

Placental formation, Growth and functions in domestic animals

- **Prof Govind Narayan Purohit**

Head, Department of Veterinary Gynecology and Obstetrics,
College of Veterinary and Animal Sciences, RAJUVAS, Bikaner,
Rajasthan, India

Placenta (Flat Cake)

Placenta is a flattened circular organ in the uterus of pregnant eutherian mammals, nourishing and maintaining the fetus through the umbilical cord.

Umbilical cord (Navel, omphalos) A flexible cordlike structure containing blood vessels and attaching a human or other mammalian fetus to the placenta during gestation.

Classification of Placenta

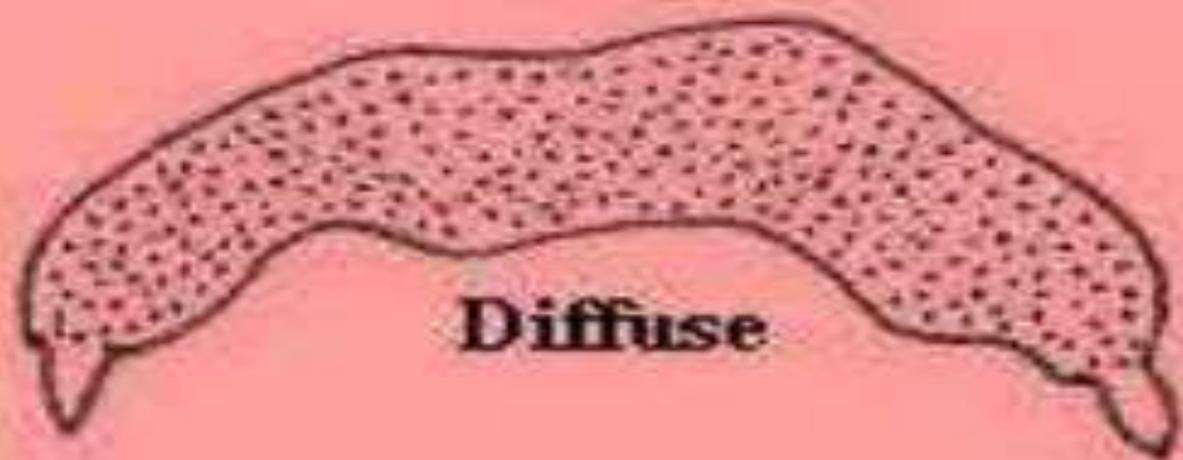
- THREE CLASSIFICATIONS
- Based on degree of tissue loss at parturition
- Based on shape or distribution of chorionic villi
- Based on tissue apposition

Based on Degree of Tissue Loss at Parturition

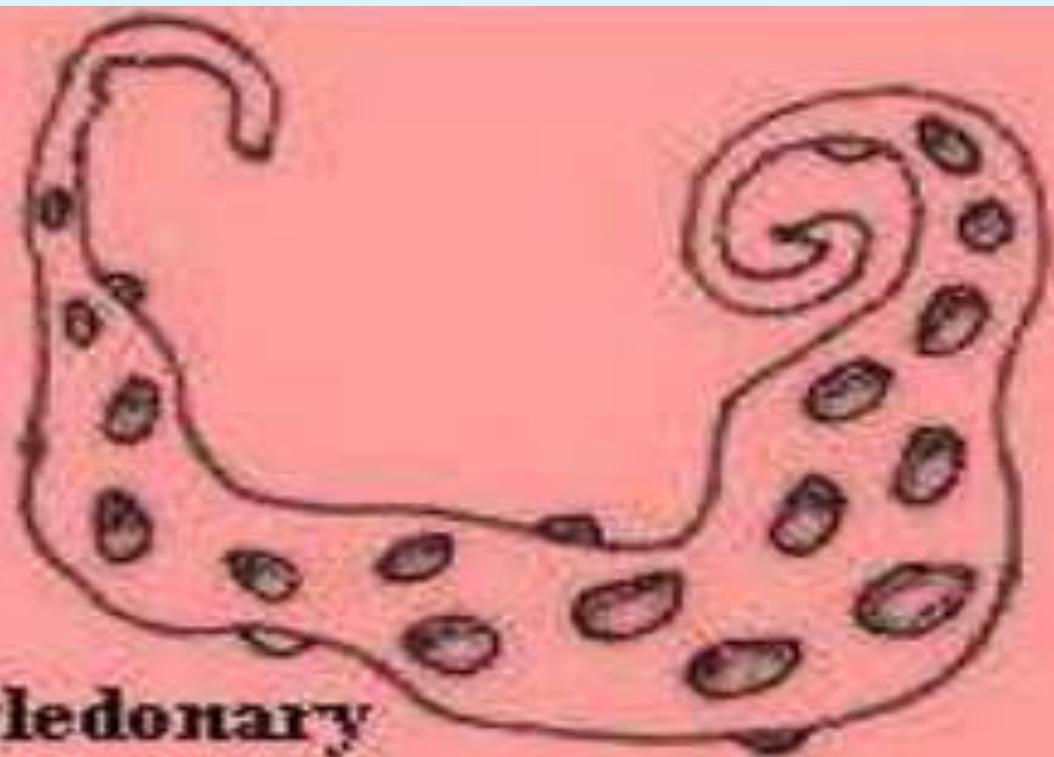
- Deciduate
 - Eccentric, interstitial
 - Rodent, human
- Indeciduate or Nondeciduate
 - Superficial
 - Farm animals
- Partially deciduate
 - Dogs, Cats

Shape or Distribution of Chorionic Villi

- Cotyledonary - cow, sheep
- Diffuse - pig, horse
- Zonary - dog, cat
- Discoid - human

