

Female Reproductive System

ANS 215

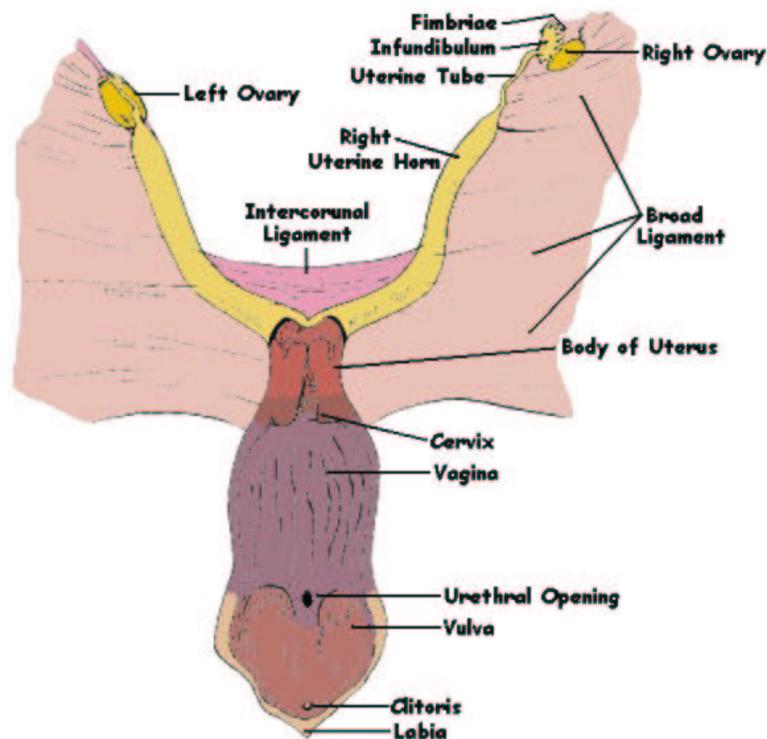
Physiology and Anatomy of Domesticated Animals

I. Function: Perpetuation of the Species

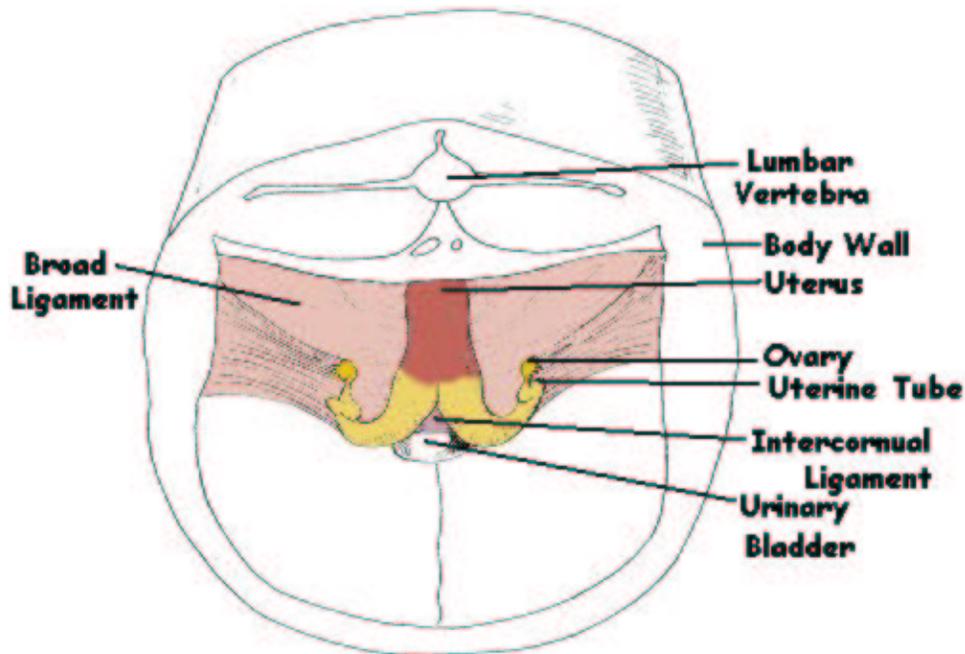
- A. Production and development of oocytes
- B. Provide an environment for the growth and nourishment of the developing fetus after fertilization.
- C. Synthesis of hormones

II. Anatomy: Ovaries, Uterine Tubes, Uterus, Vagina, and Vulva

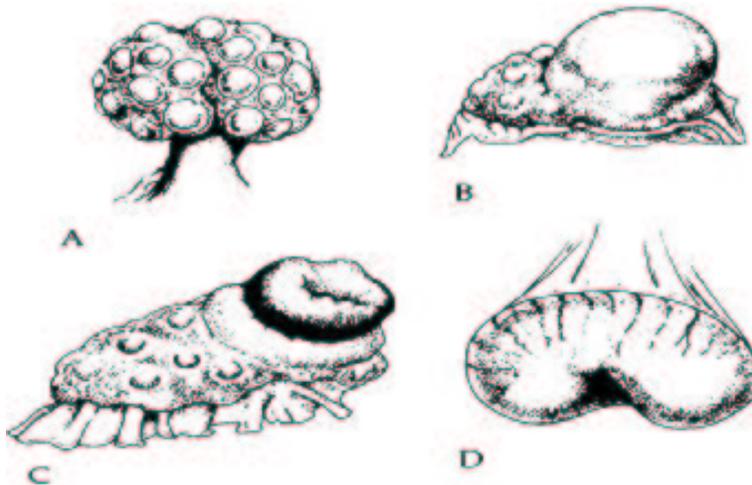
- A. Ovaries – two
 - 1. Paired glands that provide for the development of oocytes
 - 2. Production of hormones
 - 3. Suspended from the dorsal wall to the abdomen by the mesovarium
 - a. part of the broad ligament
 - 4. Easily manipulated by rectal palpation
 - 5. Almond-shaped in most species - Bean-shaped in horse – Berry-shaped in the sow
 - 6. Ovulation – release of oocyte occurs over the entire surface in most species
 - a. in the horse they are confined to one site – Ovulation Fossa (indentation)



Reproductive tract of the cow (dorsal aspect). The body of the uterus, vagina, and vulva (vestibule of the vagina) have been laid open and the right ovary withdrawn from the infundibulum. The broad ligament (a downward reflection of the peritoneum) suspends the reproductive tract from the dorsolateral abdominal wall.



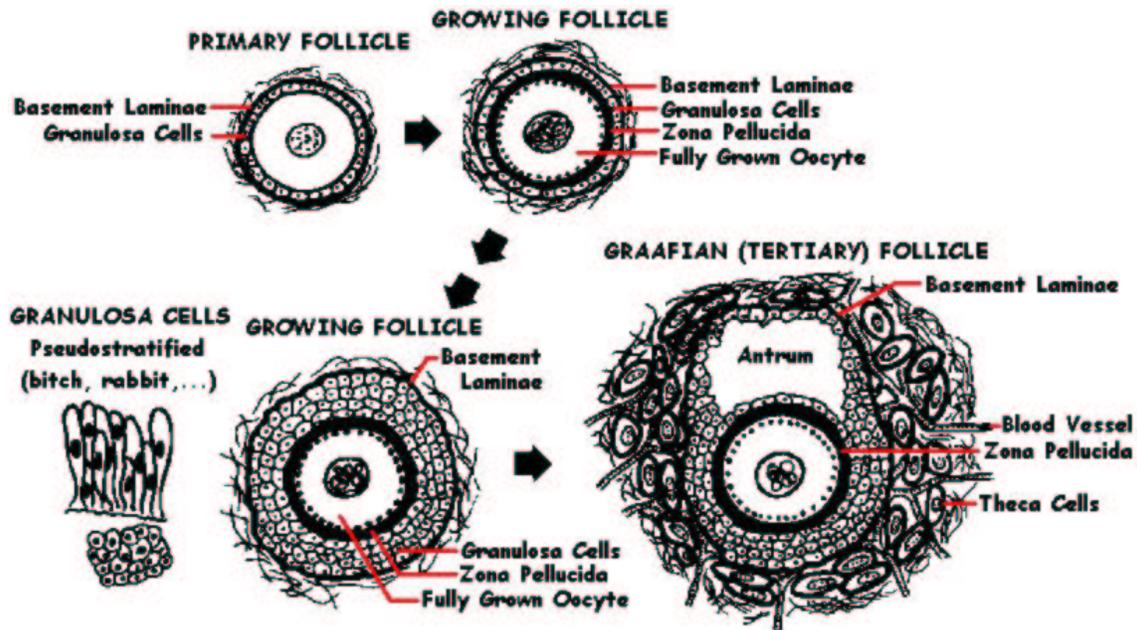
Cranial view of bovine female reproductive organs. The broad ligament is the inclusive term for the mesovarium, mesosalpinx, and mesometrium that suspend the ovary, uterine tubes, and uterus, respectively, from the dorsolateral wall of the sublumber region. The broad ligament is a reflection from the peritoneum.



