
VET-114
Animal Anatomy and
Physiology 2

Lesson 1

Urinary and Reproductive Systems

Chapters 16, 17, 18

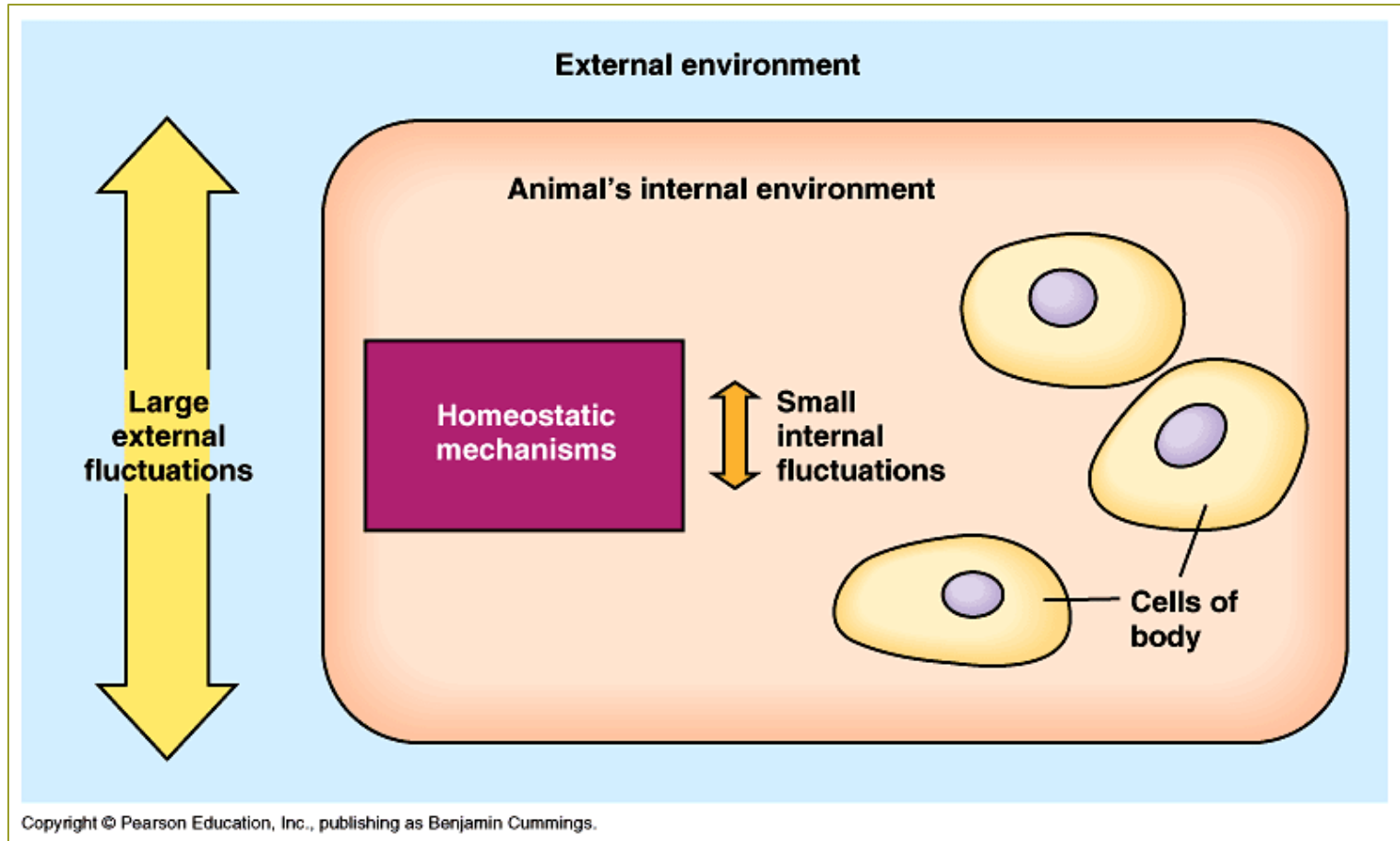
The 8 Secrets of Life!

Things to Think About While Studying
Anatomy and Life! 😊

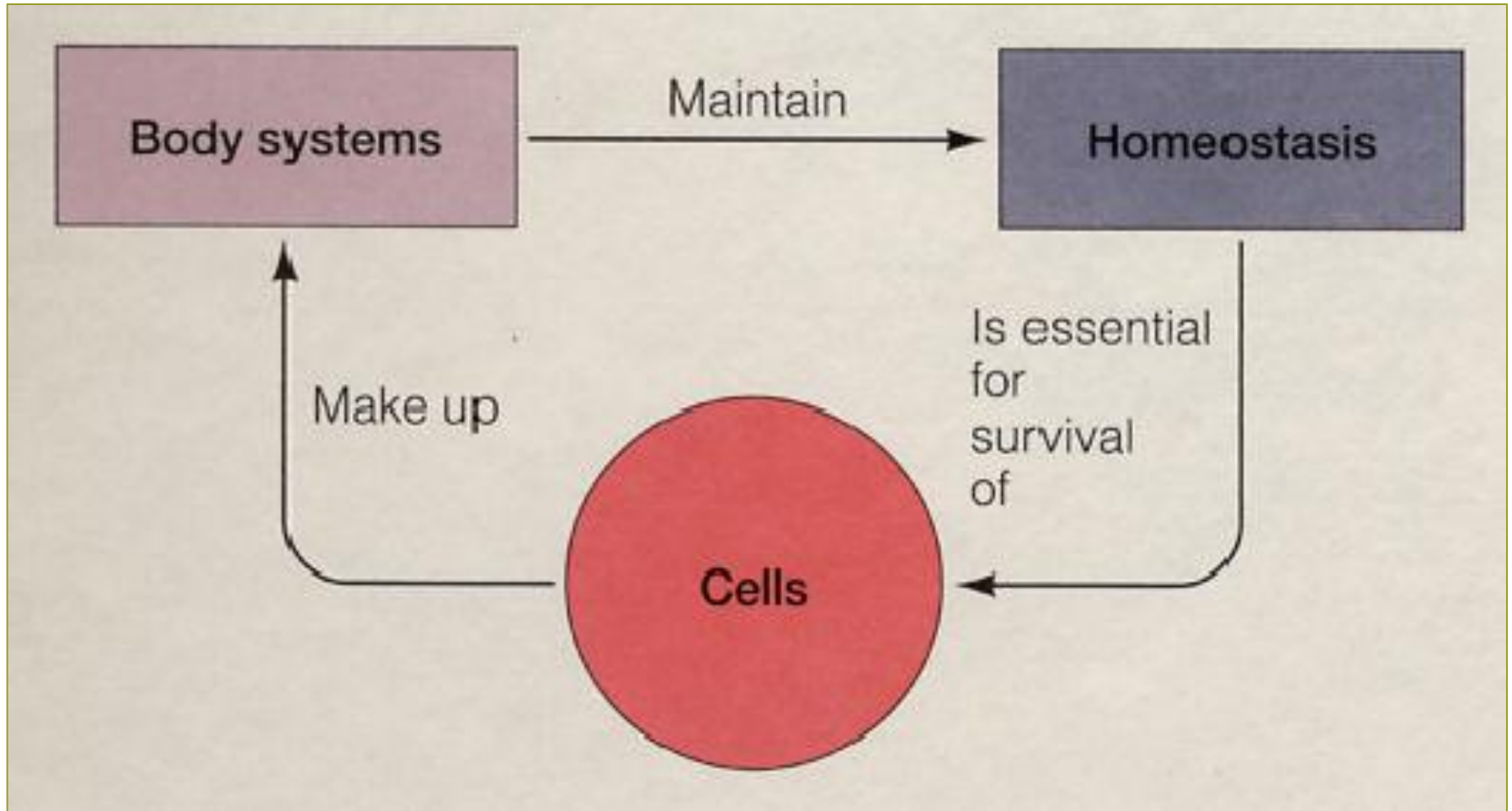
The 8 Secrets of Life! 😊

1. Balance is the key!
2. We are all “walking salt water aquariums”!
3. The solution to pollution is dilution!
4. Use it or lose it!
5. Get tough or die!
6. It's not polite to fool Mother Nature!
7. Recycle resources!
8. Thoughts are things!

1. Balance Is the Key!

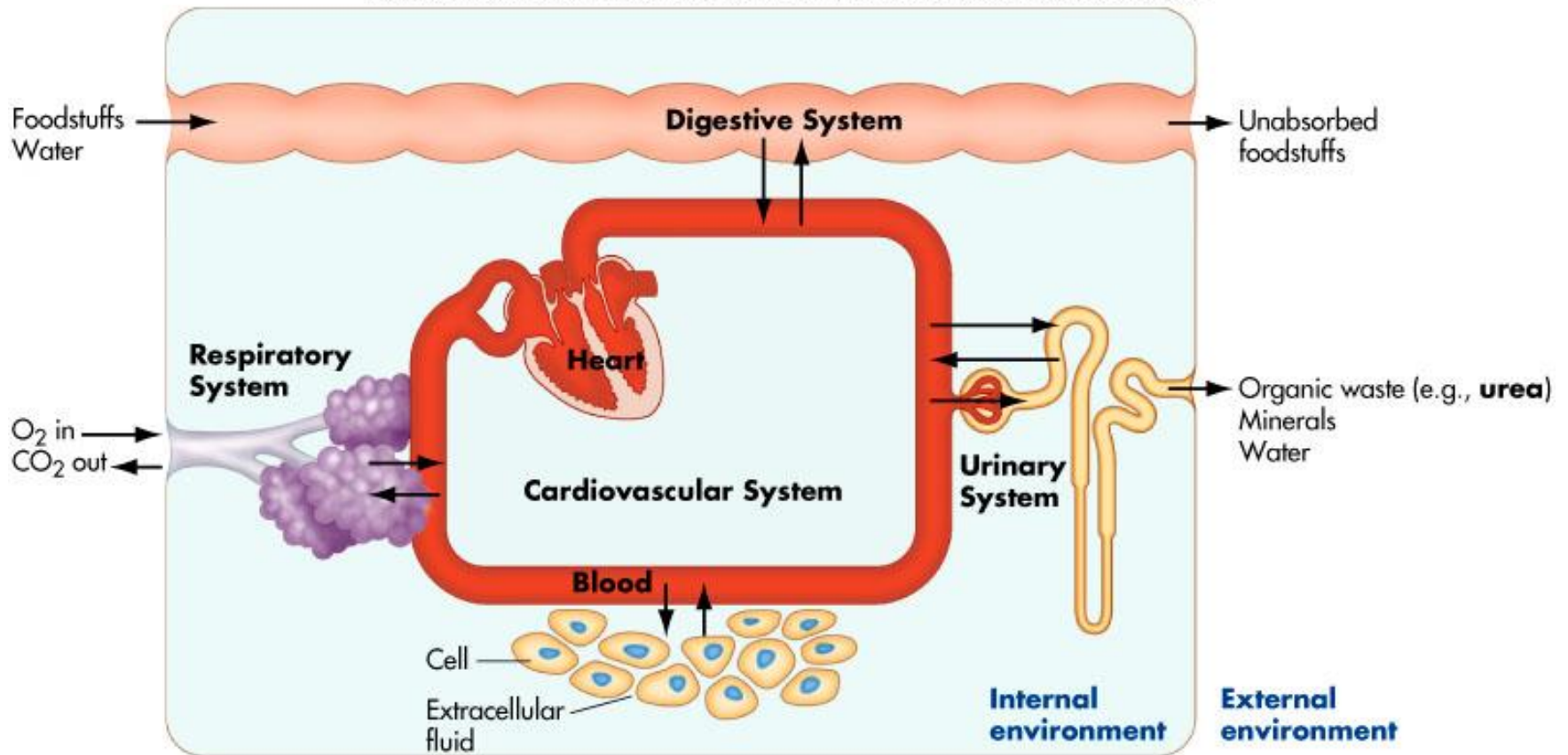


Healthy Cells = Healthy Body!