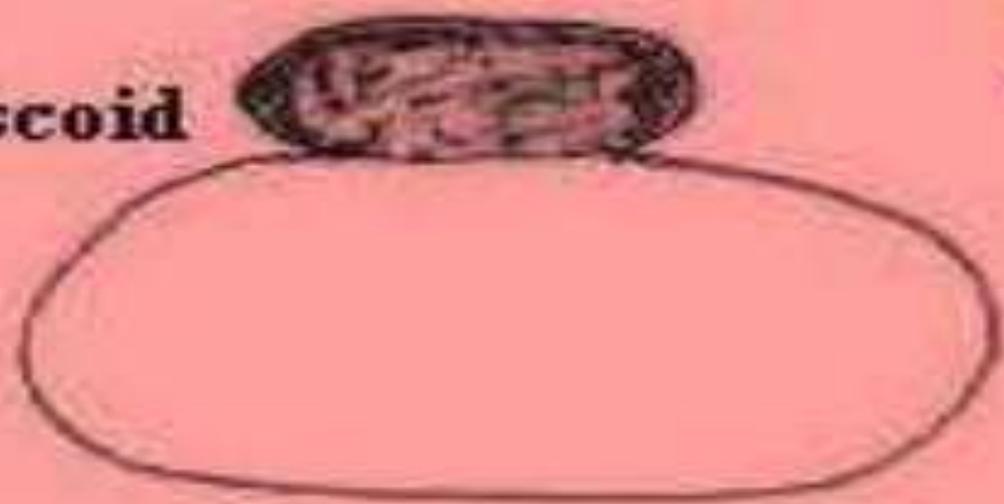


Diffuse



Cotyledonary

Discoid

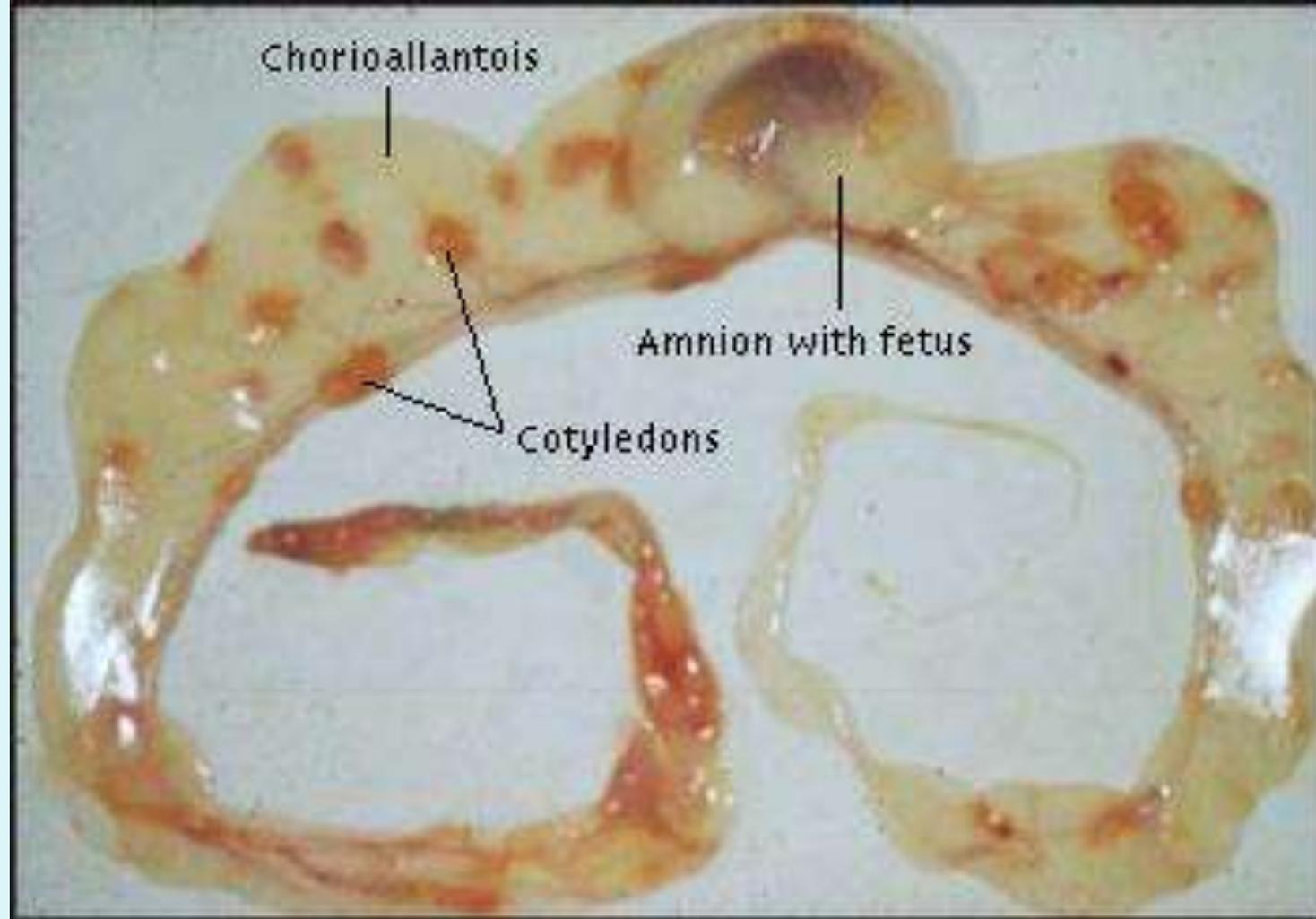


Zonary

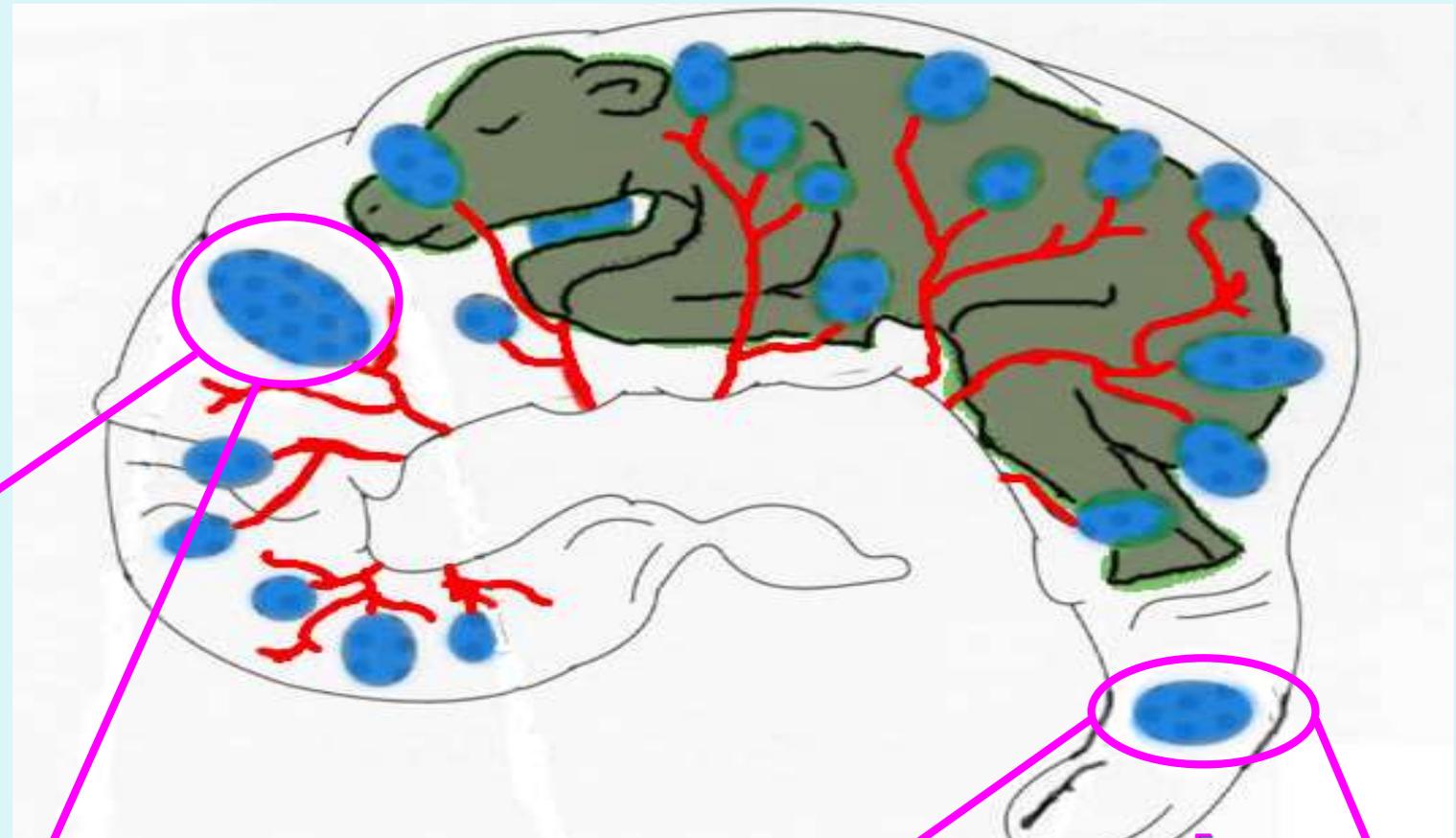


Ruminant placenta

- Instead of having a single large area of contact between maternal and fetal vascular systems, these **animals** have numerous smaller placentae. The terminology used to describe ruminant placentation is cotyledonary: Cotyledon: the fetal side of the **placenta**. Caruncle: the maternal side of the **placenta**. **Placentome**: a cotyledon and caruncle together

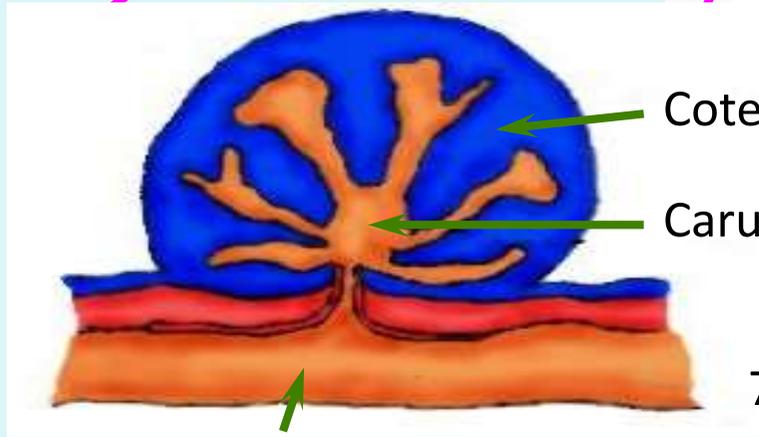


Cotelydonary Placenta



Cow

Convex



Cotelydon (Chorion)

Caruncle

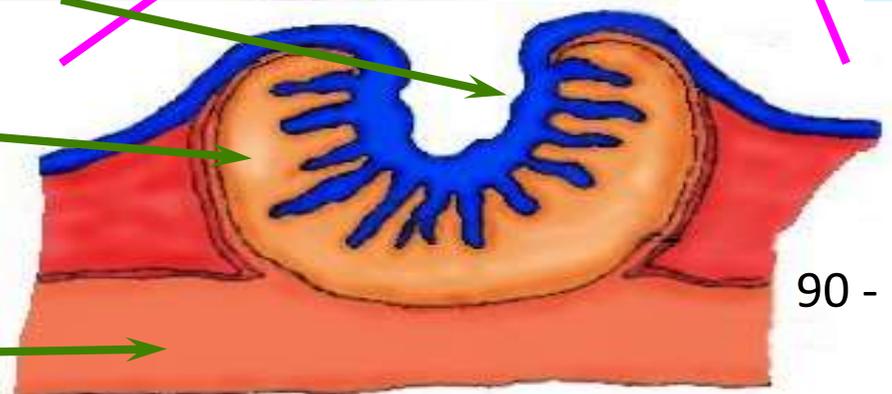
70 - 120

Endometrium



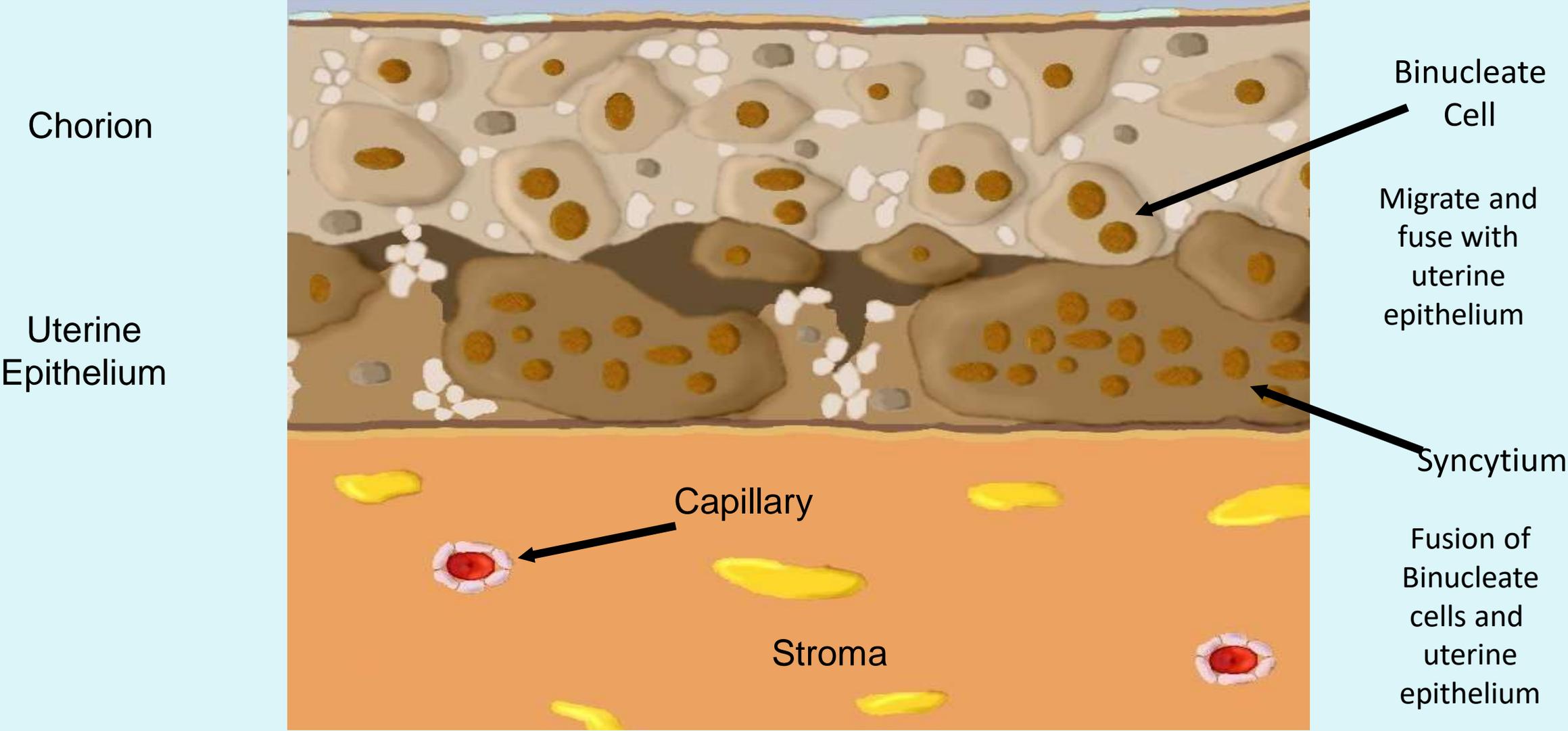
Ewe

Concave



90 - 100

Placental Attachment in Ruminant



Chorion

Uterine Epithelium

Capillary

Stroma

Binucleate Cell

Migrate and fuse with uterine epithelium

Syncytium

Fusion of Binucleate cells and uterine epithelium

(multinucleate)