Ovarian differences resulting from species morphology and functional changes. **A.** Sow ovary (berry-shaped). **B.** Cow ovary (almond-shaped) with ripening follicle. **C.** Cow ovary with fully developed corpus luteum. **D.** Mare ovary (kidney-shaped) with ovulation fossa (indentation).

7. Structure of ovary

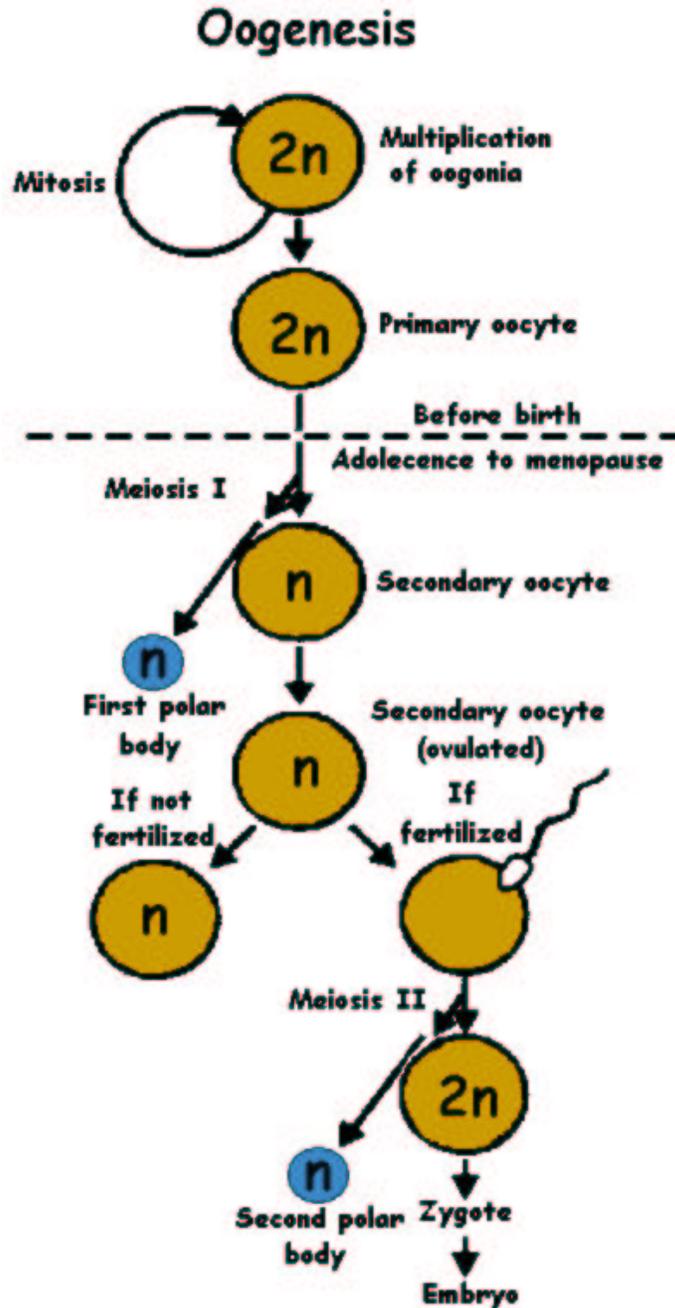
- a. epithelium – surface layer
- b. tunica albuginea – connective tissue covering the entire ovary
- c. cortex – beneath tunica albuginea
 - i. contains follicles in various stages of development
- d. medulla – loose connective tissue, blood vessels, lymphatics, and nerves



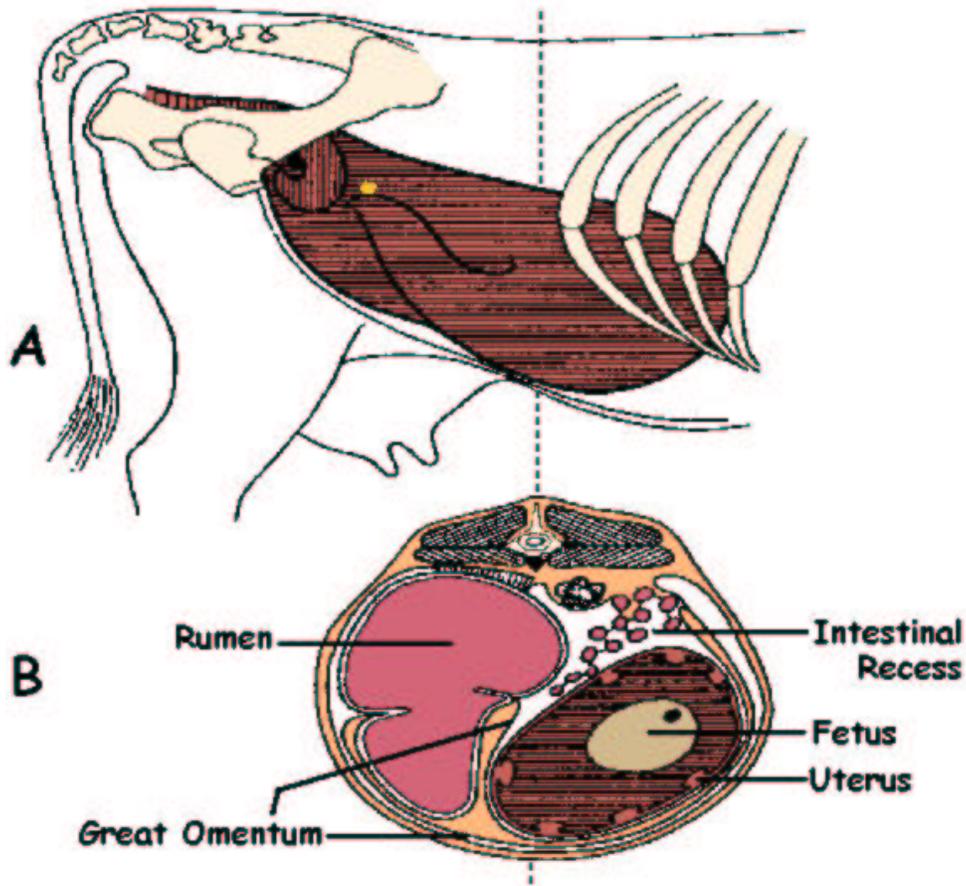
Development of an ovarian follicle from its primordial (primary) form to a graafian follicle. Growing follicles are those that have begun growth from the resting stage as primordial follicles, but have not developed thecal layers or an antrum.