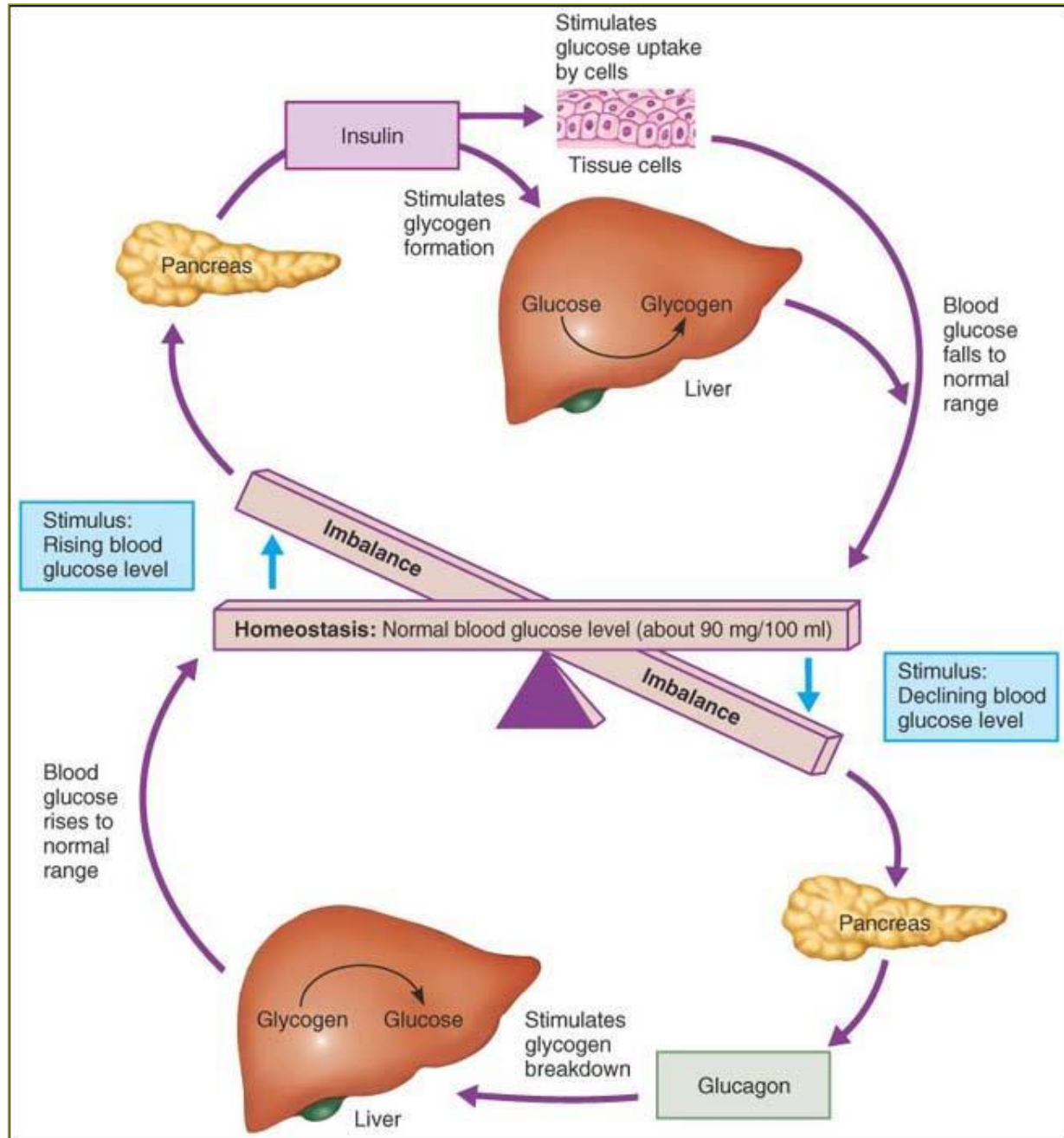


Internal Medicine Homeostasis

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Glucose Homeostasis



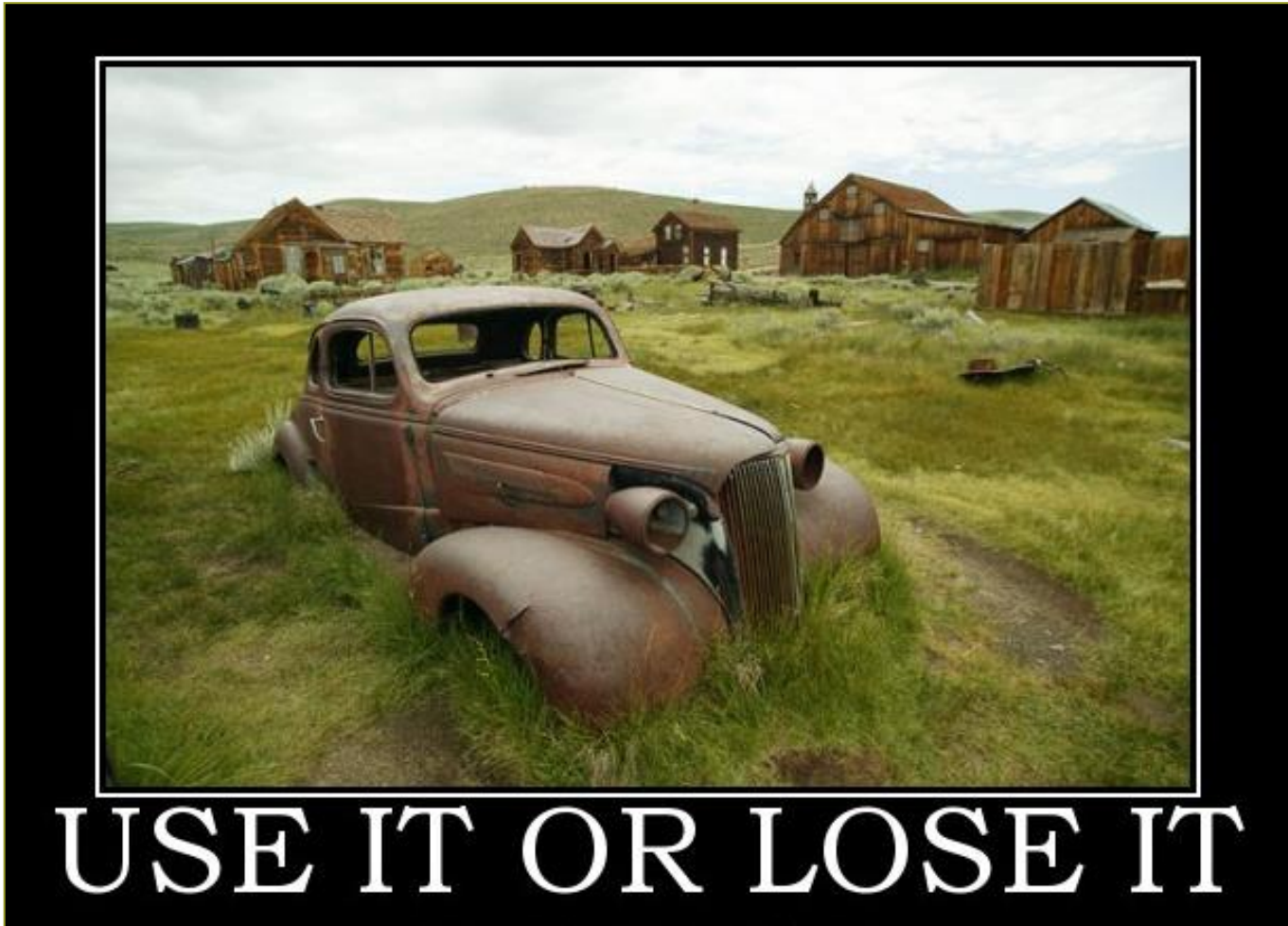
2. We Are All “Walking Salt Water Aquariums”!