Binuclear Giant Cells

- 20% of fetal placenta
- Invade endometrium
- Source
 - Placental lactogen
 - Pregnancy specific protein B

Placental Lactogens (Protein Hormones)

Prolactin-like activity:

Stimulates Milk Synthesis

Not Present in Pig and Mare

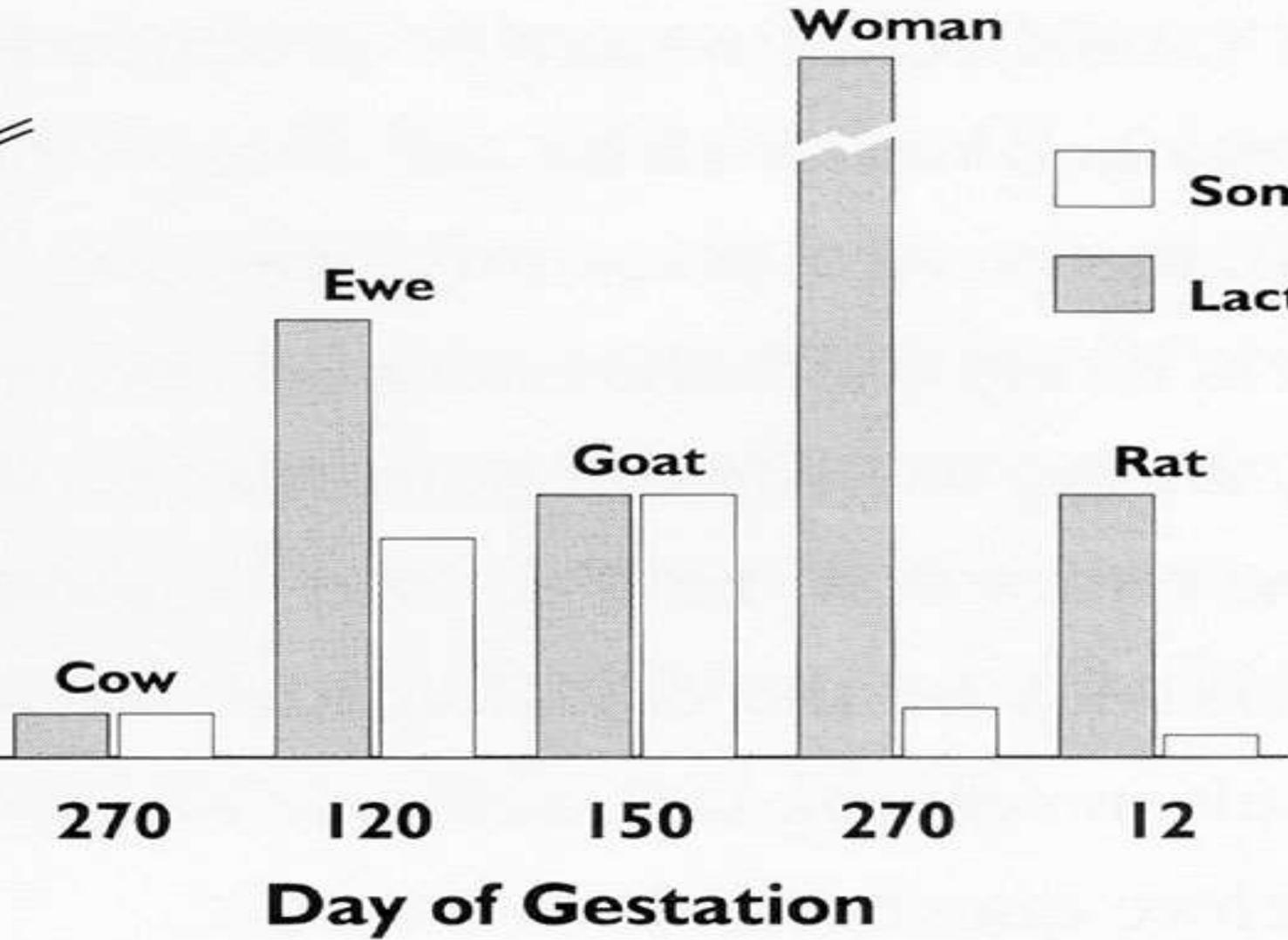
- May regulate maternal metabolism to facilitate fetal growth
- High levels in the last 1/3 of gestation.
- High levels facilitate higher milk production.
- Dairy cows have higher blood concentrations
- than beef cows

Placental Lactogens

- The bovine PL hormone is detected in maternal serum at about 4 months of gestation and remains low through parturition. In contrast, ovine placental lactogen is secreted in whopping quantities beginning at about day 50 and remains high through gestation. Placental lactogen also accumulates to high concentrations in the serum of fetal sheep

Placental Lactogen (ng/ml)

4000
600
500
400
300
200
100
0



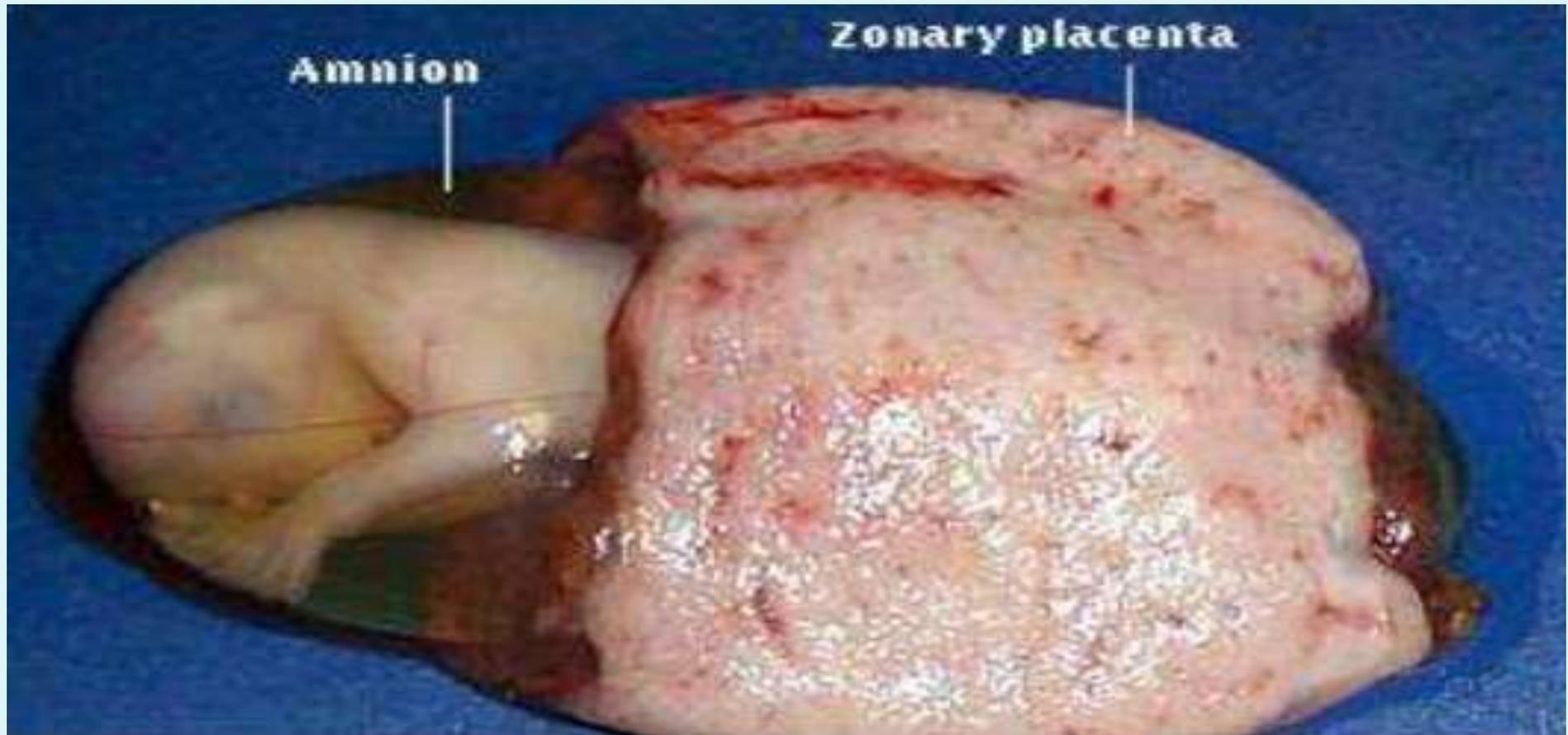
 **Somatotropic activity**
 **Lactogenic activity**

Pregnancy Specific Protein B

- Unique to ruminants
- Function uncertain
- Has been used to detect pregnancy
 - Cattle, sheep, deer
 - Can be used to detect pregnancy in cows after day 25