8. Follicles – Primordial (primary), Growing, and Graafian
 - a. primordial follicles – contain a single oocyte surrounded by a single layer of granulosa cells
 - i. granulosa cells are derived from the epithelium
 - ii. oocytes are derived from mitosis of oogonia in the embryonic genital ridge that then migrate to the ovary
 - b. growing follicles – have begun to grow from the resting stage
 - i. have not developed a thecal layer or antrum (fluid-filled cavity)
 - ii. two or more layers of granulosa cells
 - iii. zona pellucida may be present
 - surrounds the oocyte
 - provides pores for interaction with granulosa cells
 - sperm must recognize, then contact, then penetrate the zona pellucida to reach the oocyte membrane
 - c. Graafian follicles
 - i. antrum clearly visible
 - ii. two layers of thecal (theca) cells
 - interna
 - externa
 - hormone dependent and begins at puberty under the influence of gonadotropic hormones, luteinizing hormone (LH) and follicle stimulating hormone (FSH) which are secreted from the anterior pituitary
 - d. atretic follicles (regression, turning over without ovulation)
 - i. human: 4×10^5 at birth – only about 400 ovulate in the reproductive life of 30 – 40 years, so 99.9% become atretic

- e. oogenesis – oocyte formation
- i. primary function is the reduction of chromosome number
 - ii. primary oocyte + secondary oocyte + polar body + (ovulation)
 secondary oocyte + second polar body = ovum
 - haploid (n) number similar to spermatozoa
 - union of oocyte and spermatozoa produce 2n or diploid number of chromosomes
 - meiosis is arrested at the first prophase of meiotic division
 - * resumes at ovulation

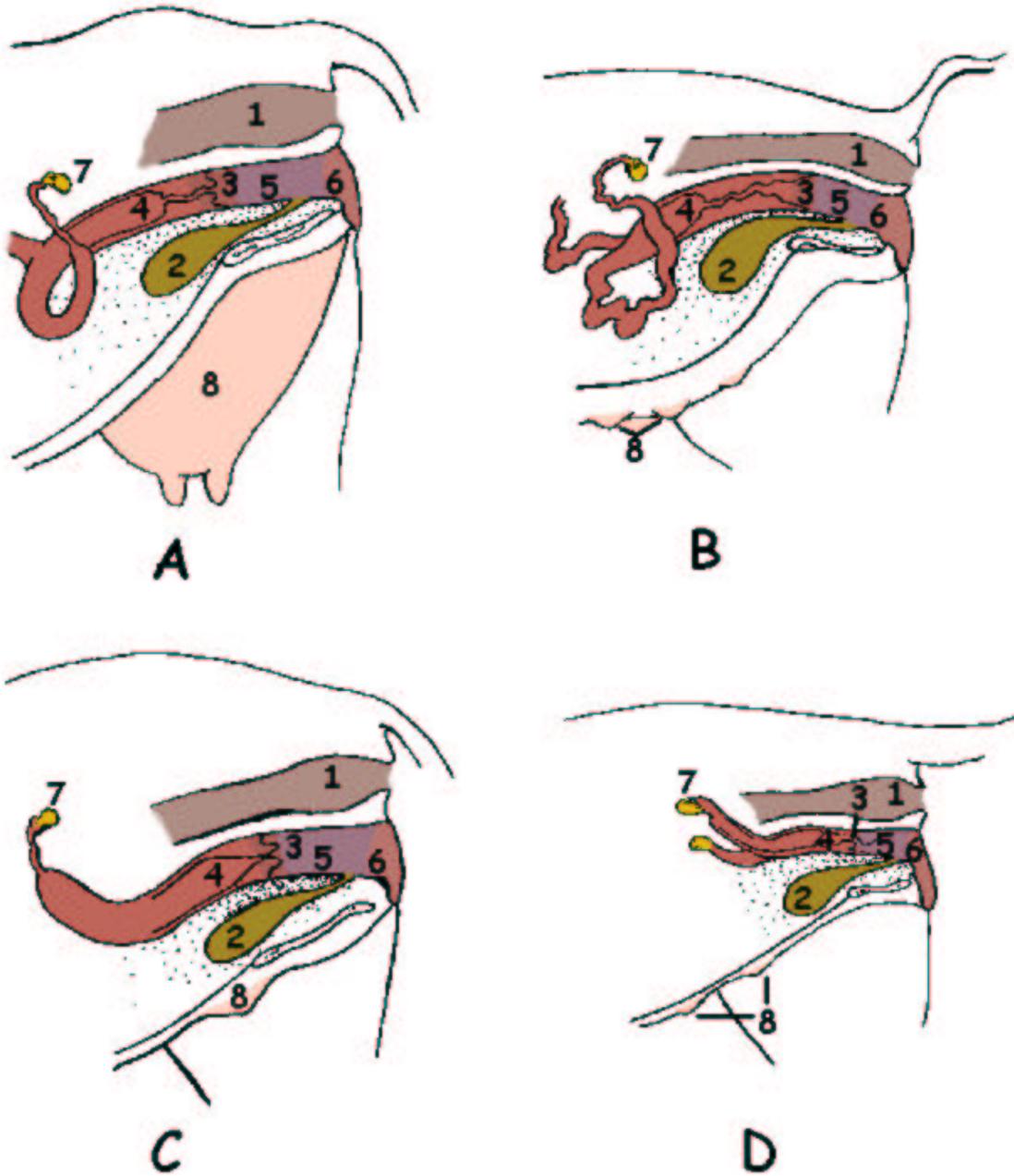


9. Corpus Luteum (CL)
 - a. formation after ovulation of follicle by rapid vascularization of granulosa cells
 - b. produces progesterone – hormone of pregnancy
- B. Uterine Tubes – Fallopian Tubes
 1. Paired, convoluted (coiled)
 2. Avenue to transport oocytes from ovaries to uterus
 3. Site of fertilization
 4. Preceded by fimbriae and infundibulum
 - a. fimbriae assist in directing the oocyte into the infundibulum
 5. Lined with both secretory and ciliated cells for the movement of both oocytes and spermatozoa
 6. Has both circular and longitudinal muscles which also aid in transport of oocytes and spermatozoa
 7. Supported by a continuation of the mesovarium
- C. Uterus – location for the developing fetus
 1. Consists of corpus (body), cervix (neck), and two cornua (horns)
 2. Tissue layers
 - a. endometrium
 - highly glandular over entire lining except ruminants
 - * ruminants have mushroom-shaped projections called caruncles where fetal membranes attach, the fetal sides are called cotyledons
 - varies in thickness and vascularity under the influence of both hormonal changes and pregnancy
 - glandular secretions provide nutrients to the embryo before implantation and development of placenta
 - b. myometrium – muscular portion of the uterus
 - hypertrophy (increased cell size) and hyperplasia (increased cell numbers) during pregnancy
 - primary function is in aiding the expulsion of the fetus
 - c. serous covering for support (mesoderm)
 - provides suspensory support for the uterus
 - two broad ligaments on from each side that support the uterus and varies structures on their respective sides