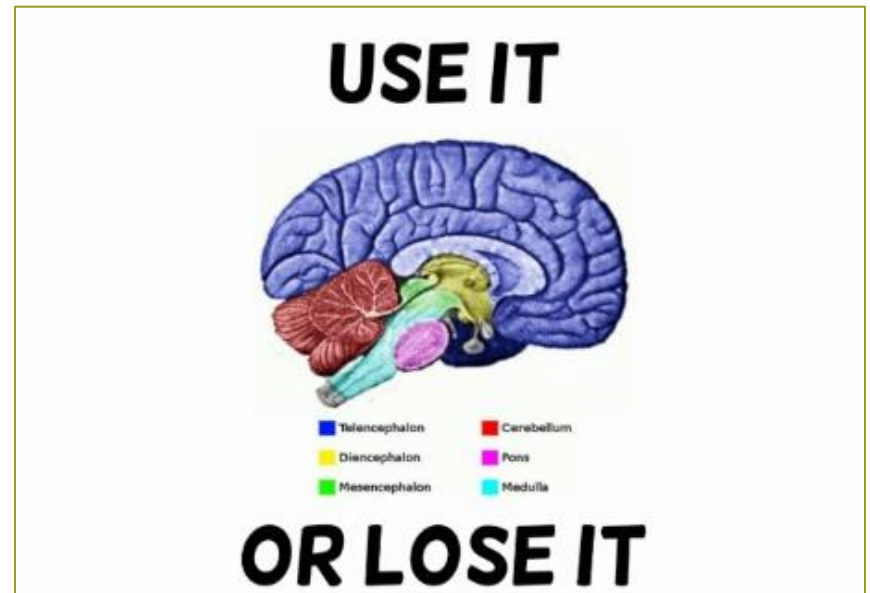
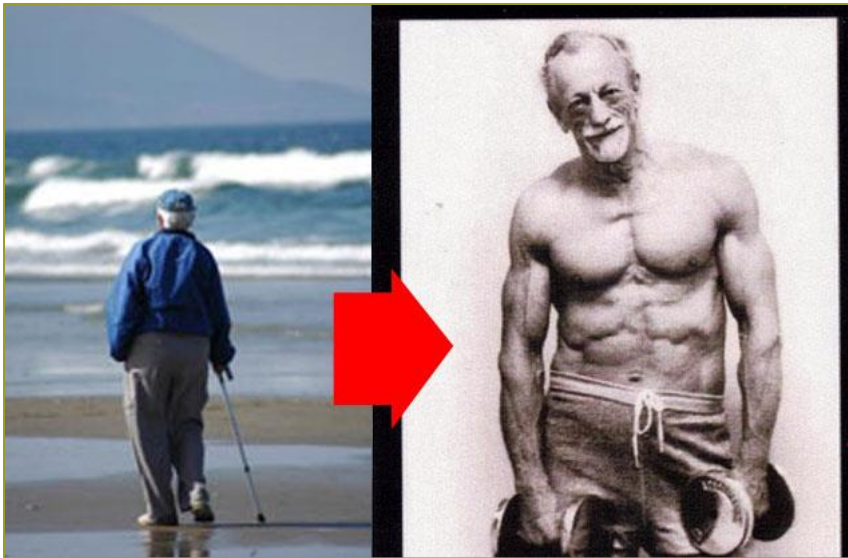
3. The Solution to Pollution Is Dilution!



4. Use It Or Lose It!



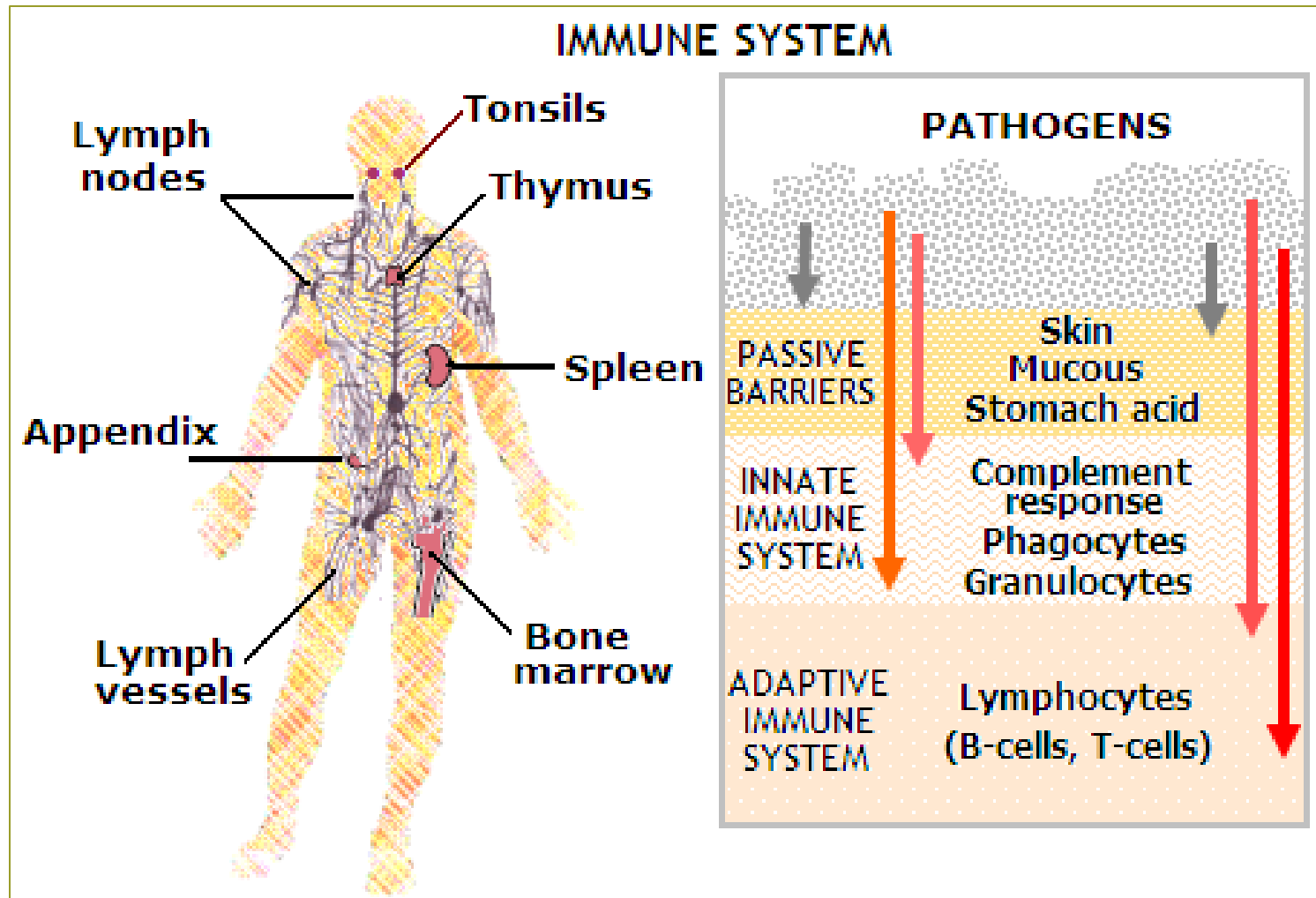
Yep! Use It Or Lose It! 😊



5. Get Tough Or Die!

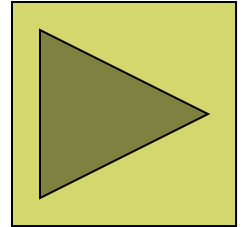


Example: Animal Immune System



6. It's Not Polite To Fool Mother Nature!

<http://www.youtube.com/watch?v=LLrTPrp-fW8>

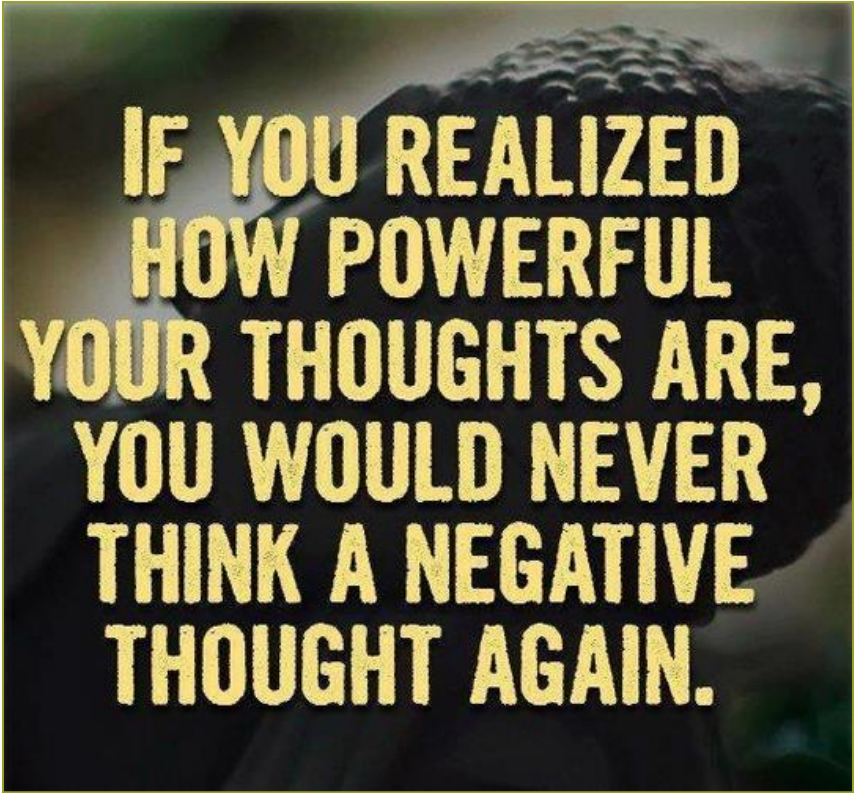


Recycle Resources!

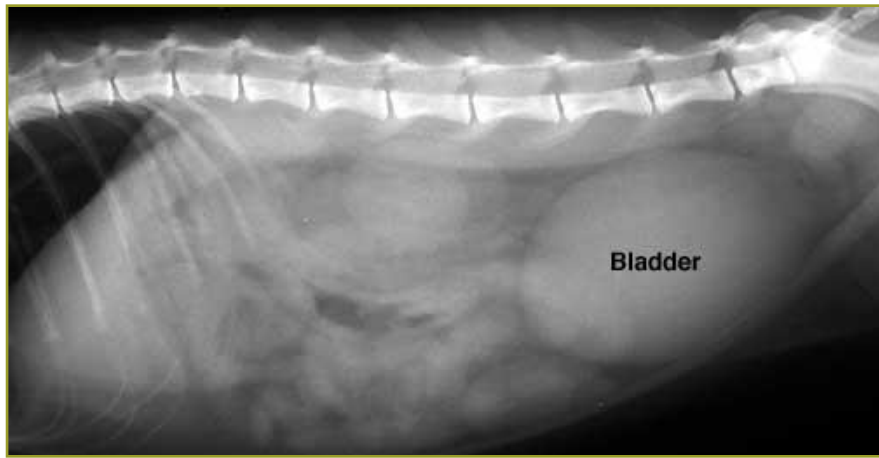


Thoughts Are Things!