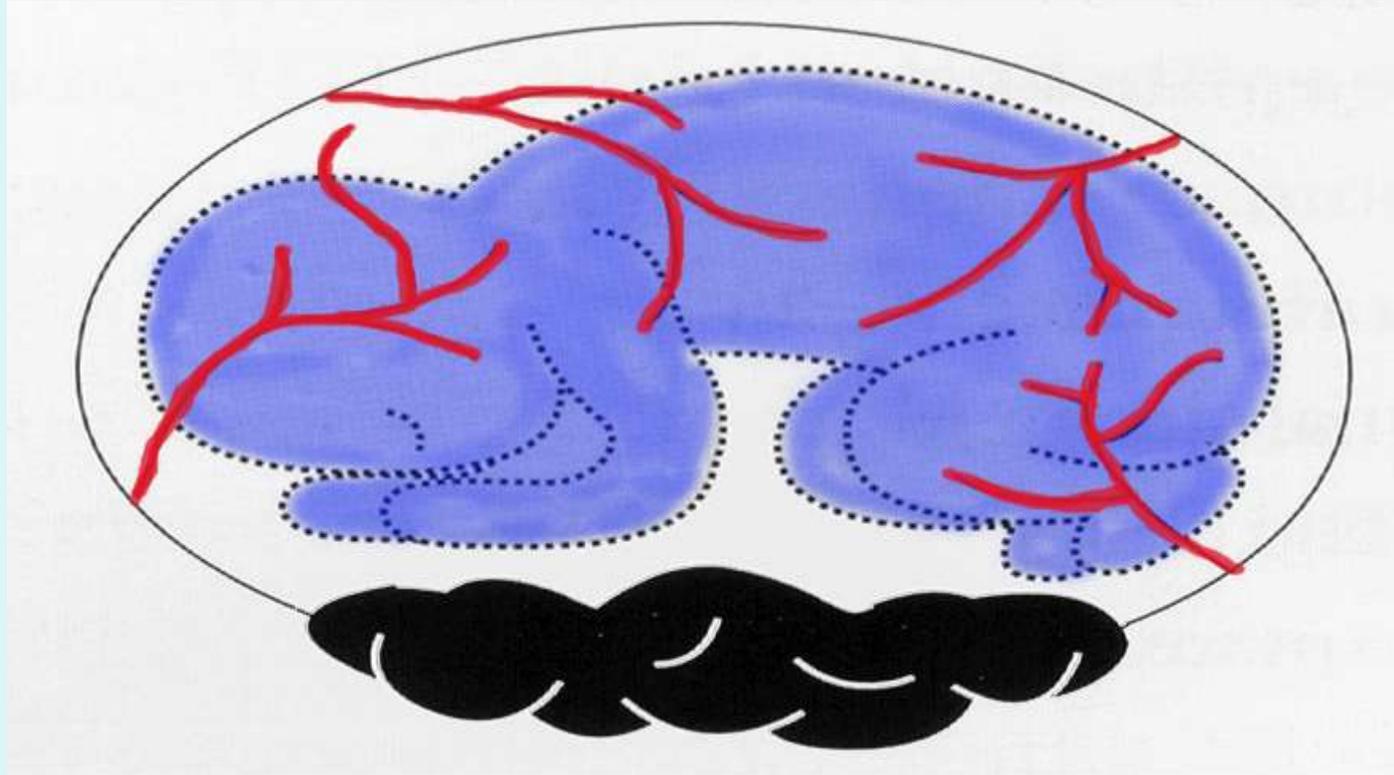
» Not early pregnancy factor!!!

ZONARY PLACENTA DOG



- The canine placenta looks very similar to that of cats. A feature usually seen in the placentae of both species is *marginal hematomas* (hematophagus zones). These are bands of maternal hemorrhage at the margins of the zonary placenta. The products of hemoglobin breakdown give them a **distinctly green coloration due to uteroverdin** in dogs, whereas in cats they are brownish and usually less obvious. The canine placenta is said to produce little if any quantity of steroid hormones. As with other species, maintenance of pregnancy is dependent on continued secretion of progesterone during gestation, but corpora lutea appear to be the exclusive source of progesterone in the bitch. Luteal secretion of progesterone is, in turn, dependent on secretion of **luteinizing hormone** and probably **prolactin** from the anterior pituitary. Removal of the ovaries at any time during canine gestation leads to termination of the pregnancy. Also, progesterone profiles in pregnant and pseudopregnant bitches are indistinguishable until late in gestation or diestrus.

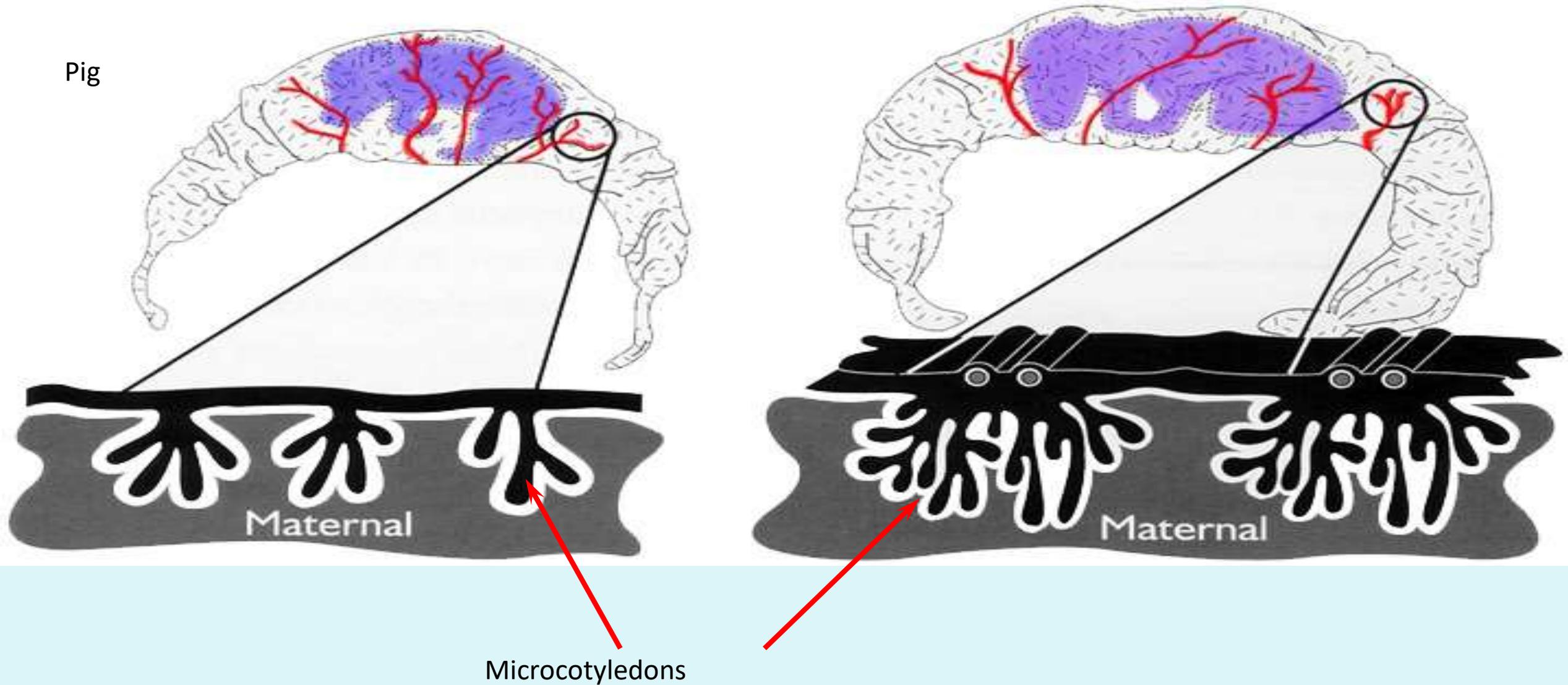
Discoid Placenta (human)