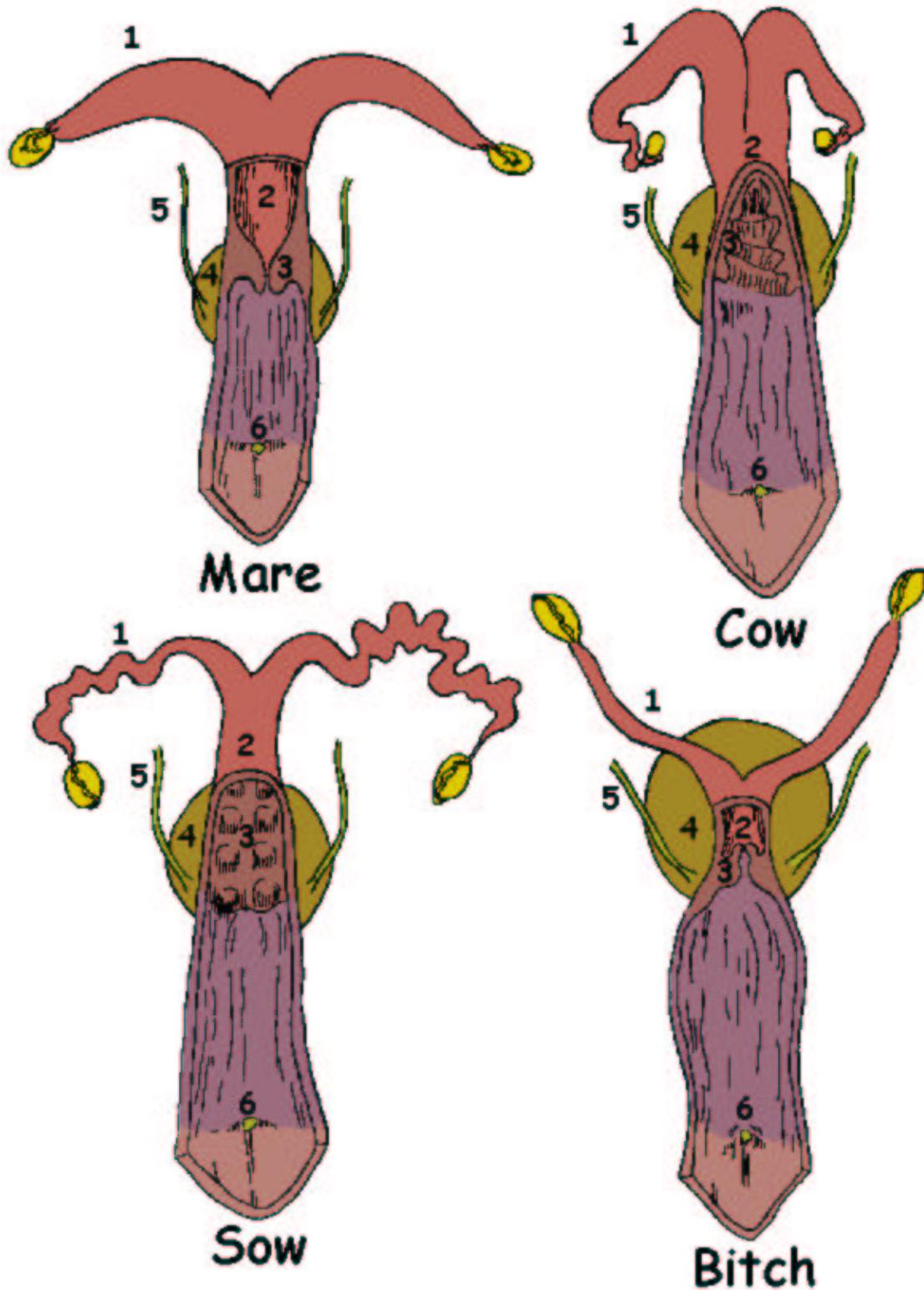


Position of the cow's uterus at the third and sixth month of pregnancy. A. Superimposed uterus and ovary (left) (note the location of the ovary – gold color) represents the uterus at the third month of pregnancy. B. Cross-section of uterus at the sixth month of pregnancy with its contained fetus relative to the adjoining abdominal viscera (rumen on left and uterus on right side of abdomen).

- d. cervix – heavy, smooth muscle sphincter
 - tightly closed except during estrus and parturition
 - secretes outward flowing mucus from goblet cells
 - * mucus flow prevents infective materials from entering the uterus from the vagina
- e. vagina
 - within the pelvis, between the uterus and vulva
 - sheath for male penis during copulation
 - urethral opening of discharge of urine
 - passage of fetus during parturition
- f. vulva (vestibule of the vagina) – caudal portion of the female genitalia
 - located from the urethral opening to the exterior of the genitalia
 - clitoris (femal vestigial counterpart to the male penis)
 - * erectile tissue
 - * sensory nerve endings
- g. labia – external portion of vulva



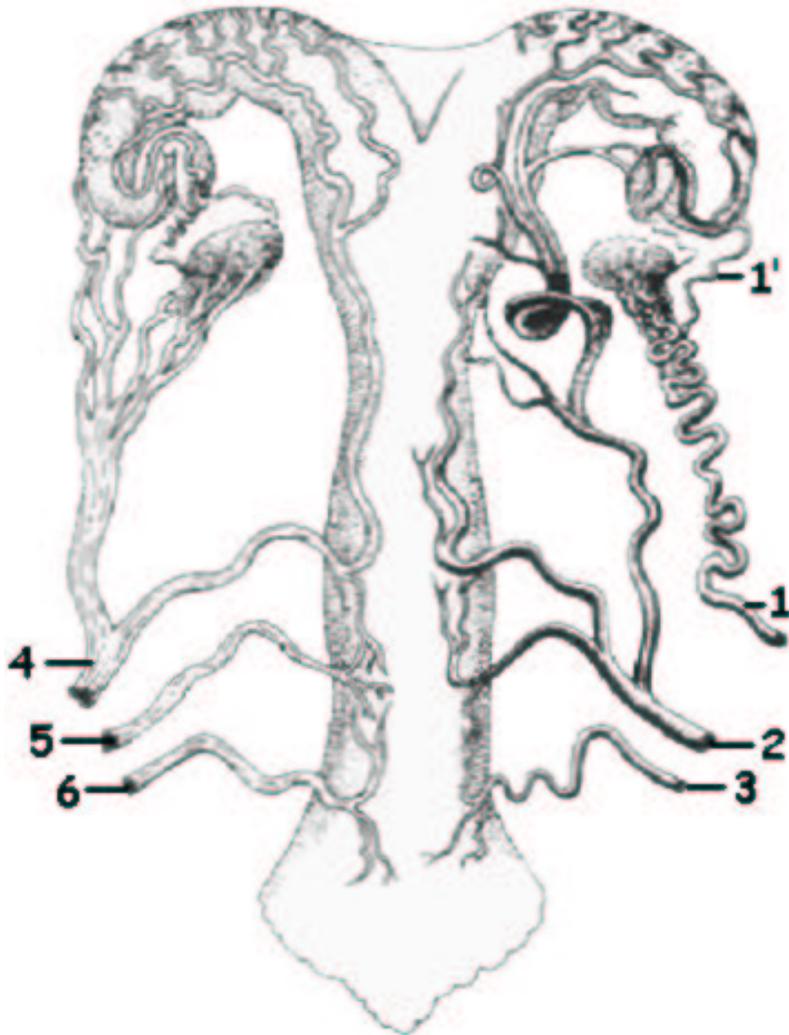
Location of reproductive organs relative to the rectum and urinary bladder. A. Cow, B. Sow, C. Mare, D. Bitch. Note species differences in anatomy of the cervix and mammary gland(s).



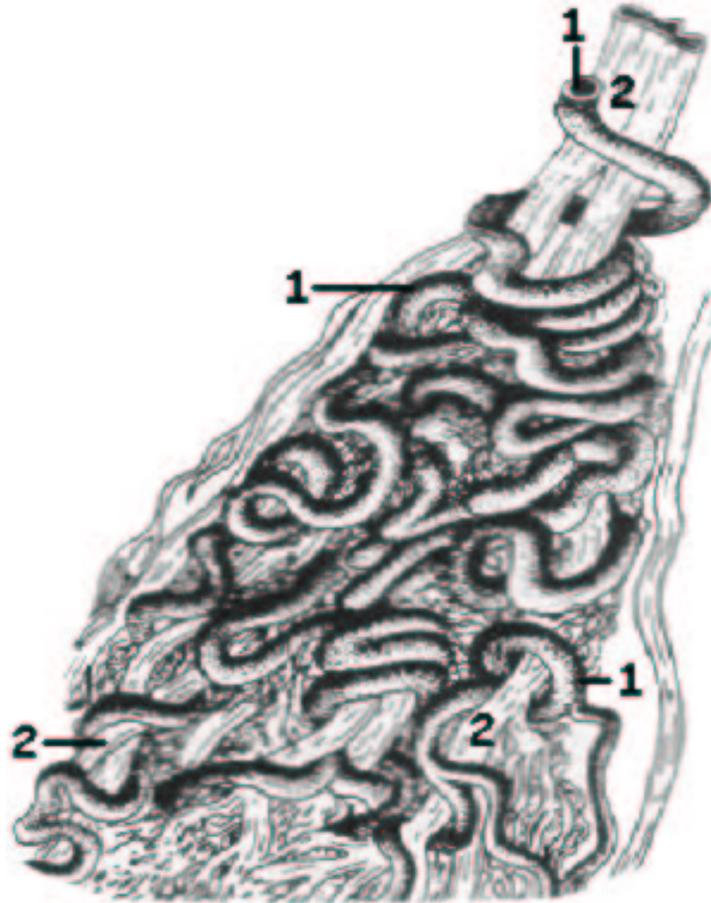
Genital tract comparisons among some domestic animals. 1, uterine horn; 2, uterine body; 3, cervix; 4, urinary bladder; 5, ureter; 6, urethral opening. The genital tracts are opened dorsally near the body of the uterus, and the opening is extended caudally to the labia to show the cervix and urethral opening. Note that the relative proportions of uterine horns, uterine body, and cervix varies among species. The illustrations are not drawn to scale, therefore size comparison here would be inaccurate.

