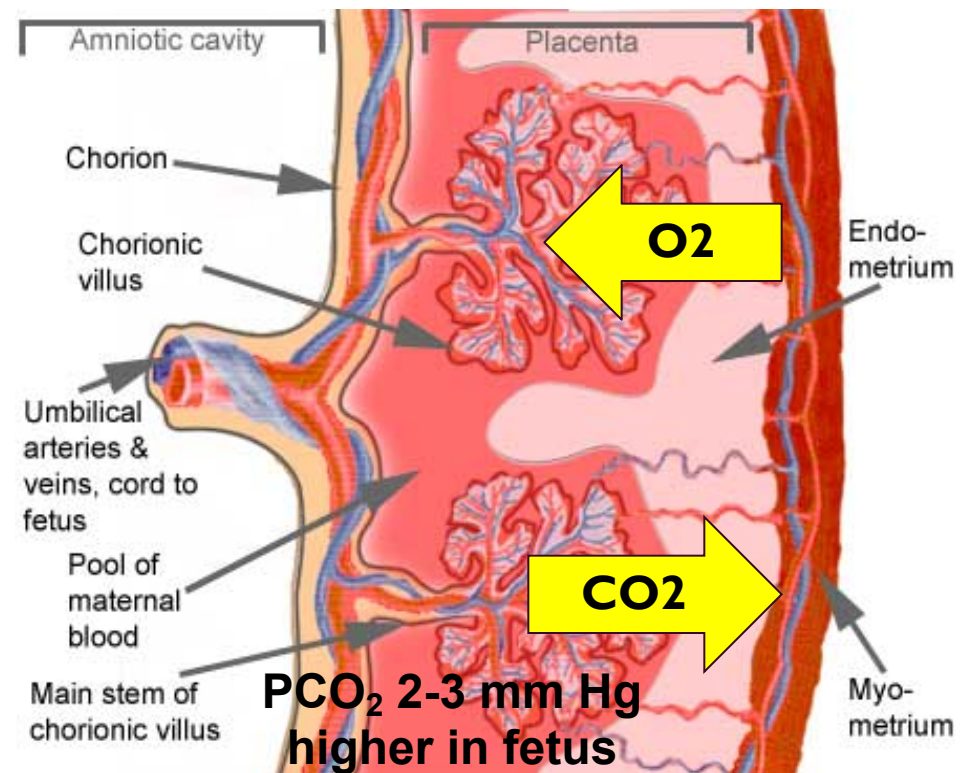
- Difference in pO_2 (concentration) between maternal and fetal blood (mother $pO_2 >$ fetus pO_2)
- High fetus haemoglobin (HbF)(16 - 17 g/dl) which has high affinity for O_2 than mother's haemoglobin (HbA)

At the low Po_2 levels in fetal blood, the fetal hemoglobin can carry 20 to 50% more oxygen than maternal hemoglobin can



IMPORTANT FACTORS FACILITATING DELIVERY OF OXYGEN TO THE FETAL TISSUES

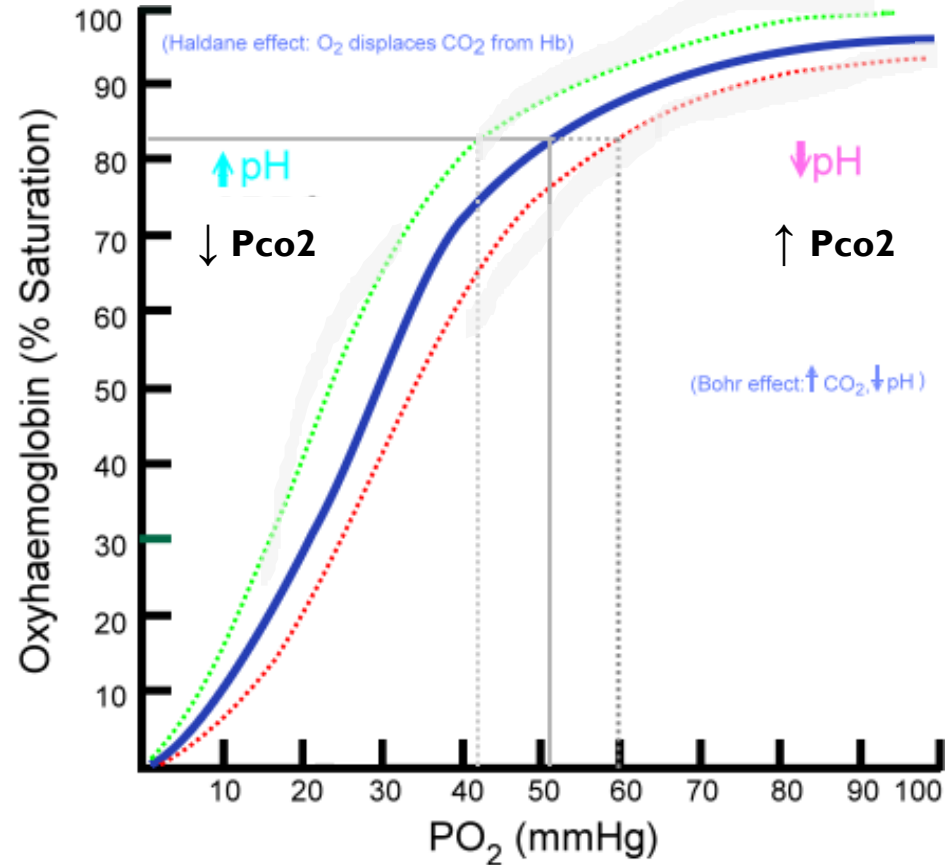
- High fetal cardiac output
- **Double Bohr Effect**
- High pH in fetal blood (alkaline)
- Low pH in mother's blood (acidic)



RESPIRATION

- Important shifts of the dissociation curves take place in the placenta:
- The maternal blood gains CO_2 , the pH falls and the curve shifts to the right releasing additional oxygen.
- On the fetal side of the placenta CO_2 is lost, the pH rises and the curve shifts to the left allowing additional oxygen uptake.

Hemoglobin can carry more oxygen at a low Pco_2 than it can at a high Pco_2



NUTRITION

- Fetus uses mainly glucose for nutrition so the trophoblast cells in placental villi transport glucose by carrier molecules; GLUT (facilitated diffusion)
- Fatty acids diffuse due to high solubility in cell membrane (more slowly than glucose)
- The placenta actively transports all amino acids, with fetal concentrations exceeding maternal levels.
- K^+ , Na^+ and Cl^- diffuse from maternal to fetal blood

EXCRETION

- Excretory products of the fetus *diffuse* through the placental membrane to maternal blood to be excreted with the waste products of the mother
 - Urea, uric acid and creatinine
- Higher conc. of excretory products in fetal blood ensures continuous diffusion of these substances to the maternal blood