Diffuse Placenta

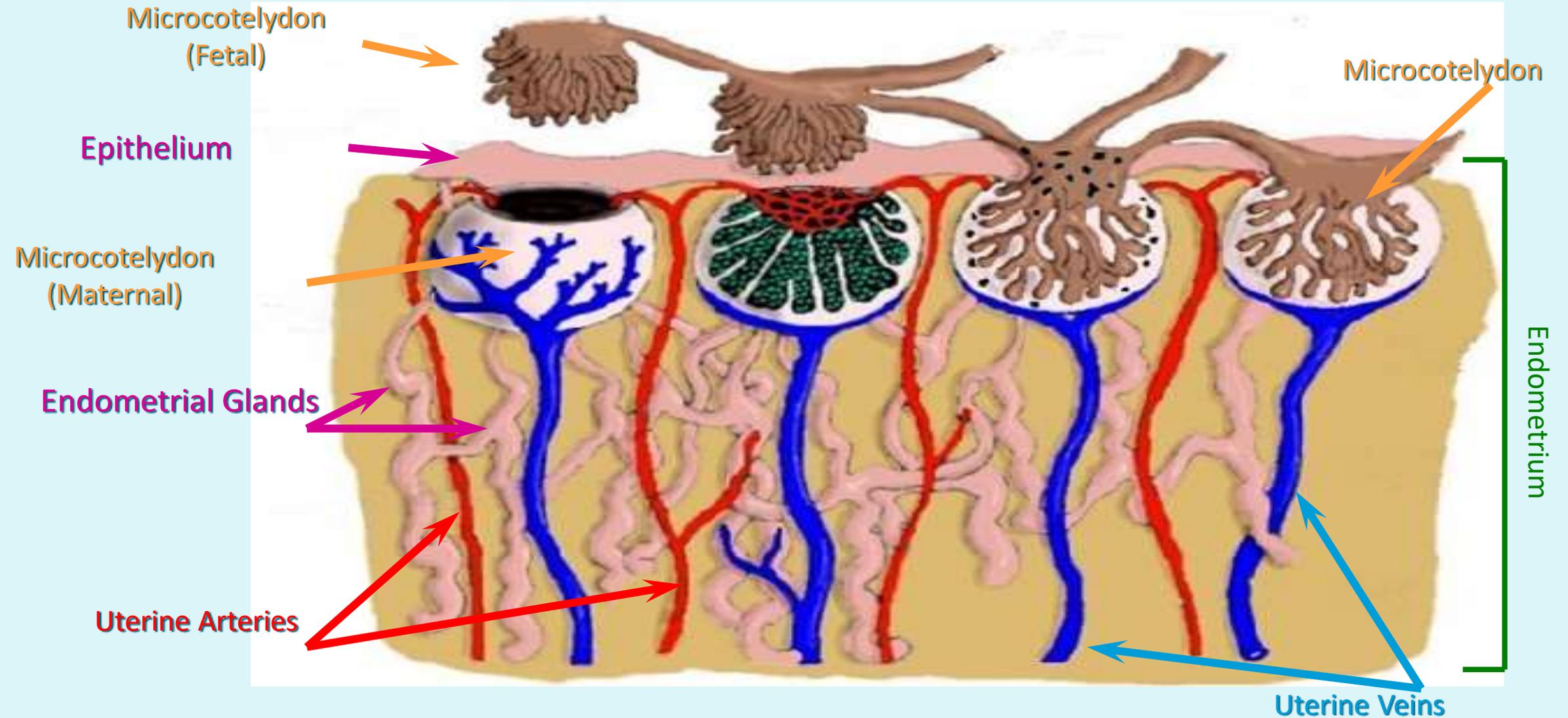
Horse

Pig



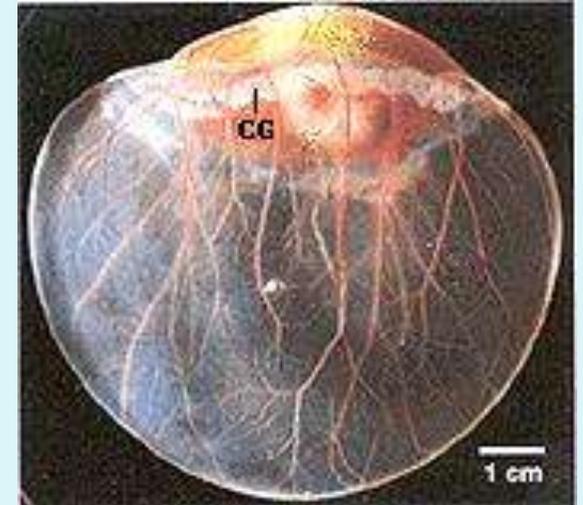
Microcotelydons

Increase placental surface area



Endometrial Cups in Mare

- From both trophoblast and endometrium
- 5 to 10
- Form between days 35 to 60
- Produce equine chorionic gonadotropin (eCG, PMSG)
- Sloughed off after day 60



Endometrial cups develop from cells of the chorionic girdle, which can first be detected histologically at roughly 25 days of gestation. Initially, this structure is a narrow band of thickened trophoblast that develops circumferentially around the conceptus at a point where the membranes of the allantois and yolk sac meet.

Girdle cell invasion and proliferation result in formation of tightly packed mass of trophoblast-derived cells containing little stroma - these are the endometrial cups. Invasion of endometrial glands leads to destruction of their apical epithelium; deeper segments of those glands are spared, but their lumens are obstructed by cup cells and they become distended with secretions.

Endometrial cups are destroyed by Day 100-140

Immunological destruction of the endometrial cups appears to be a response to paternal class I MHC antigens, which are highly expressed on invading girdles cells. In conjunction with the cellular response is a vigorous humoral immune response to these antigens.

- Several interesting observations on endometrial cup biology have been made in inter-specific equine pregnancies. In mares carrying **donkey** conceptuses, the chorionic girdle fails to invade the endometrium, and endometrial cups do not develop. Most of these pregnancies are aborted between days 80 and 90, but the roughly 30% that survive and are carried to term do so in the absence of eCG. However, in donkeys carrying a **hinny** fetus, the cups develop to a much larger size and considerably higher concentrations of eCG are achieved than in donkeys carrying a donkey fetus.

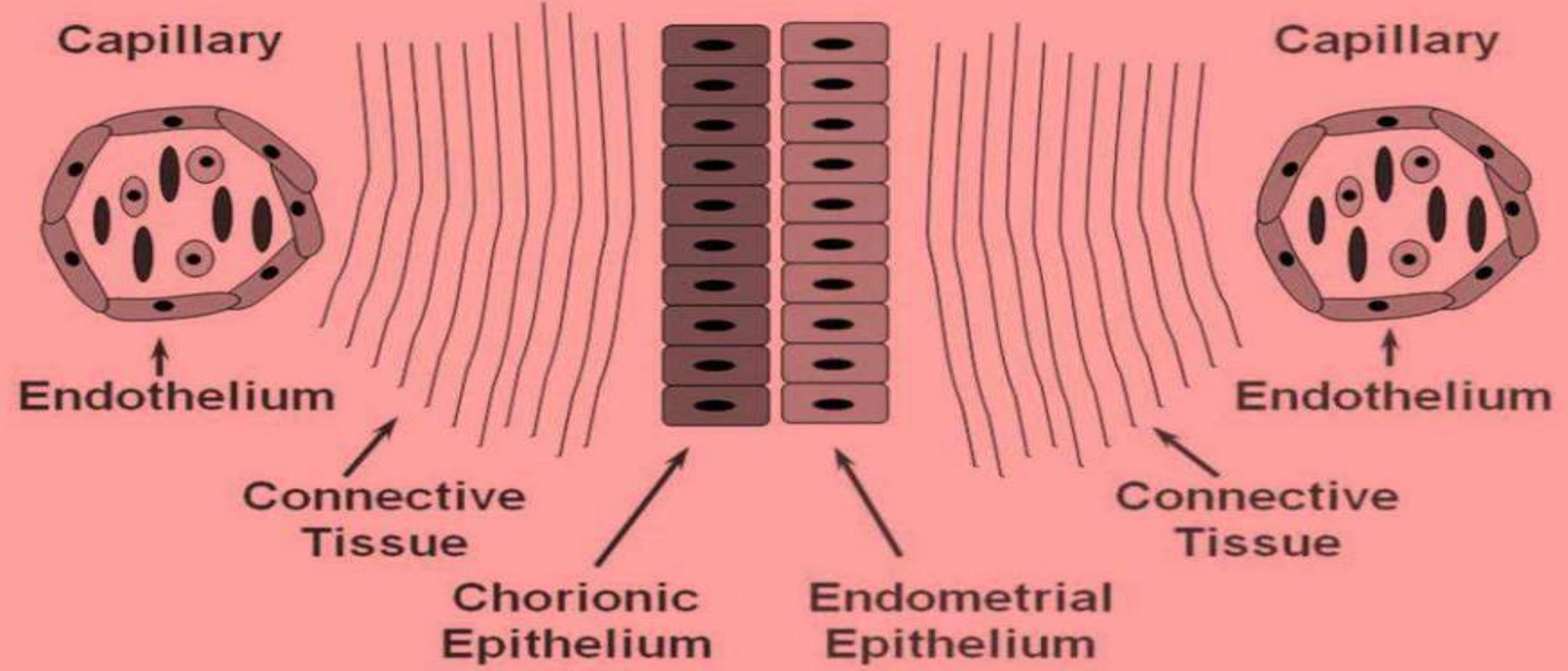
Histological Classification

Tissues	epithelial-chorial	syndesmo-chorial	endothelial-chorial	hemo-chorial	hemo-endothelial
Maternal					
endothelium	+	+	+	-	-
conn. tissue	+	+	-	-	-
epithelium	+	-	-	-	-
Fetal					
epithelium	+	+	+	+	-
conn. tissue	+	+	+	+	-
endothelium	+	+	+	+	+
Species	pig horse ruminant	*ruminant	dog cat	human	rat rabbit

Cell Layers Separating Maternal and Fetal Blood

Fetal

Maternal



Important!!!!

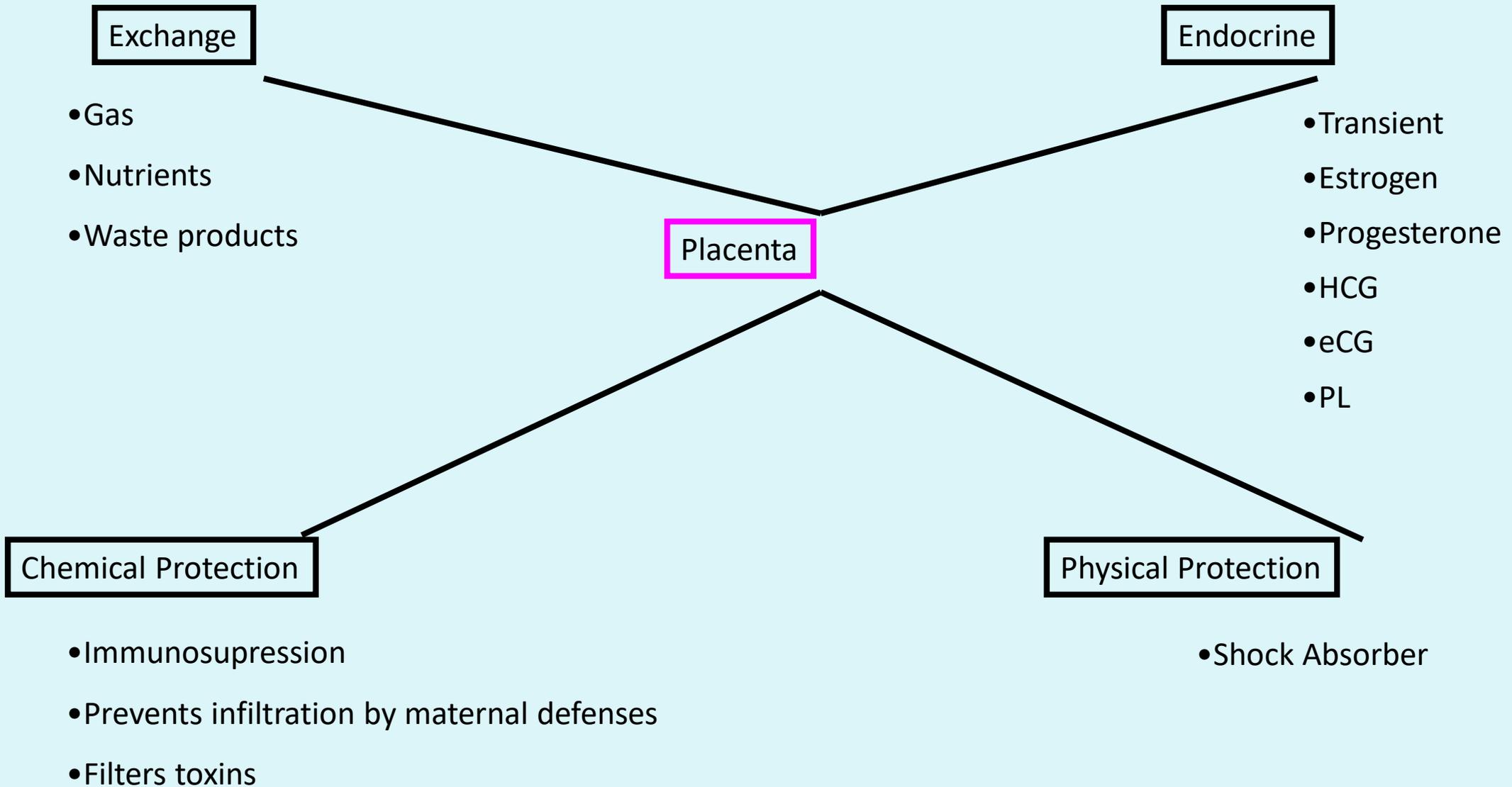
- In all cases, fetal and maternal blood does not mix.