D. Blood Supply

1. Ovarian artery
 - a. ovaries and oviducts
 - b. cranial part of the uterus
2. Uterine artery
 - a. major part of the uterus
- 3.. Vaginal artery
 - a. vagina



Blood supply to the reproductive tract fo the cow. The arteries are shown on the right side and the veins on the left. 1, ovarian artery/ 1' uterine branch; 2, uterine artery; 3, vaginal artery; 4, ovarian vein; 5, uterine vein; 6, vaginal vein.



Relationship of the ovarian artery of a ruminant and its branches (1) to those of the uterine vein (2).
The intertwining ensures a large area of contact.

III. Hormones of Female Reproduction

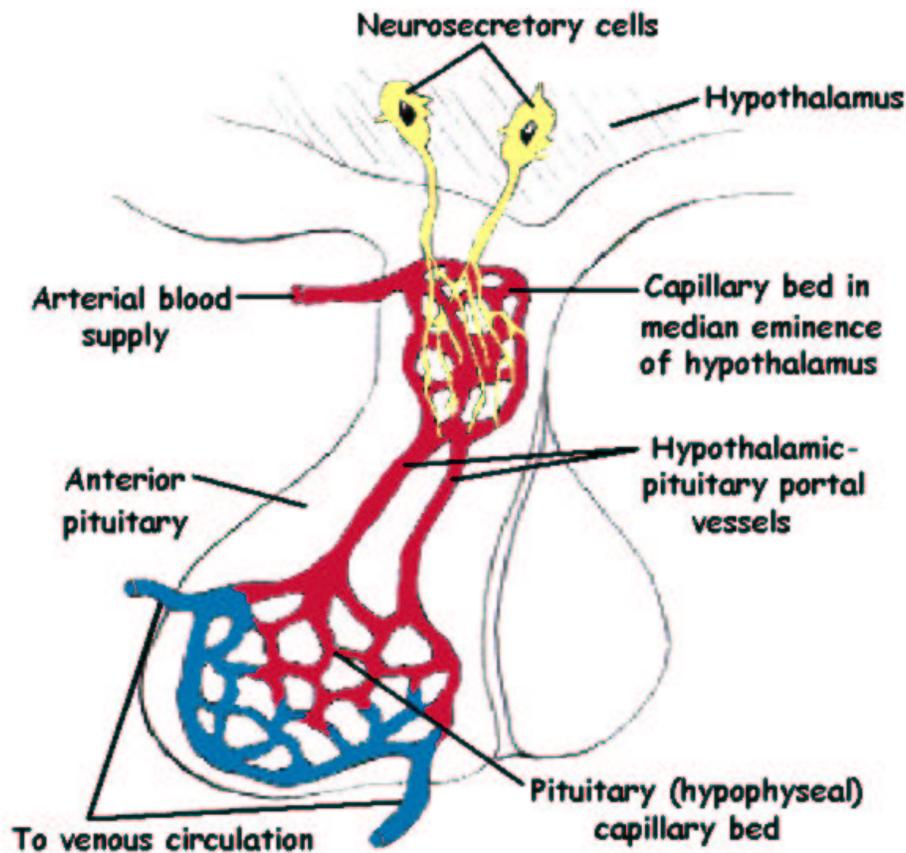
A. Estrogen – Steroid

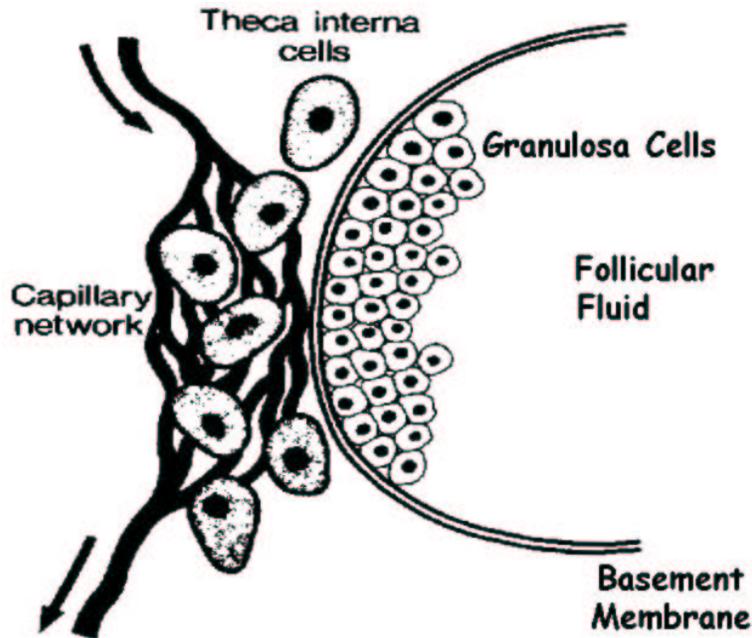
1. Produced by granulosa cells of the follicles on the ovaries
2. Major roles:
 - a. stimulate endometrial gland growth
 - b. stimulate duct growth in mammary gland
 - c. increase secretory activity of the uterine tubes
 - d. initiation of sexual receptivity
 - e. regulation of PGF
 - f. early union of epiphysis – ceasing of long bone growth

B. Progesterone – Steroid (Hormone of Pregnancy)

1. Produced by corpus luteum (CL) – yellow body
2. Major roles:
 - a. promotion of endometrial gland growth
 - b. stimulation of secretory activity of the oviduct and endometrial glands to provide nutrients for the developing embryo before implantation
 - c. stimulate mammary gland growth
 - d. prevent contractility of uterus during pregnancy
 - e. regulate secretions of gonadotropins

- C. Gonadotropins – Glycoprotein – (‘gonad-‘ gamete producing, ‘-trophin’ stimulating effect)
1. Produced and secreted by anterior pituitary
 - a. follicle stimulating hormone (FSH)
 - stimulates follicle growth
 - b. luteinizing hormone (LH)
 - ovulation of follicle
 - luteinization of granulosa cells to form corpus luteum (CL)
 - * luteinization – hypertrophy and vascularization of the ovulatory site
- D. Luteinizing Hormone Releasing Hormone (LHRH)/Gonadotropin Releasing Hormone (GnRH) (same hormone, two different names) - Peptide
1. Secreted from the hypothalamus
 - a. into the blood stream to affect a response in the anterior pituitary to secrete LH and FSH
- E. Prostaglandins – Eicosanoids – PGF_2 specifically
1. Secreted by the uterus
 2. Transported to the ovaries via uterine vein then diffusion across to the ovarian artery – an important mechanism, one pass through the lungs breaks down PGF_2
 3. Brings about the demise of the CL