**THOUGHTS BECOME
THINGS...
CHOOSE THE GOOD
ONES!**

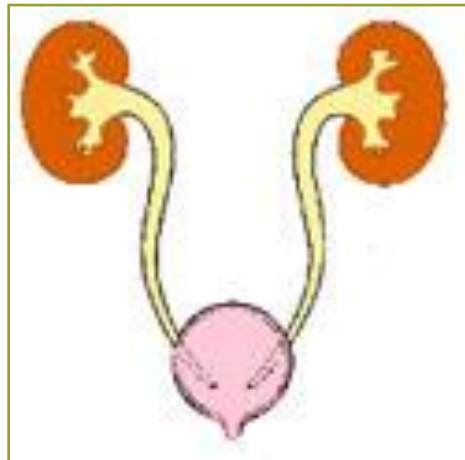


**IF YOU REALIZED
HOW POWERFUL
YOUR THOUGHTS ARE,
YOU WOULD NEVER
THINK A NEGATIVE
THOUGHT AGAIN.**



The Urinary System

Chapter 16



Pages 374-386

Textbook Learning Objectives

Chapter 16 – Page 374

- List and describe the functions of the kidneys.
- Describe the gross and microscopic anatomy of the kidneys.
- List the main blood vessels associated with the kidneys.
- Define the terms *glomerular filtration*, *renal threshold*, *polyuria*, *polydypsia*, *urolithiasis*, and *uremia*.
- Describe the production of urine.
- Describe the mechanisms that affect urine volume.
- Describe the structures and functions of the ureters and urinary bladder.
- Describe the processes involved in micturition.
- Describe the structure and functions of the urethra.

Topic 1

Discuss the structures and functions of the urinary system



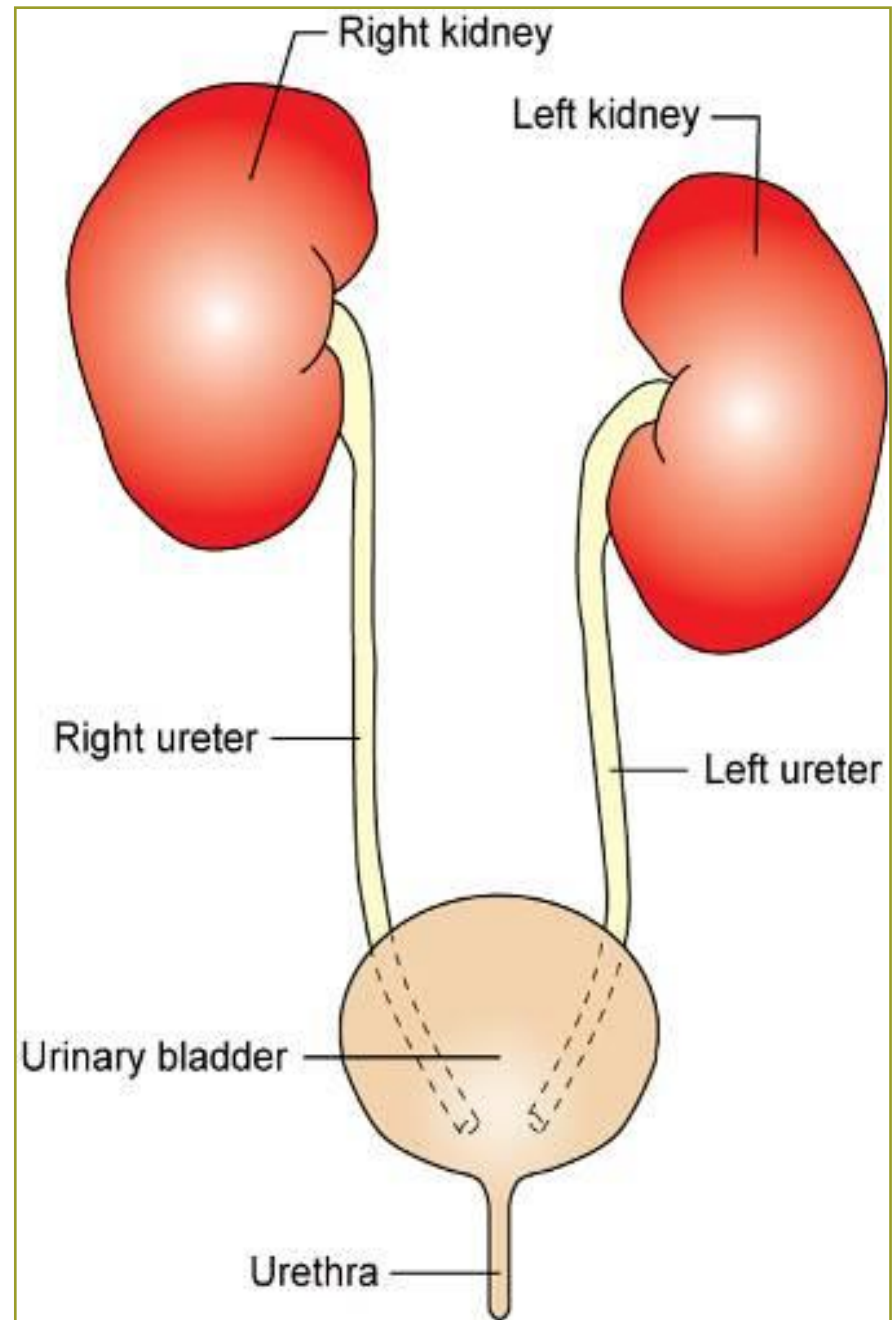
Waste Excretion in Animal's Body

- Separation of wastes from body fluids and eliminating them
 - Respiratory system: CO₂ and water vapor
 - Integumentary system (sweat glands) : water, salts, lactic acid, urea
 - Digestive system: water, salts, CO₂, lipids, bile pigments, cholesterol
 - Urinary system: urea, many metabolic wastes, toxins, drugs, hormones, salts, H⁺ and water

Urinary System Gross Anatomy

Figure 16-1, Page 375

- Urology
- Kidneys
- Ureters
- Urinary bladder
- Urethra

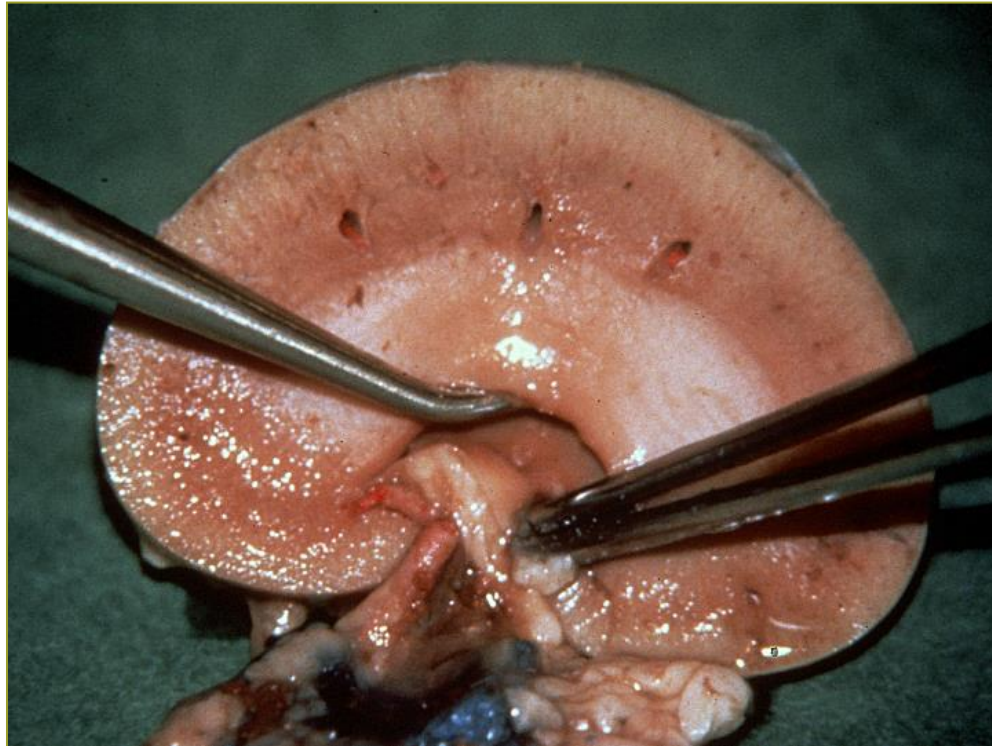


Urinary System Functions

- Maintain homeostasis through:
 - Filtration, reabsorption, secretion
 - Fluid balance regulation
 - Acid-base balance regulation – pH
 - Production of hormones