Type of Placenta	Common Examples
Diffuse, epitheliochorial	Horses and pigs
Cotyledonary, epitheliochorial	Ruminants (cattle, sheep, goats, deer)
Discoid, hemochorial	Humans, apes, monkeys and rodents
Zonary, endotheliochorial	Carnivores (dog, cat, ferret)

Gestation length in domestic animals

Species	Gestation length (days)
Dairy cows	270 – 280
Beef cows	280 – 290
Mare	340 - 390
Ass	365 – 375
Hinny (Stallion x Ass)	348 – 350
Mule (Jack x Mare)	355
Ewe	143 – 155
Goat	146 – 155
Pig	111 – 116
Bitch	59 – 68
Queen	56 – 65
Buffalo	310-320
Female Camel	370-380

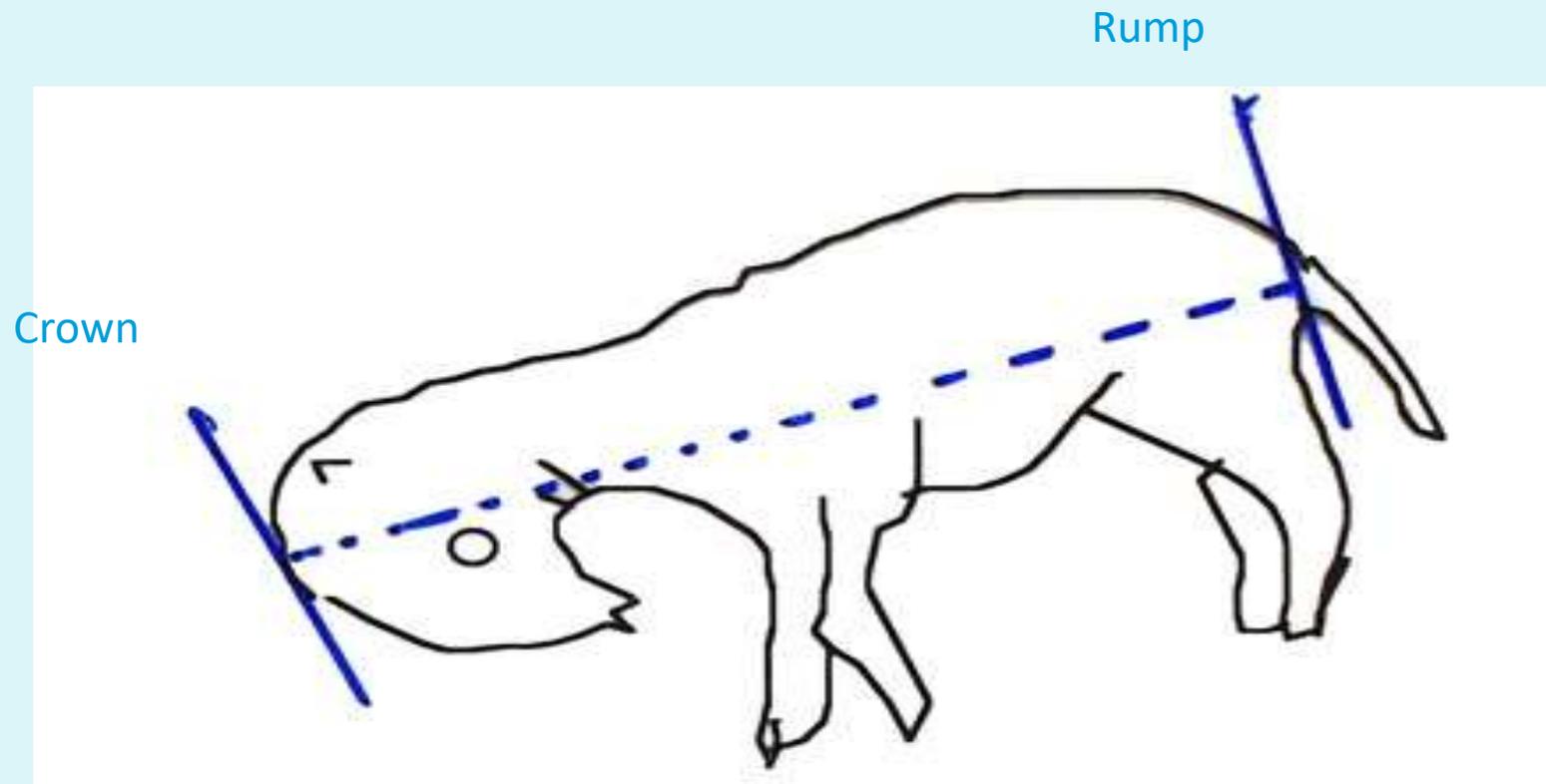
Placental Functions



Developmental Features

Developmental Horizons	Mare	Cow	Ewe	Sow	Woman
Germ layers	13-14	14	10-14	7-8	10-14
Open neural tube		20	15-21	13	
Fusion of chorioamnionic folds		18	17	16	
Heart beat apparent	24	21-22	20	16	25
Limb buds visible	24	25	28-35	17-18	28
Cotyledons first appear		30			
Eye differentiation	40	30-45	42-49	21-28	
Birth	340	280	147-155	112	266

Critical Organ Systems Develop Early!