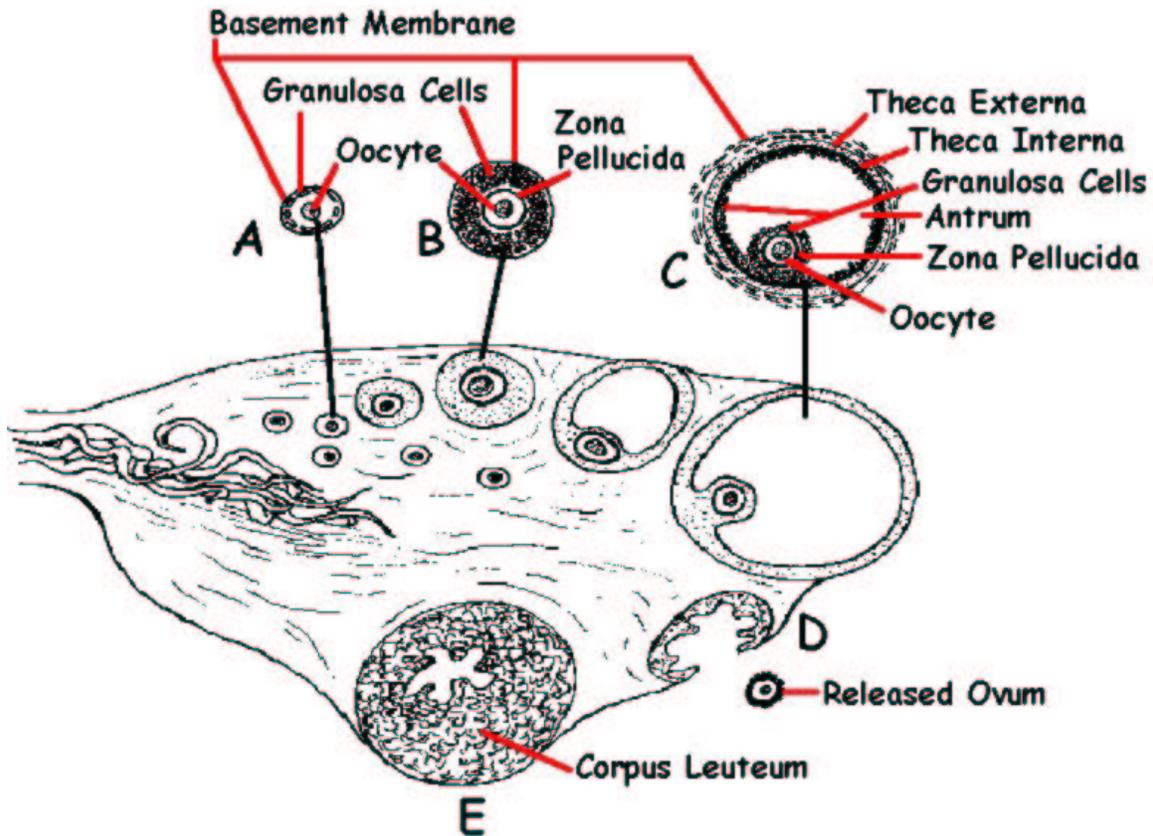




IV. Ovarian Activity and Follicular Growth

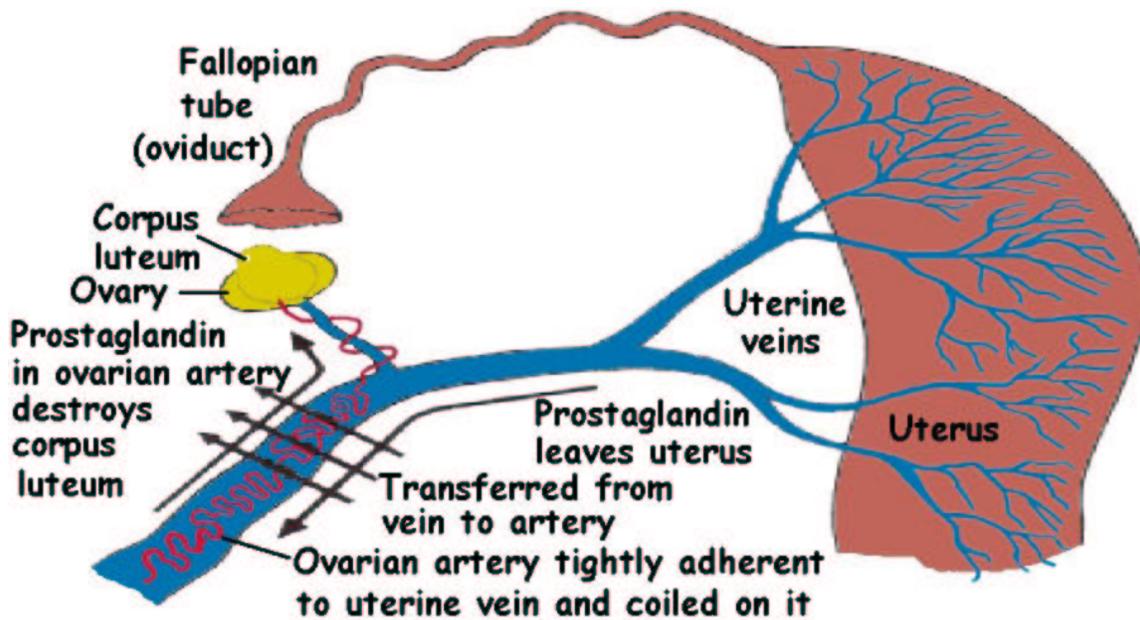
A. Puberty – beginning of reproductive life

1. Beginning of ovarian activity
2. Hormone dependent development of Graafian follicles from growing follicles
 - a. under the cyclic influence of LH and FSH which are released in response to the release of GnRH (LHRH) from the hypothalamus
 - LH and FSH which are then secreted from the anterior pituitary
 - at the same time on the ovary the interstitial cells begin to surround the basement membrane of the granulosa cells to form the theca interna and theca externa, these cells then become vascularized with a capillary bed
 - capillaries increase in size and are located next to the basement membrane
 - LH receptors form on the granulosa cells
 - under the influence of LH – androgens are produced by the thecal cells which cross the basement membrane, then the granulosa cells, under the influence of FSH, convert these androgens to estrogen
 - under the influence of estrogen, the antrum of the follicle is formed
 - FSH also stimulates the formation of LH receptors on the granulosa cells
 - the surge in LH, approximately 24 hours before ovulation, causes a reduction of FSH receptors that bring about a decrease in the conversion of androgens to estrogen
 - the LH receptors on the granulosa cells, which convert to luteal cells after ovulation, will produce progesterone
 - this site of ovulation now is called a corpus luteum (CL)



V. Ovarian Hormone Cycle

- A. PGF regresses CL
- B. LH and FSH increases
- C. LH increases androgen production on the theca, which then crosses the basement membrane to the granulosa cells
- D. FSH converts androgens to estrogen, estrogen increases
- E. LH receptors form on granulosa cells
- F. Antrum formed
- G. Increasing estrogen surge causes the release of LH
- H. LH surge starts = meiosis to the first polar stage
- I. LH surge promotes production of other prostaglandins which bring about rupture of the follicle at a stigma releasing the oocyte (ovulation)
- J. LH attaches to granulosa cells that then begin the conversion of the cells from estrogen-producing to progesterone-producing
- K. Ovulatory site becomes CL
- L. CL secretes progesterone which causes a decrease in the secretion of LH and FSH
- M. CL regresses after 14 – 15 days – progesterone decreases and the cycle starts over
- N. Demise of the CL
 1. PGF2 dependent



VI. Sexual Receptivity

- A. Female must be receptive to the male
 1. estrogen dependent from the antral follicle
 2. progesterone acts as a primer for the hypothalamus to be sensitive to estrogen
 - a. important after parturition
 - b. low progesterone, low reception or expression of estrus
- B. Estrous cycle – the onset of receptivity until the onset of the next period of receptivity
 1. estrus – sexual receptivity, ovulation usually at the end
 2. metestrus – period right after ovulation when CL is developing
 3. diestrus – period of mature CL
 4. proestrus – CL regression

Estrus	Metestrus	Diestrus	Proestrus	Estrus
18 hrs.	4 days	14 - 15 days	24 - 25 hrs.	18 hrs.
	Luteal Phase		Follicular Phase	