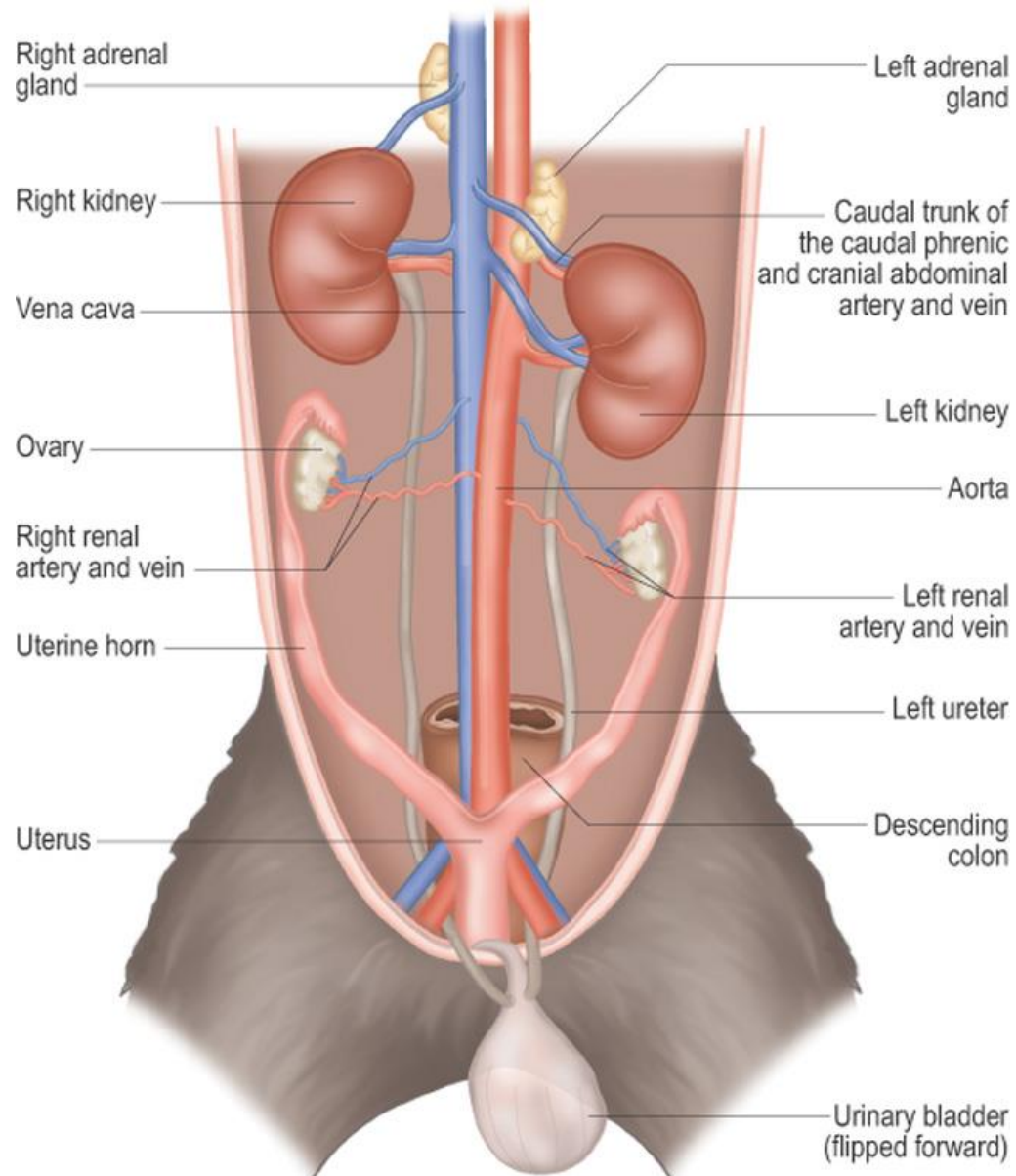
Topic 2

Describe the gross anatomy of the kidney and urinary system



Kidneys

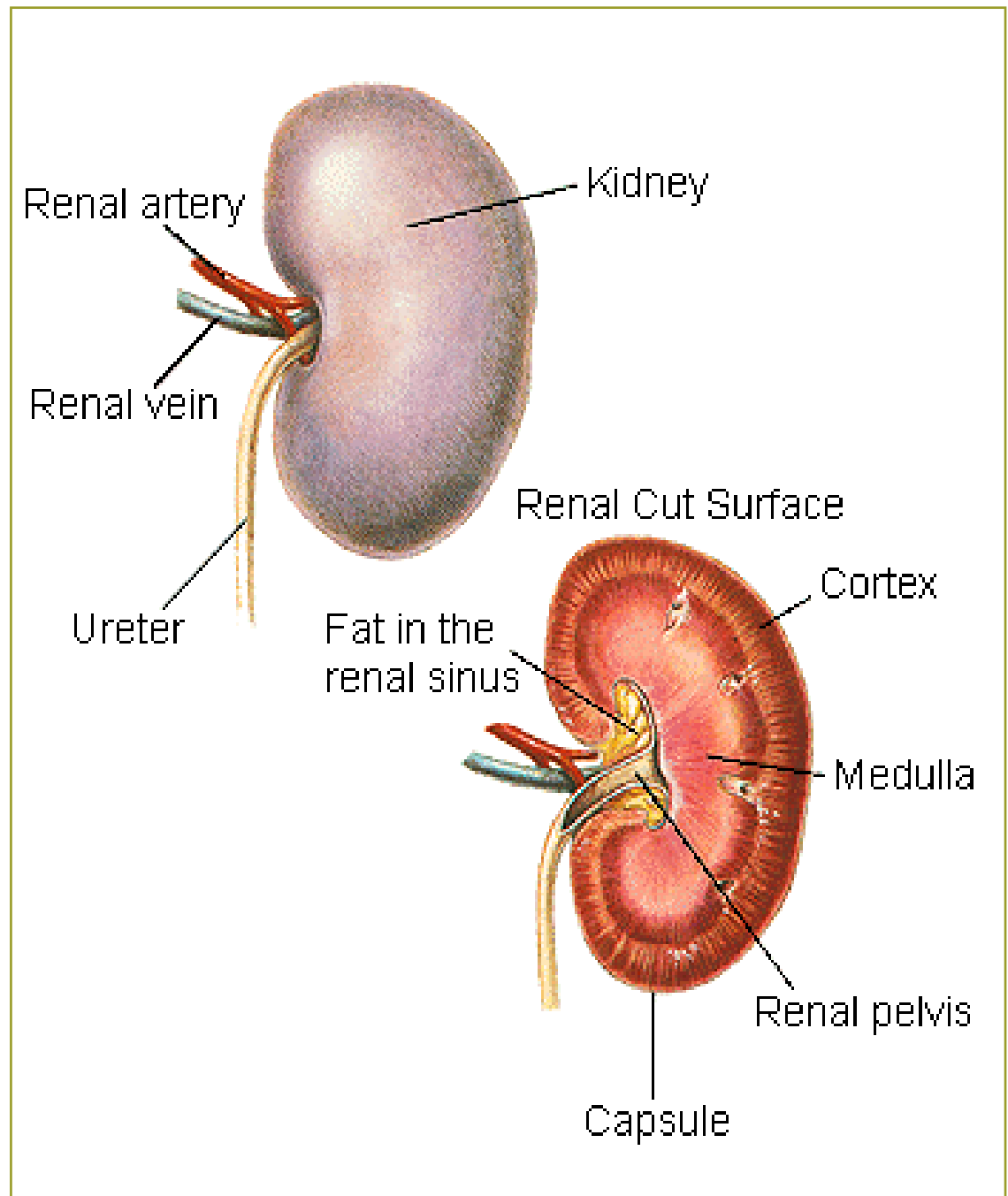
- Located in dorsal abdominal area ventral to and on either side of the first few lumbar vertebrae
- Retroperitoneal to abdominal cavity; between peritoneum and dorsal abdominal muscles
- In most domestic animals, right kidney is more cranial than the left
- Thick layer of peri-renal fat usually surrounds kidneys to help protect them from pressure exerted by surrounding organs



Renal Anatomy

Figure 16-2, Page 376

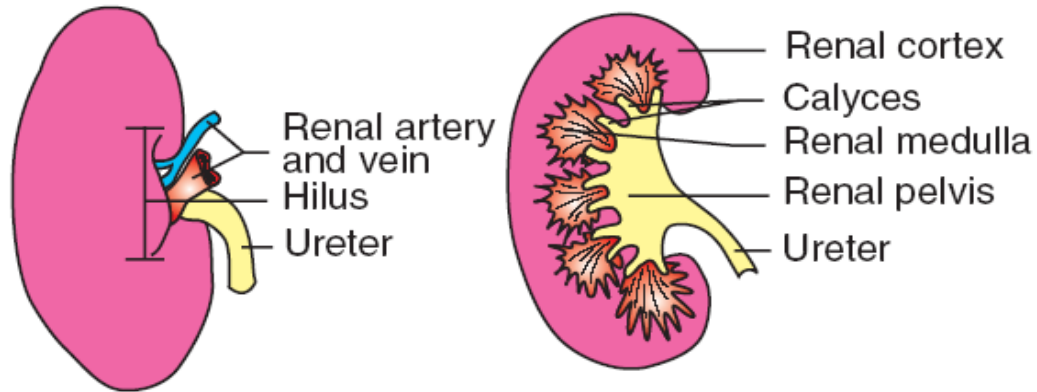
- Renal cortex
- Renal medulla
- Renal hilus
- Renal pelvis
- Renal capsule
- Renal artery
- Renal vein