Estimates of Age

- Crown rump length
- Length femur, radius or tibia
- Circumference of head

Factors Influencing Fetal Growth

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graph TD; A[Factors Influencing Fetal Growth] --> B[Genetics]; A --> C[Environment]; A --> D[Fetal Hormones]; B --- B1[Species]; B --- B2[Breed]; B --- B3[Litter size]; B --- B4[Genotype]; C --- C1[Mother]; C --- C2[Nutrition]; C --- C3[Size, Parity]; C --- C4[Placenta]; C --- C5[Blood flow]; C --- C6[Size]; D --- D1[Thyroid]; D --- D2[Insulin]; D --- D3[Growth hormone];
```

Genetics

Species

Breed

Litter size

Genotype

Environment

Mother

Nutrition

Size, Parity

Placenta

Blood flow

Size

Fetal Hormones

Thyroid

Insulin

Growth hormone

Factors Influencing Fetal Growth



Genetics

Species

Breed

Litter size

Genotype

Certain lines of animals may grow faster.

Factors Influencing Fetal Growth

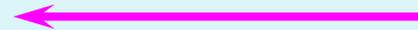
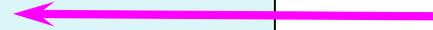


Fetal Hormones

Thyroid

Insulin

Growth hormone



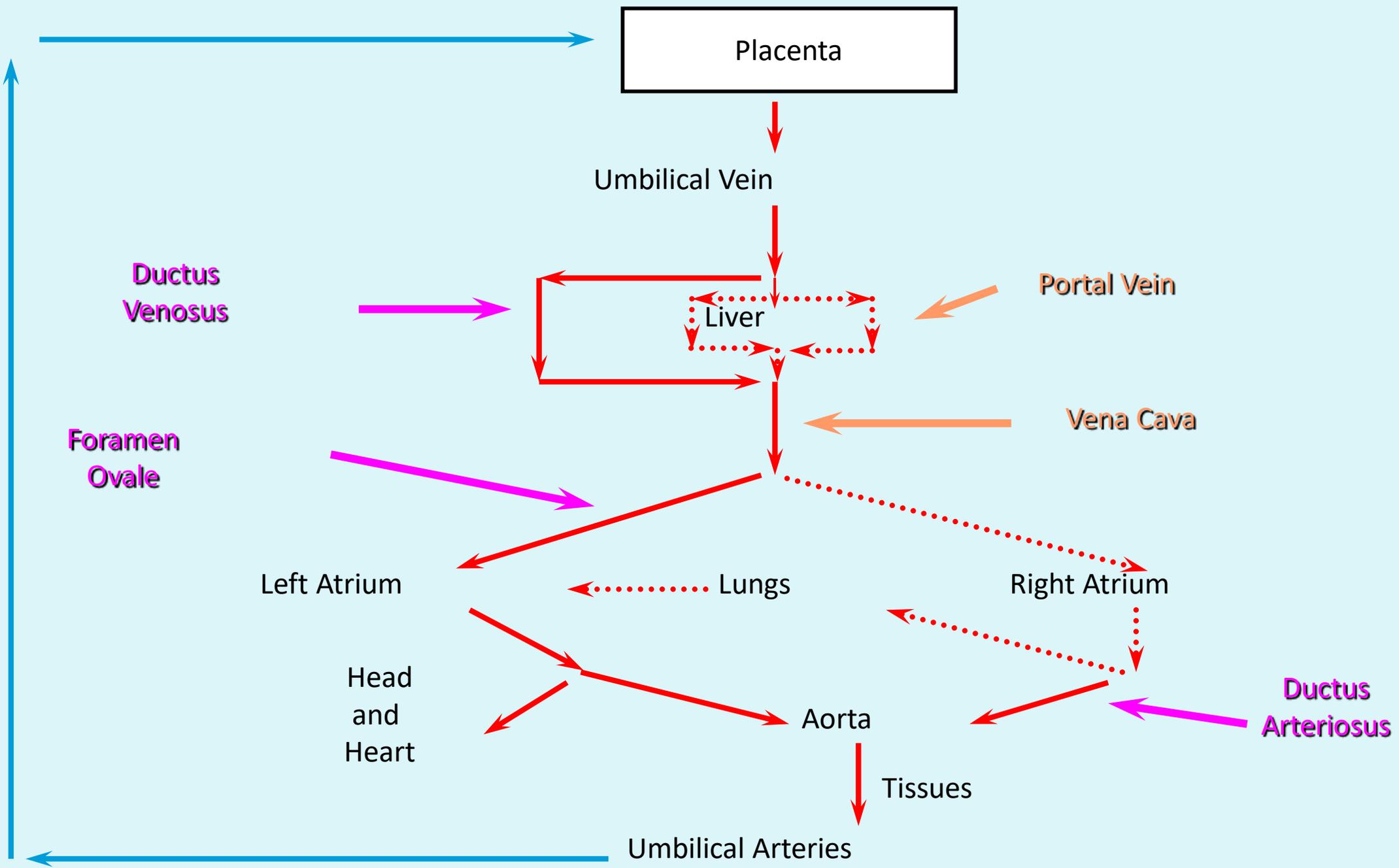