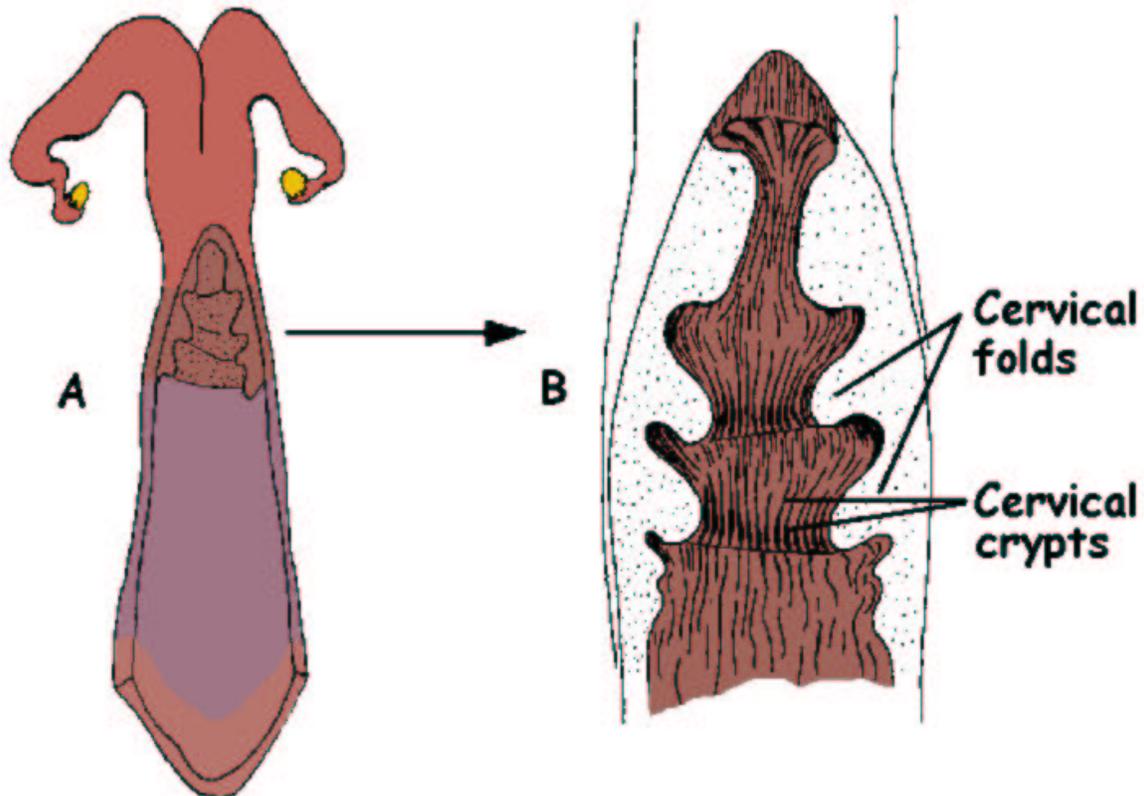
- C. Types of estrous cycles
 1. monstros – one per year
 - a. wild carnivorous mammals – dogs (bitch) are an exception
 2. polyestrous – repeated cycles
 - a. cattle – most domestic animals
- D. Photoperiod – relative length of altering periods of light and dark
 1. KNOW TABLE 13.1 pg. 385...
 2. Seasonal breeders
 - a. queen, doe, ewe, and mare
 3. no effect from photo period – cow?
- E. Nutrition – effects age at puberty, affects days post birth for the resumption of

ovarian activity and uterine involution (involution - return to normal)

VII. Fertilization and Pregnancy

A. Transportation of oocyte and spermatozoa

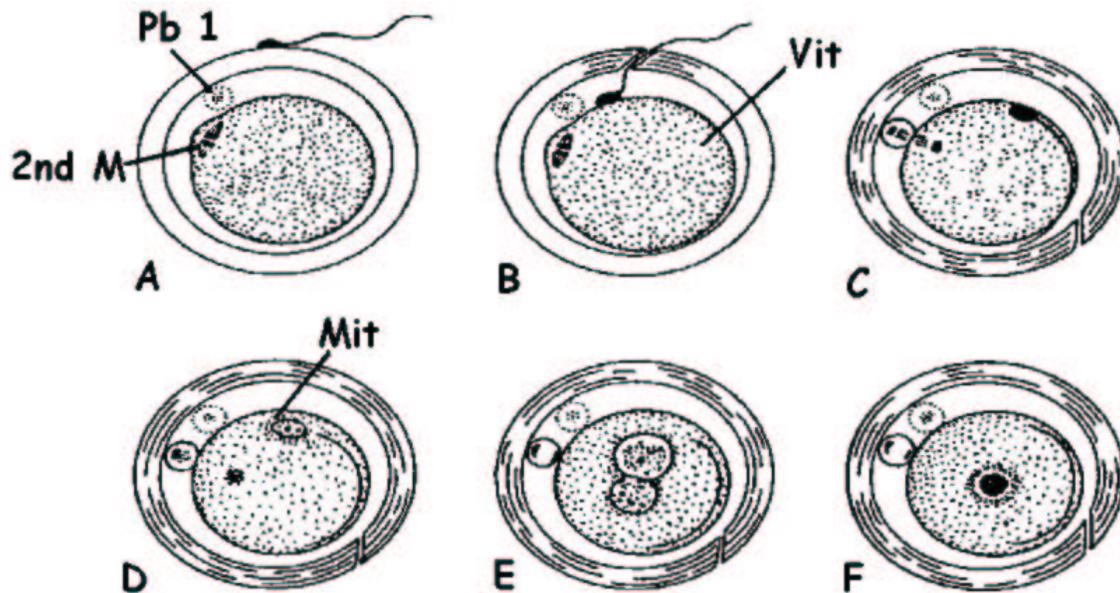
1. oocyte is caught by the contractile fimbriae
2. within oviduct, the oocyte is moved by cilia and oviduct motility
3. spermatozoa, released by ejaculation of the male, travel to the oviduct via uterine contractility among other mechanisms
4. spermatozoa are caught in various uterine structures (crypts and folds) to assure viable sperm present the time the oocyte is present in the oviduct
 - a. reservoirs at the junction of the uterine body and the uterine tubes
5. spermatozoa must undergo capacitation
 - a. changes necessary for penetration of the zona pellucida and subsequent fertilization of oocyte
 - i. requires several hours – 8 hrs. in the bovine
6. ovulation occurs after the onset of sexual receptivity (estrus) – allows time for capacitation to take place
7. oocytes are viable for 12 – 18 hrs.
8. spermatozoa are viable for 24 – 48 hrs. (cow, ewe, and sow), up to 90 hrs. for bitch and 120 hrs. for a mare



B. Fertilization is the fusion of male and female gametes, oocyte and spermatozoa

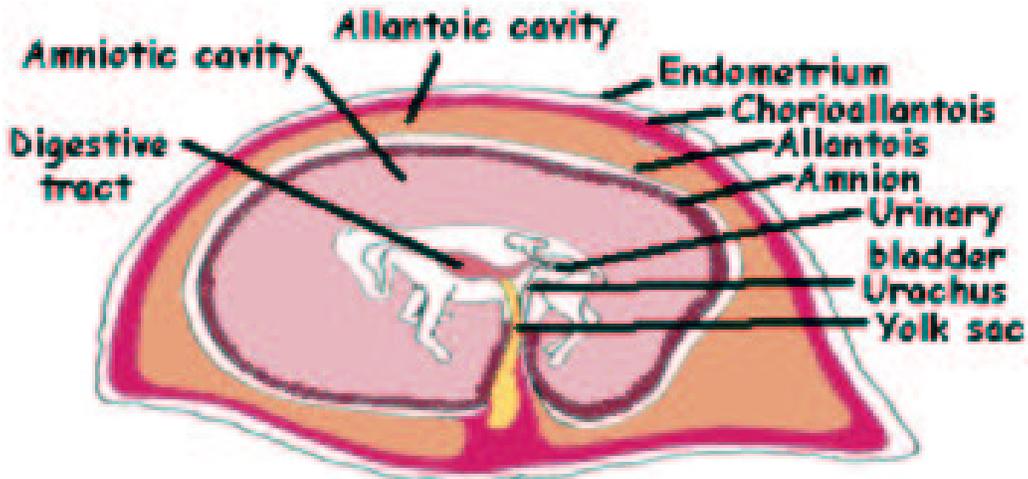
1. Penetration of zona pellucida by sperm

- a. enzymes involved: hyaluronidase and acrosin
- b. meiosis resumes and second division takes place
- c. once penetration takes place, the zona reaction takes place to prevent more spermatozoa from entering the oocyte
- d. pronuclei develop from each gamete, they join creating a nucleoli where the haploid number of chromosomes unite creating a full complement