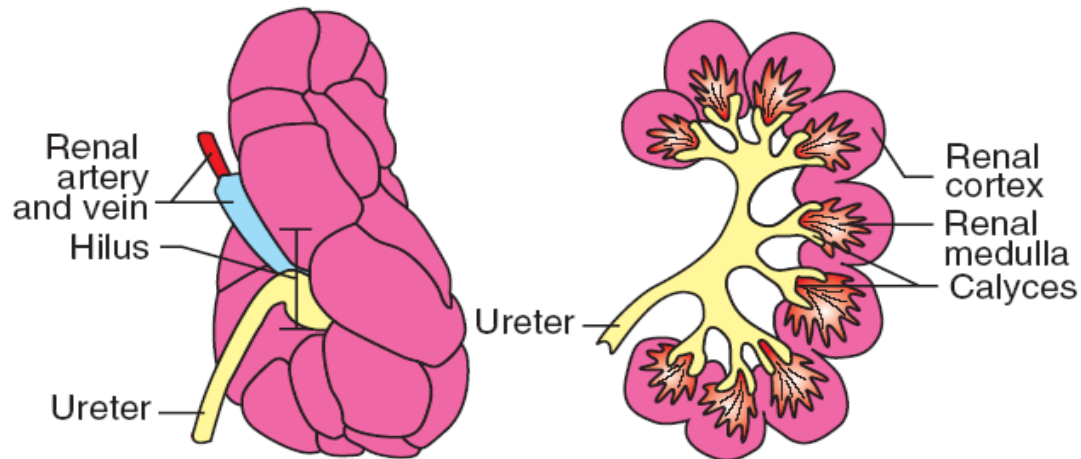
Comparative Renal Anatomy

Figure 16-2, Page 376

A

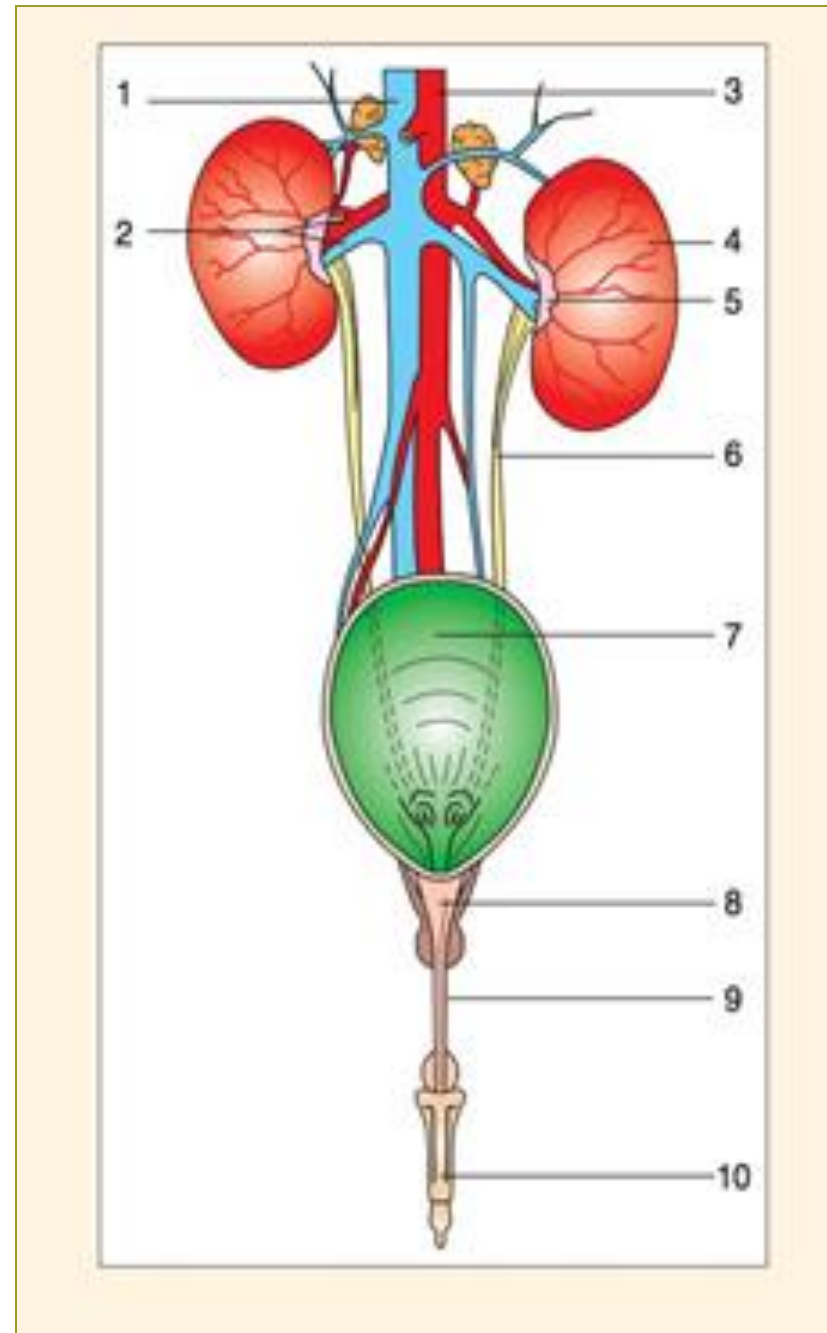


B



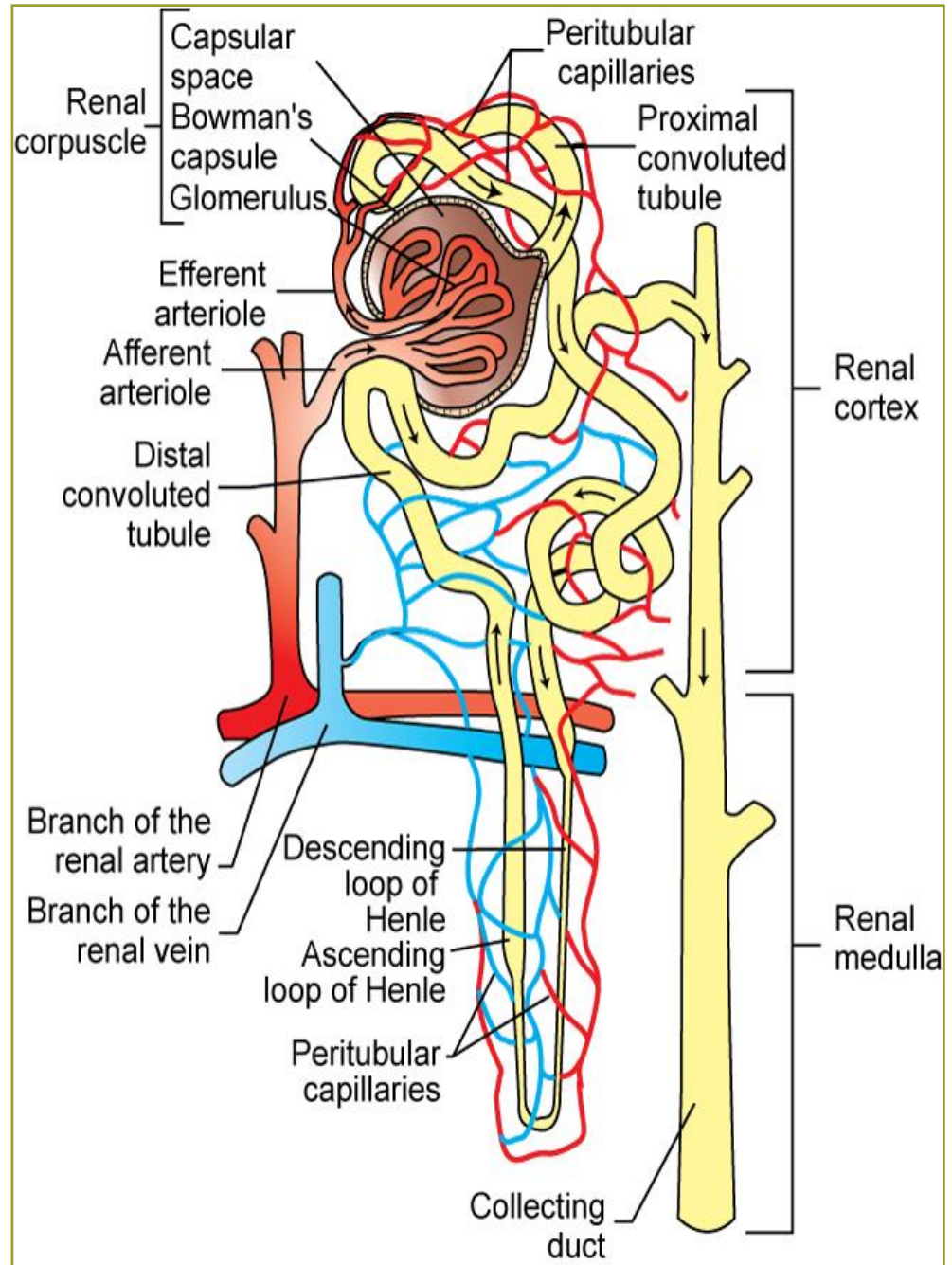
Identify the Structures of the Male Urinary System

**Bassett Lab Manual –
Page 404**



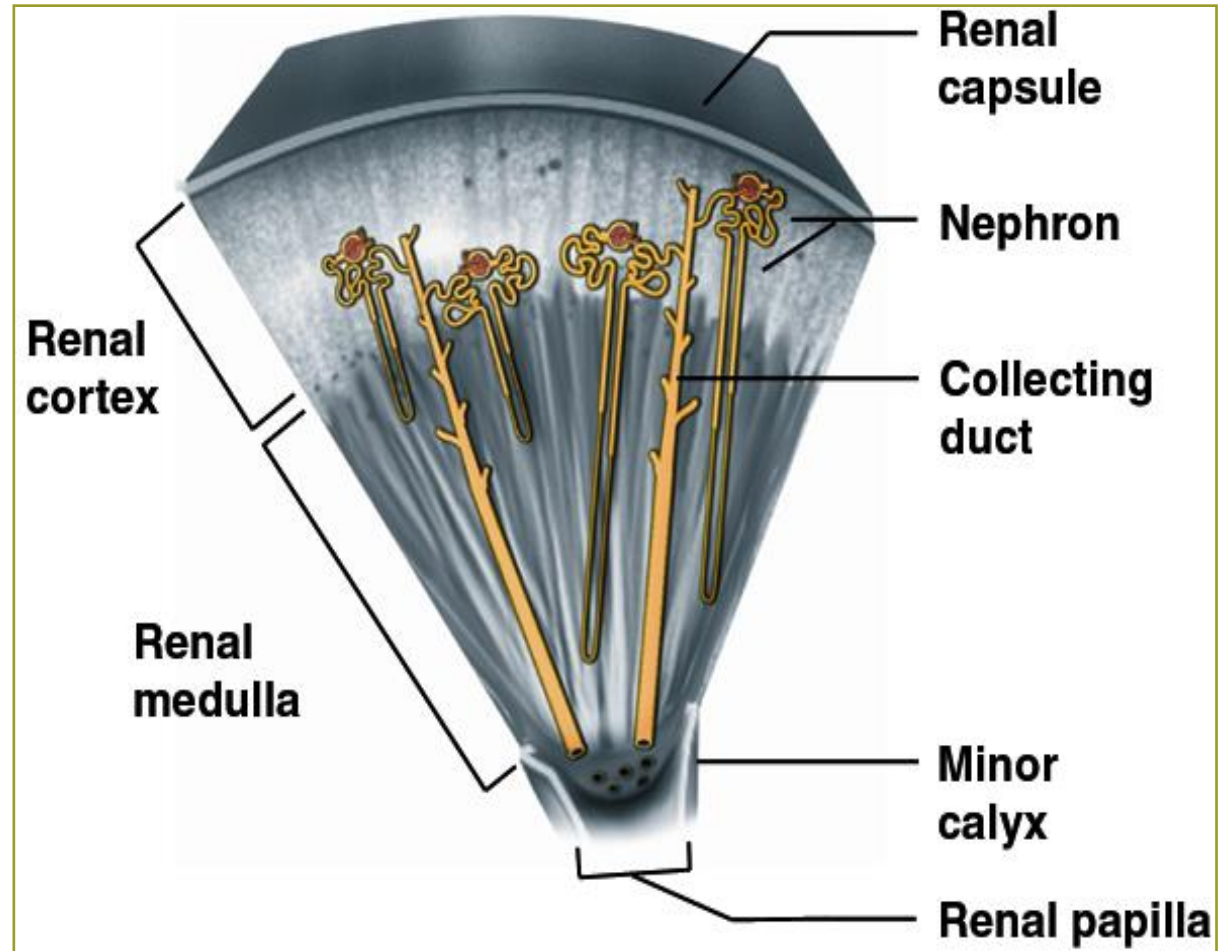
Topic 3

Describe the microscopic anatomy of the nephron, explaining the function of each structure in the nephron