Skeletal and muscular development

Increased energy substrate availability and stimulates placental growth

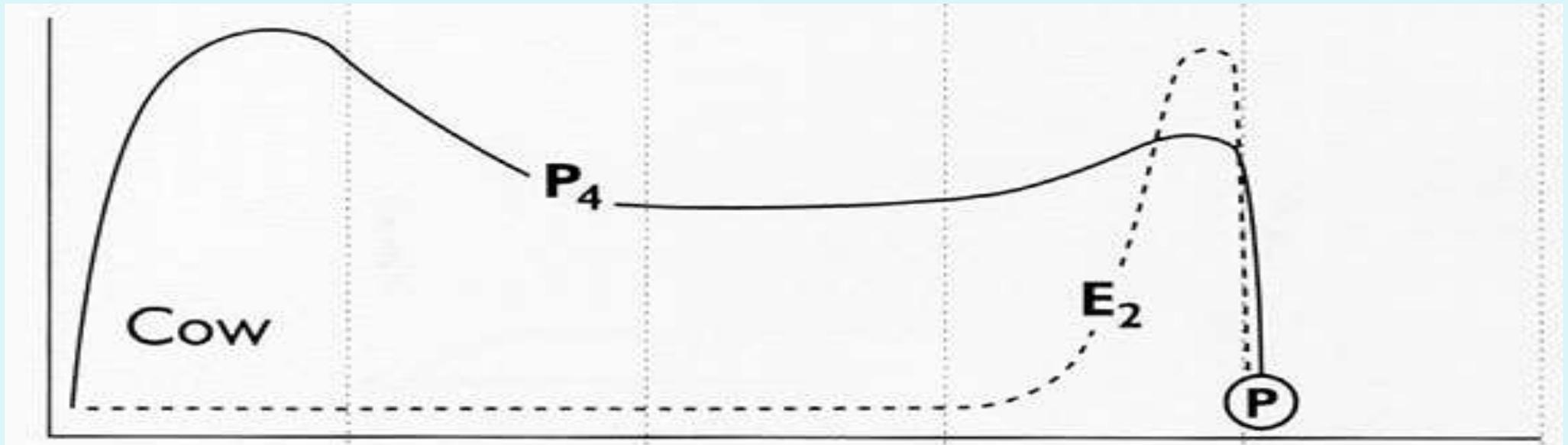
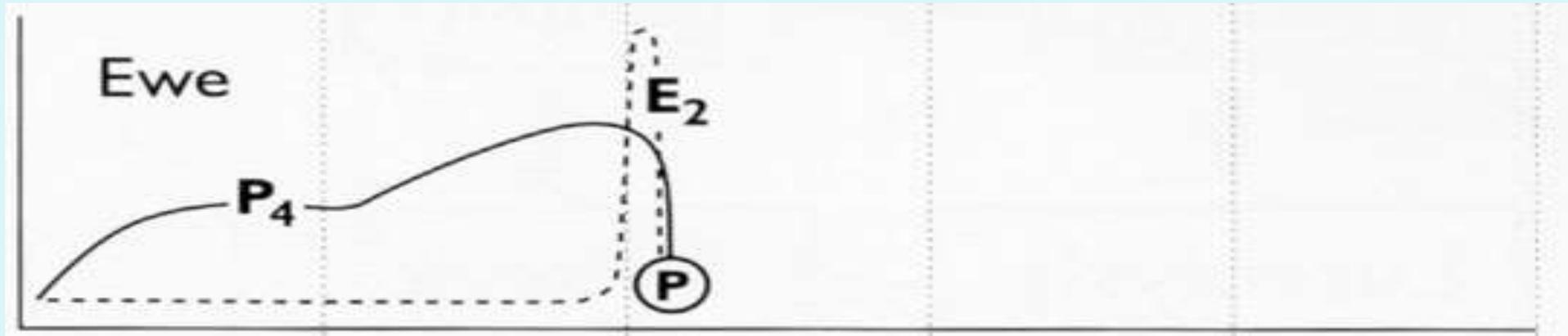
Stimulates fetal growth

Uterine Size Changes During Pregnancy

- Hyperplasia
 - Increase in the number of cells
- Hypertrophy
 - Increase in size of cells
- Stretching



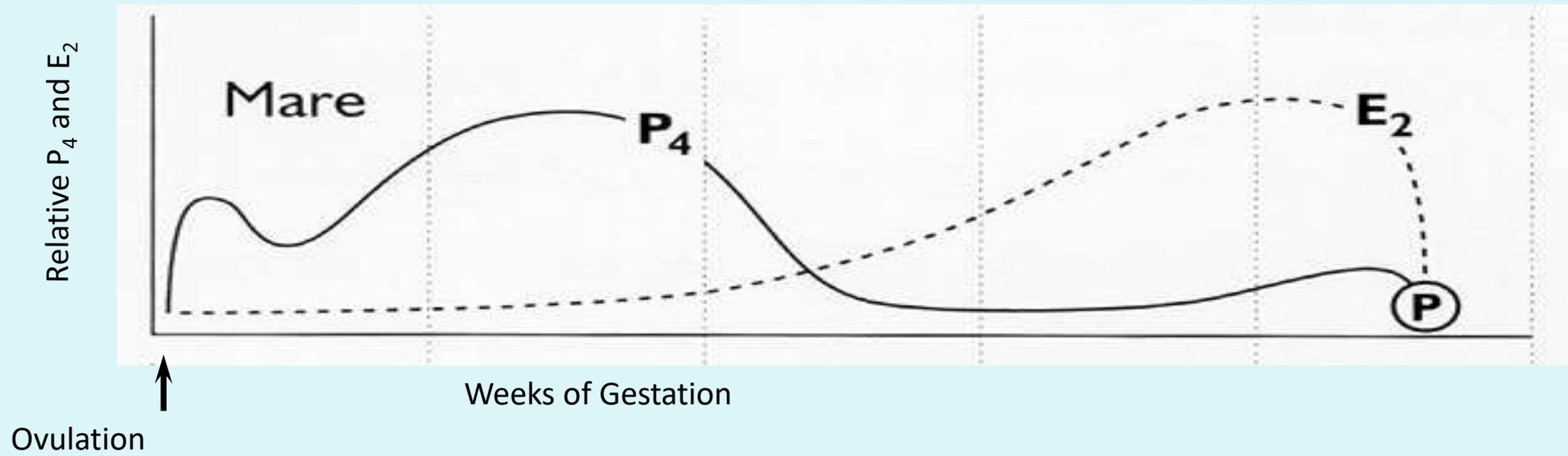
Relative P_4 and E_2

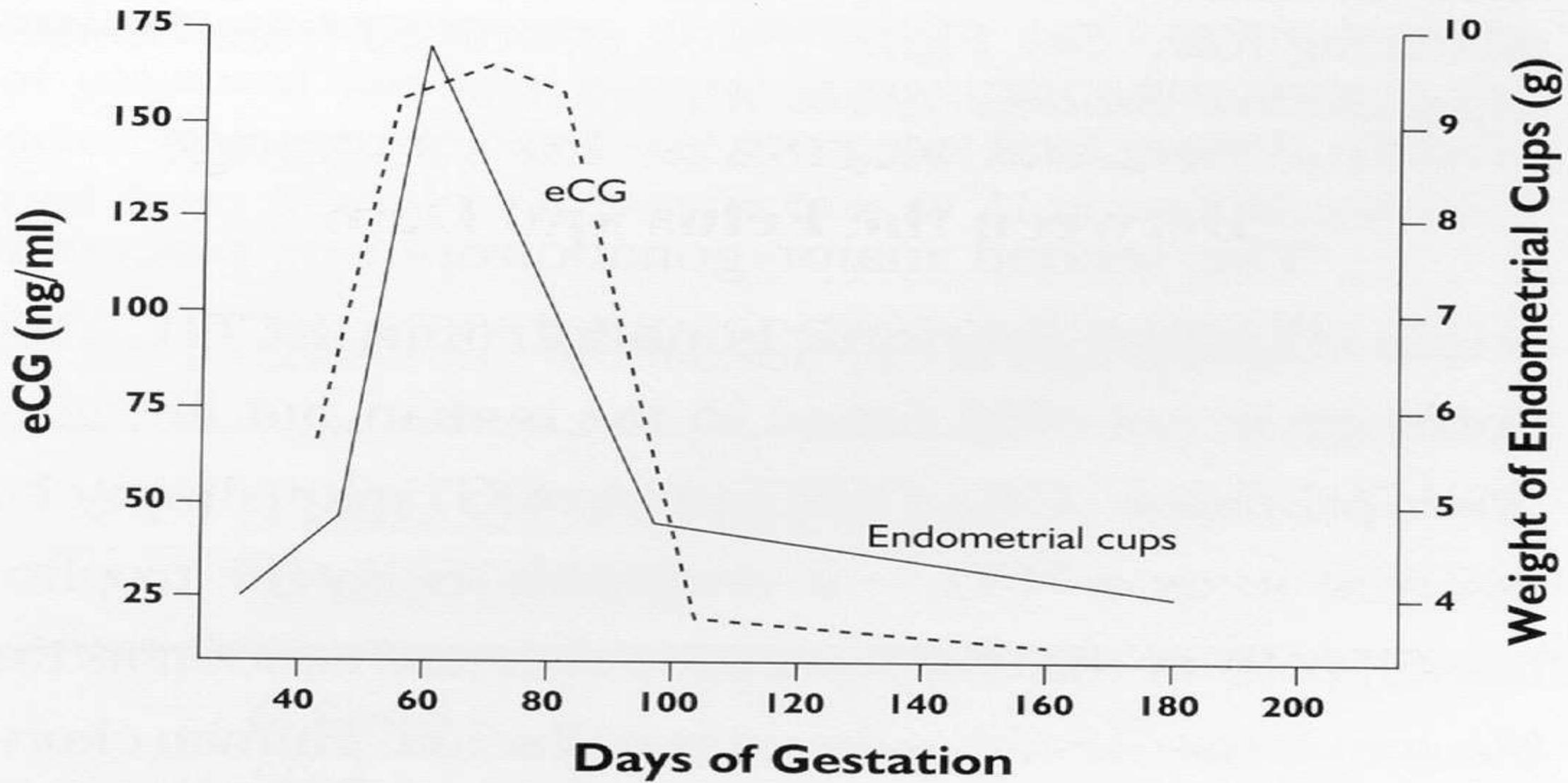


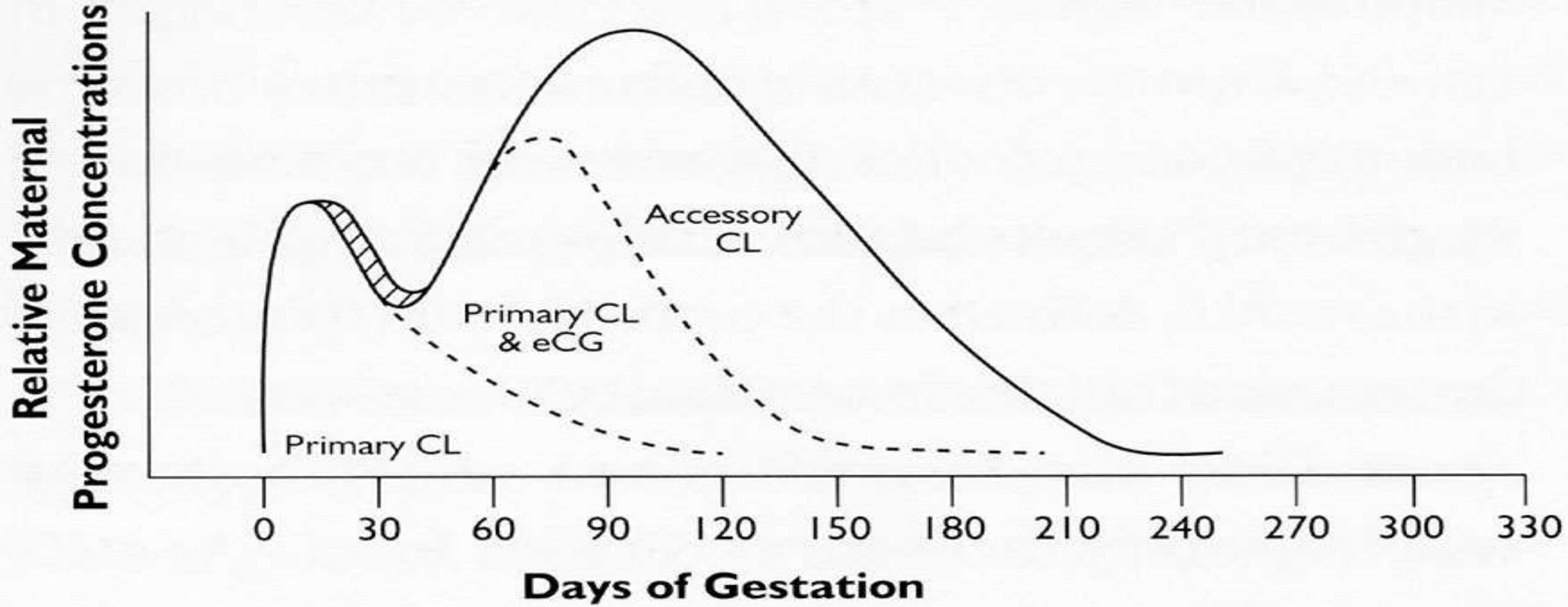
Weeks of Gestation

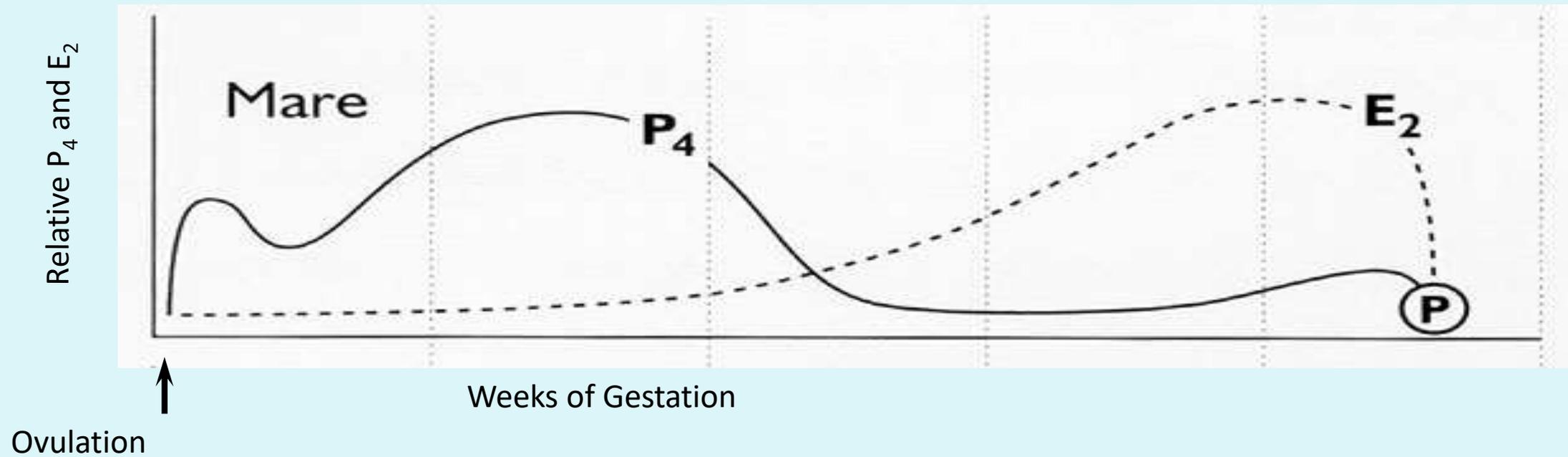
Ovulation

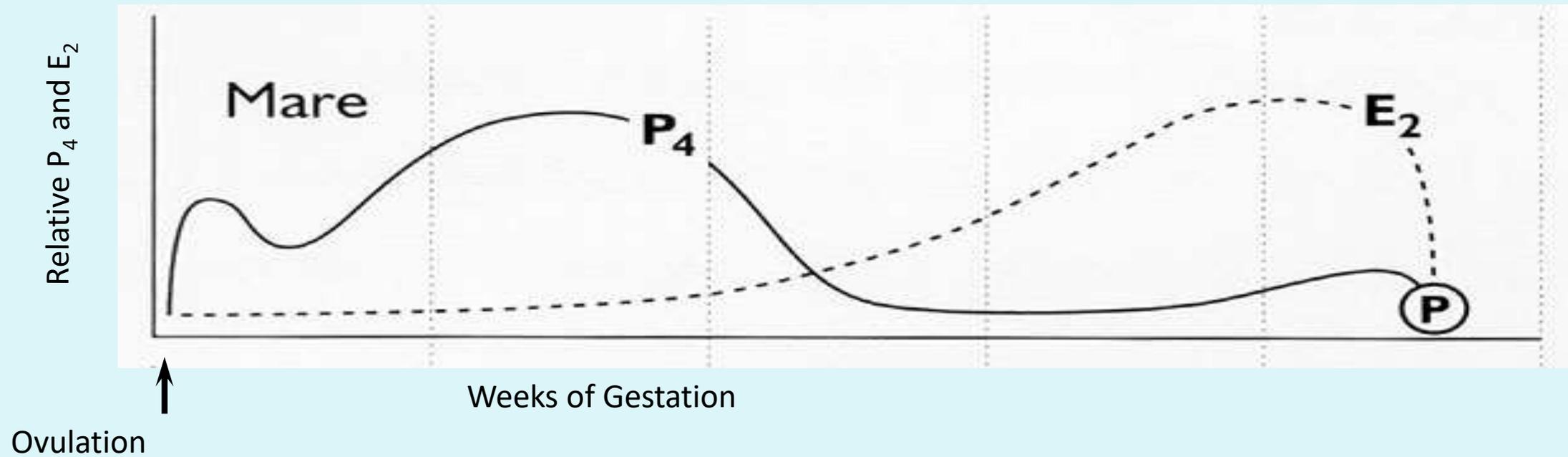




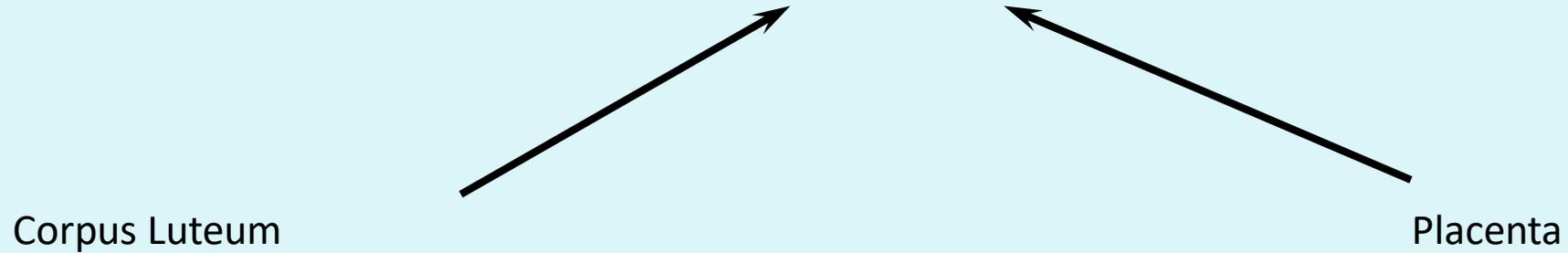








Progesterone is Essential To Maintain Pregnancy



Species	Gestation Length	Placental Takeover
Sow	3.8 mo	3.8 mo (none)
Cow	9 mo	6 - 8 mo
Ewe	5 mo	50 d
Mare	11 mo	70 d
Human	9 mo	60-70 d

Other Species in Which Placenta Does not Take-over Progesterone Production

- Bitch
- Queen
- Alpaca, Llama, Camel
- Rabbit
- Goat

Thank You

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