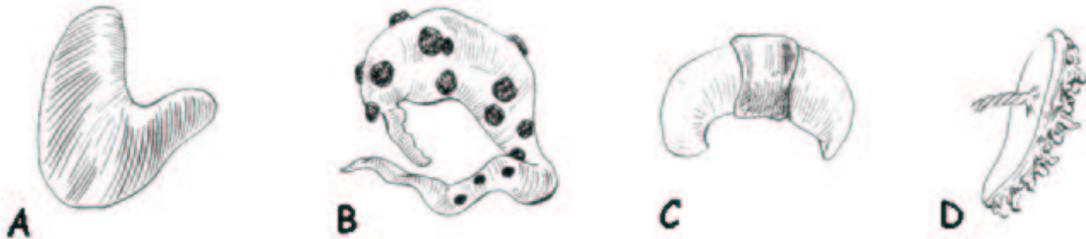


- e. the zygote remains in the uterine tube for 3 – 4 days, then the developing CL must be fully functional for the zygote to survive in the uterus
 1. progesterone is the hormone of pregnancy
 - minimizes uterine contractions that are present during estrogen dominance of the estrous cycle
 - causes the development to the glandular endometrium that secretes uterine milk to nourish the developing embryo before implantation
- f. 16 – 32 cell stage of the developing embryo is called the morula
- g. a cavity forms within the morula by day 6 – 8 and the cell mass is called the blastocyst
2. three phases or stages
 - a. oocyte period
 - i. until blastocyst attaches to endometrium
 - ii. nutrition from yolk sac and uterine milk
 - b. embryonic period
 - i. until about day 45
 - ii. rapid growth – major tissues, organs, and systems
 - iii. become recognizable by ultrasound
 - iv. nutrition from mother = uterus and the developing placenta
3. placentation
 - a. development of extraembryonic membranes
 - b. three parts

- i. chorion
 - outer layer next to the endometrium or the outermost tissue
- ii. allantois
 - middle layer which fuses with the chorion
- iii. amnion
 - the innermost layer
 - envelops the fetus and contains fluid derived from fetal urine and respiratory secretions
 - * the amniotic fluid protects the fetus from external shock
 - * prevents adhesion of fetal skin to the amnion
 - * aids in dilation of the cervix and lubrication during parturition



Fetus of horse within the placenta. The chorioallantois is the combination of the allantois with the chorion. Umbilical arteries and veins (not shown) occupy the space between the outer allantois and chorion. The chorion is associated intimately with the endometrium. The inner allantois is fused with the amnion.



- c. types of placentation
 - i. diffuse – attachment is continuous throughout the entire surface of the endometrium
 - horse and pig
 - ii. cotyledon – attach at mushroom-like structure throughout the endometrium
 - ruminants such as the cow, sheep, and goat

- fetal side is called cotyledons
- maternal side is called caruncle
- together the unit is called placentome
- iii. discoid – human
 - disk-shaped area
- iv. zonary – dog and cat
 - girdl-like band

V. Hormones

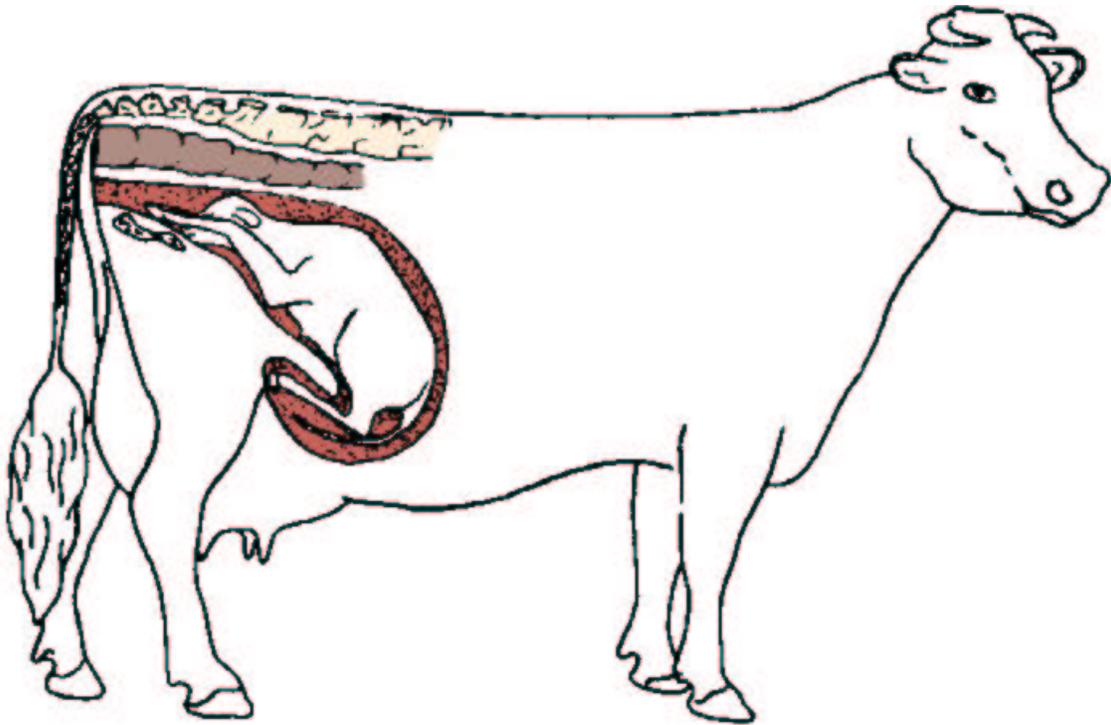
A. Progesterone

1. source: CL and Placenta
2. varies among species
 - a. CL – cow, bitch, queen, sow, and doe – CL is needed for entire or at least most of pregnancy
 - b. CL of the mare till about day 100, the placental source (PMSG) from endometrial cups
 - c. ewe till about day 60 then placental

VI. Pregnancy Diagnosis

- A. Ultrasound at day 26 in cows, day 22 in horse – depending on experience
- B. Rectal palpation at 32 days in cows
- C. At 3 months (90 days) buzzing fo the uterine artery – fremitus
- D. Fetal membranes and small placentomes at 3 months
- E. 4 – 5 months, the fetus is over the brim of the pelvis – very difficult to palpate
- F. 7 months – bump the calf on the left side
- G. Biological test
 1. PMSG and the rabbit dies
 2. HCG in humans at day 8 after ovulation this is one day after implantation
 - a. HCG is secreted from the placenta to signal maintenance of CL

VII. Parturition: delivering of the fetus and placenta



Normal presentation of the bovine fetus.

A. Signs of pending parturition

1. enlarged vulva
2. sinking of the area around the tail head – hormone relaxin relaxes ligaments
3. leaking milk
4. restlessness and wanting to leave herd
5. respiratory rates increase
6. some species build nest

B. Hormonal changes associated with parturition

1. increased production of fetal cortisol
2. estrogen increases, thus increasing uterine contractility
3. estrogen increases secretion of PGF which regresses the CL and its secretion of progesterone
4. release of oxytocin increases contractility from PGF sensitizing the uterus
5. abdominal and uterine muscle contractions expel the fetus through contractions and continued dilation of the cervix, pelvic symphysis, and pelvic ligaments

C. Stages of parturition

1. uterine contractions
2. contractions associated with expulsion of the fetus
3. expulsion of the placenta

VIII. Involution of the Uterus (returns to normal)

- A. Points of placental attachment must slough
- B. Myometrium contracts and cells shorten
- C. New epithelium heals endometrium
- D. Reduces in size and restores endometrial glands by day 21 – 35
- E. Estrus is usually observed by day 35

- F. Normally completely repaired for rebreeding in cows by day 45
 - 1. energy state, disease and production level influence rate of involution
- G. Mare has a foal heat 6 – 13 days postpartum – low fertility, but does ovulate and can become pregnant
- H. Ewe and sow complete involution by day 24 – 28
 - 1. weaning of pigs can induce ovulation within 3 – 5 days in sows
 - 2. photoperiod is determining factor in ewe and mare