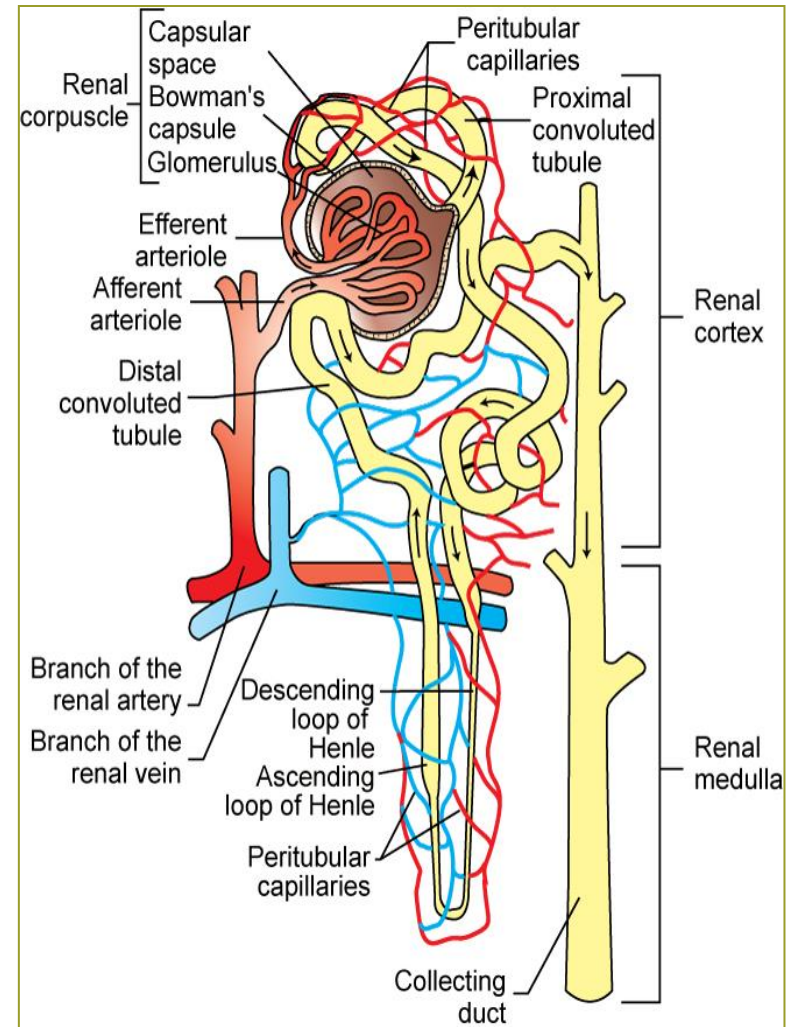
Microscopic Anatomy of Kidney

- Nephron
- 1 million nephrons per kidney



Microscopic Anatomy (Histology) of Kidneys

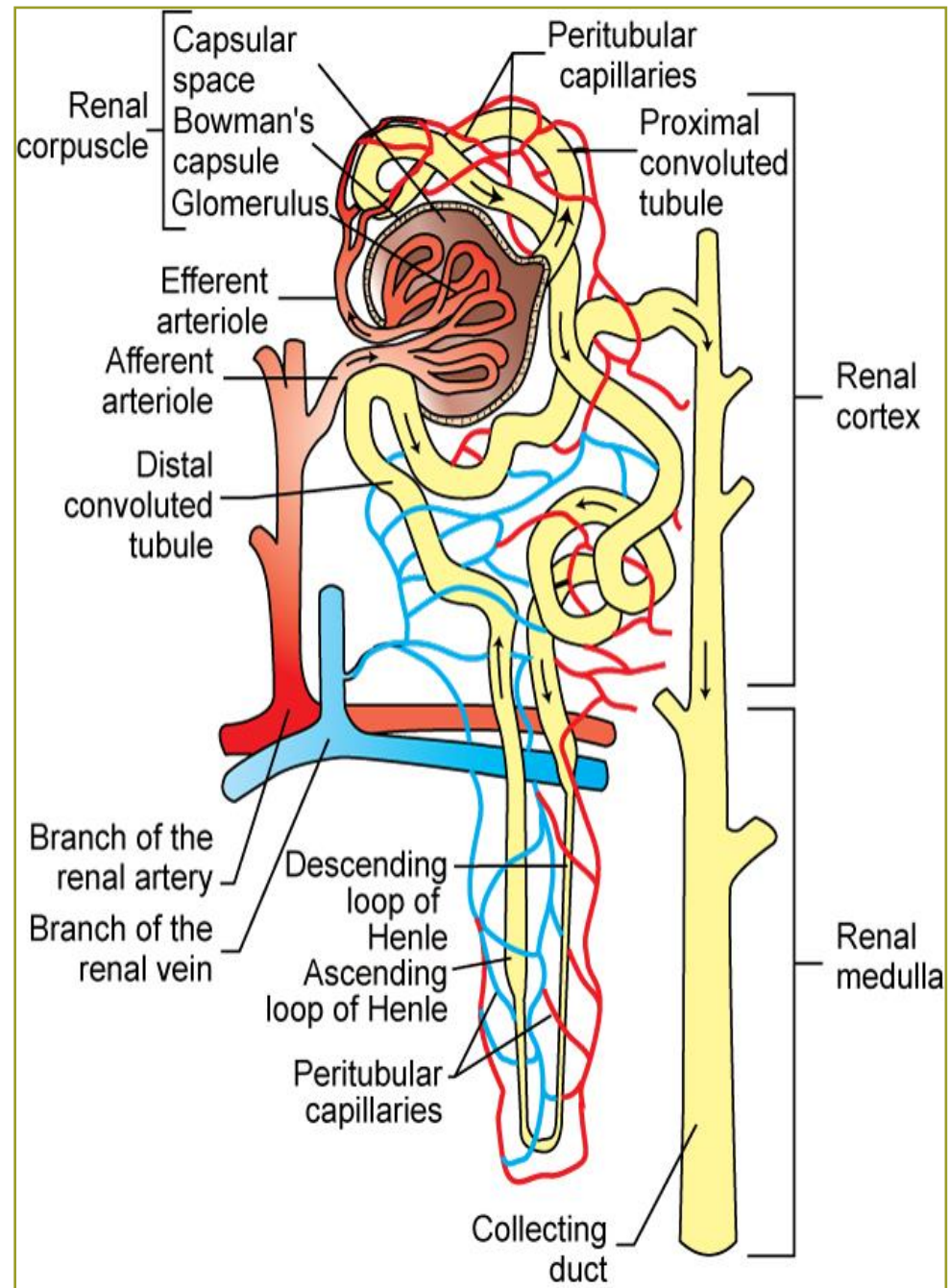
- Nephron: basic functional unit of kidneys
- Number of nephrons per kidney varies
- Each nephron consists of a renal corpuscle, proximal convoluted tubule, loop of Henle and distal convoluted tubule



Nephron Structure

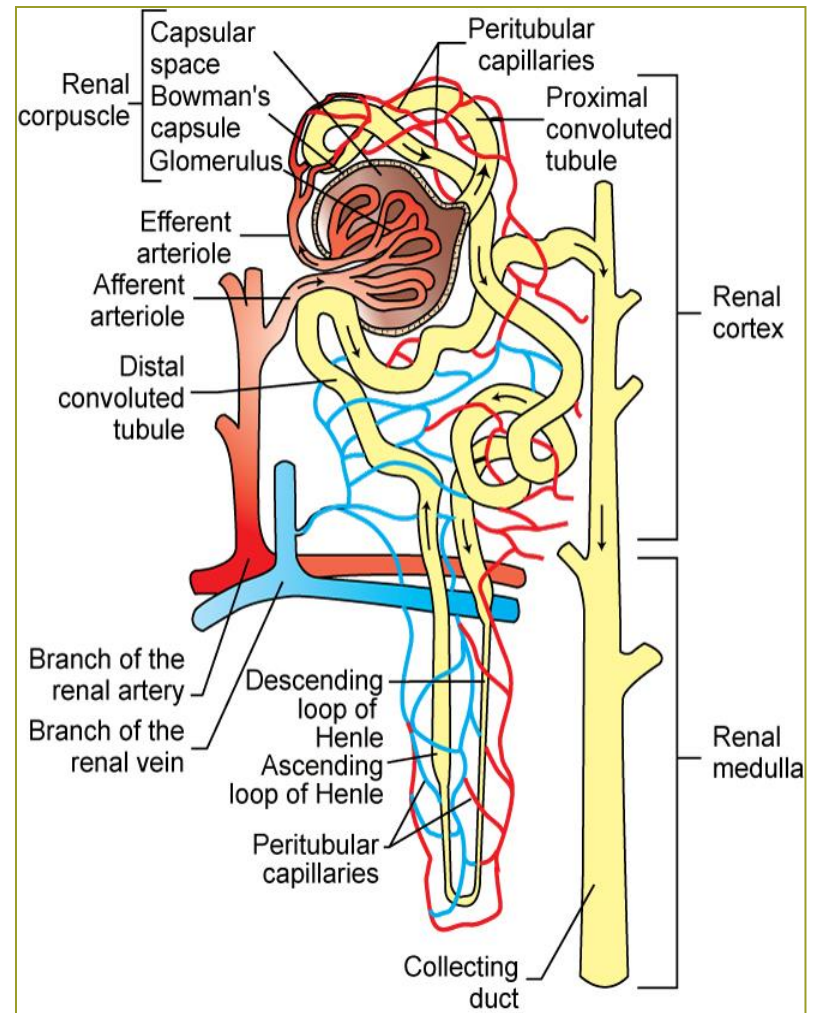
Figure 16-3, Page 377

- Glomerulus
- Bowman's capsule
- Glomerular filtrate
- Proximal convoluted tubule (PCT)
- Loop of Henle
- Distal convoluted tubule (DCT)
- Collecting ducts



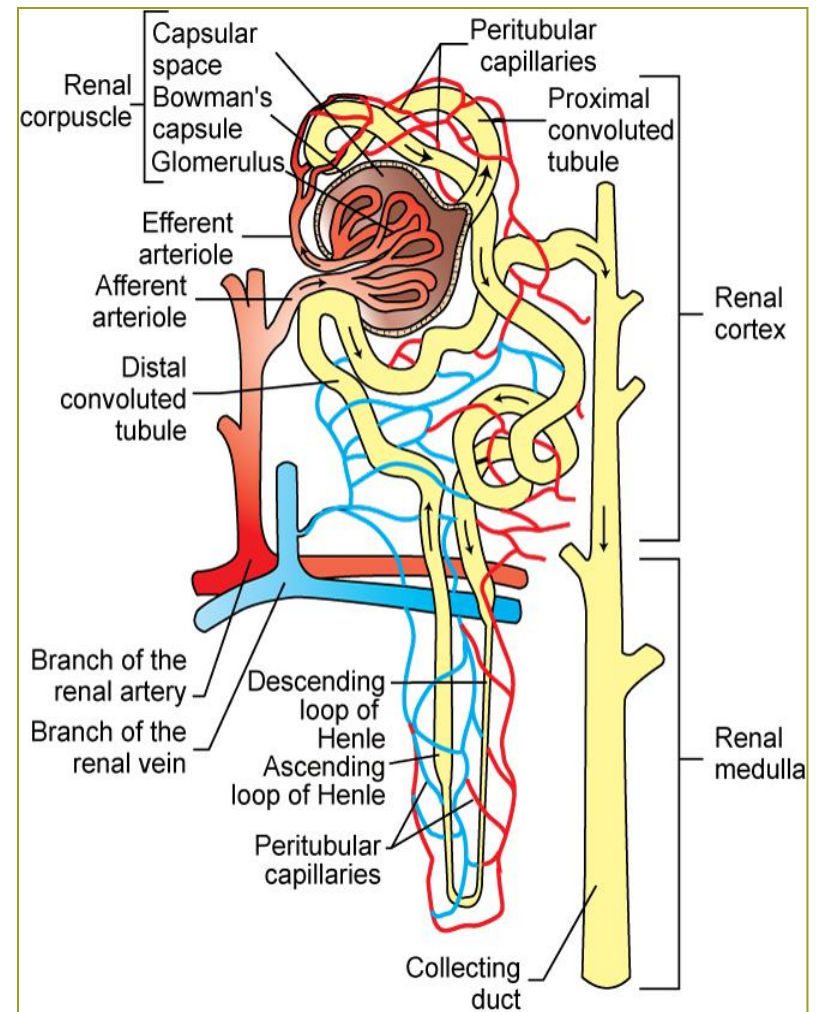
Renal Corpuscle

- Located in renal cortex
- Function: filters blood in first stage of urine production
- Composed of glomerulus surrounded by Bowman's capsule
 - Glomerulus: "tuft" of capillaries
- Fluid filtered out of blood is called *glomerular filtrate*



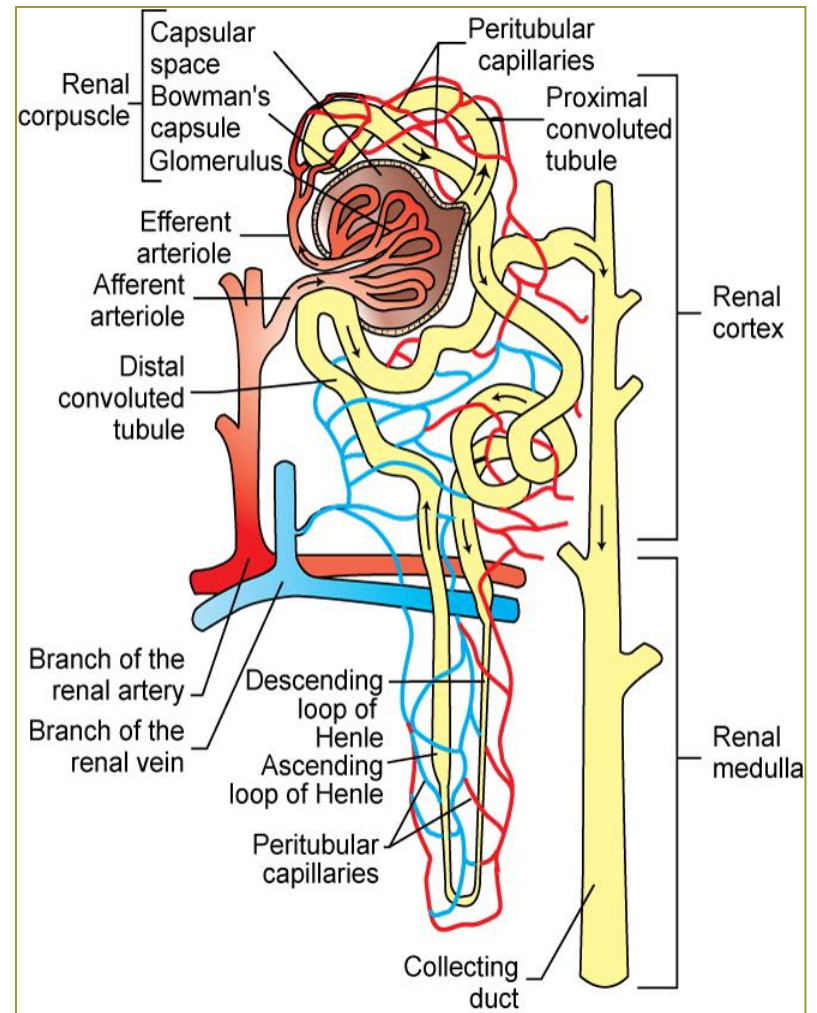
Proximal Convoluted Tubule (PCT)

- Continuation of capsular space of Bowman's capsule
- Lined with cuboidal epithelial cells with a brush border on lumen side
- Twisting path through the cortex
- Glomerular filtrate now called the *tubular filtrate*



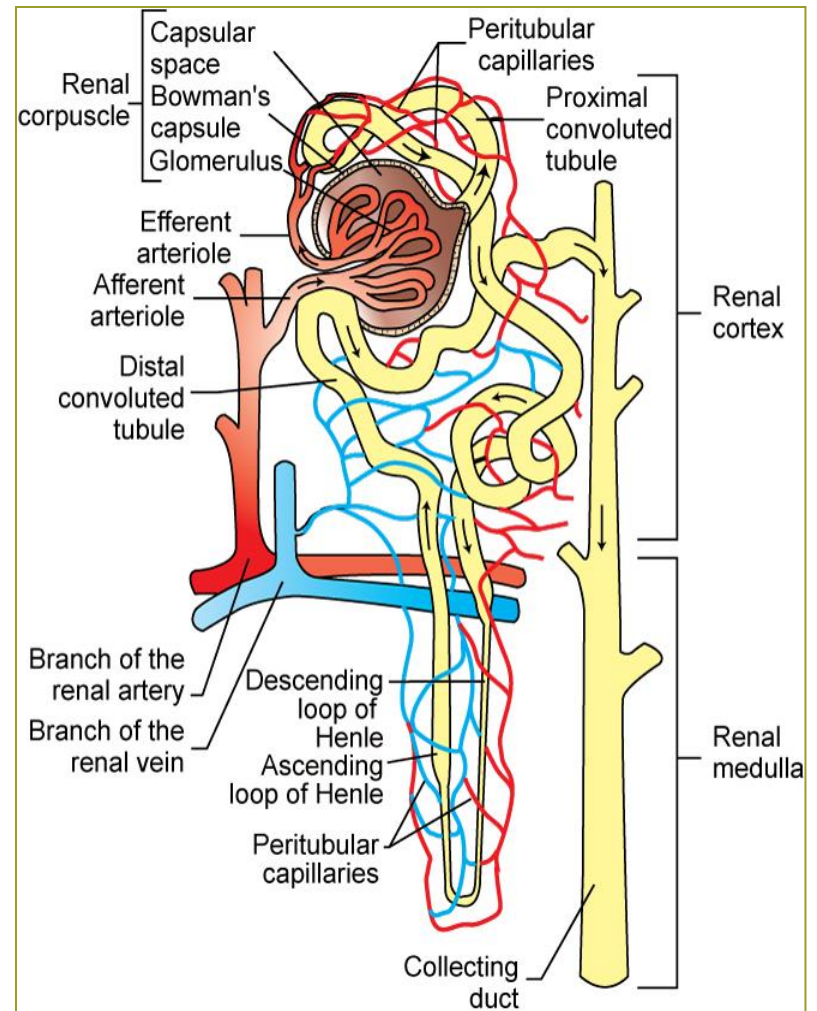
Loop of Henle

- Descends from PCT into medulla, turns, heads upward into cortex
- Descending loop has epithelial cells similar to those of PCT
- At bottom of loop, epithelial cells flatten to simple squamous epithelial cells and lose their brush border
- Ascending loop wall becomes thicker again



Distal Convoluted Tubule (DCT)

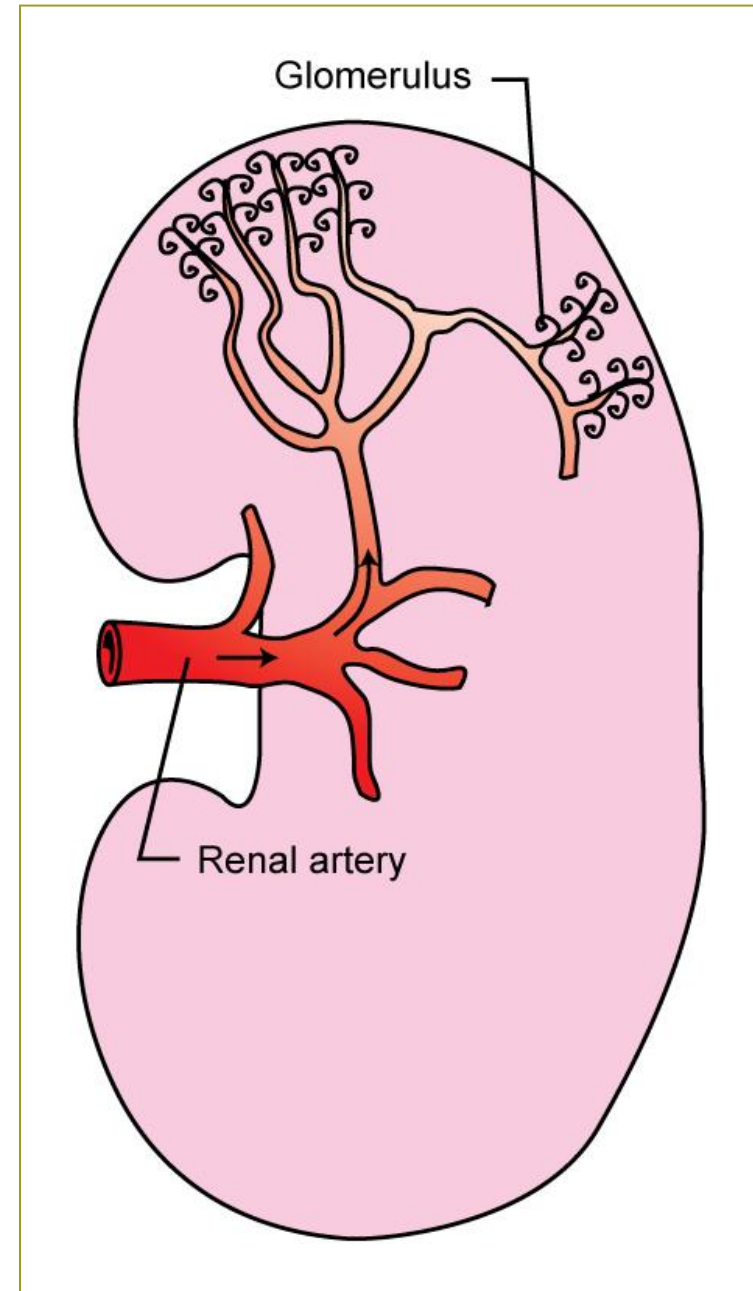
- Continuation of ascending loop of Henle
- DCT from all nephrons in the kidney empty into collecting ducts
 - Carry tubular filtrate through medulla
 - Empty into renal pelvis
 - Primary site of action of ADH and regulation of potassium and acid-base balance



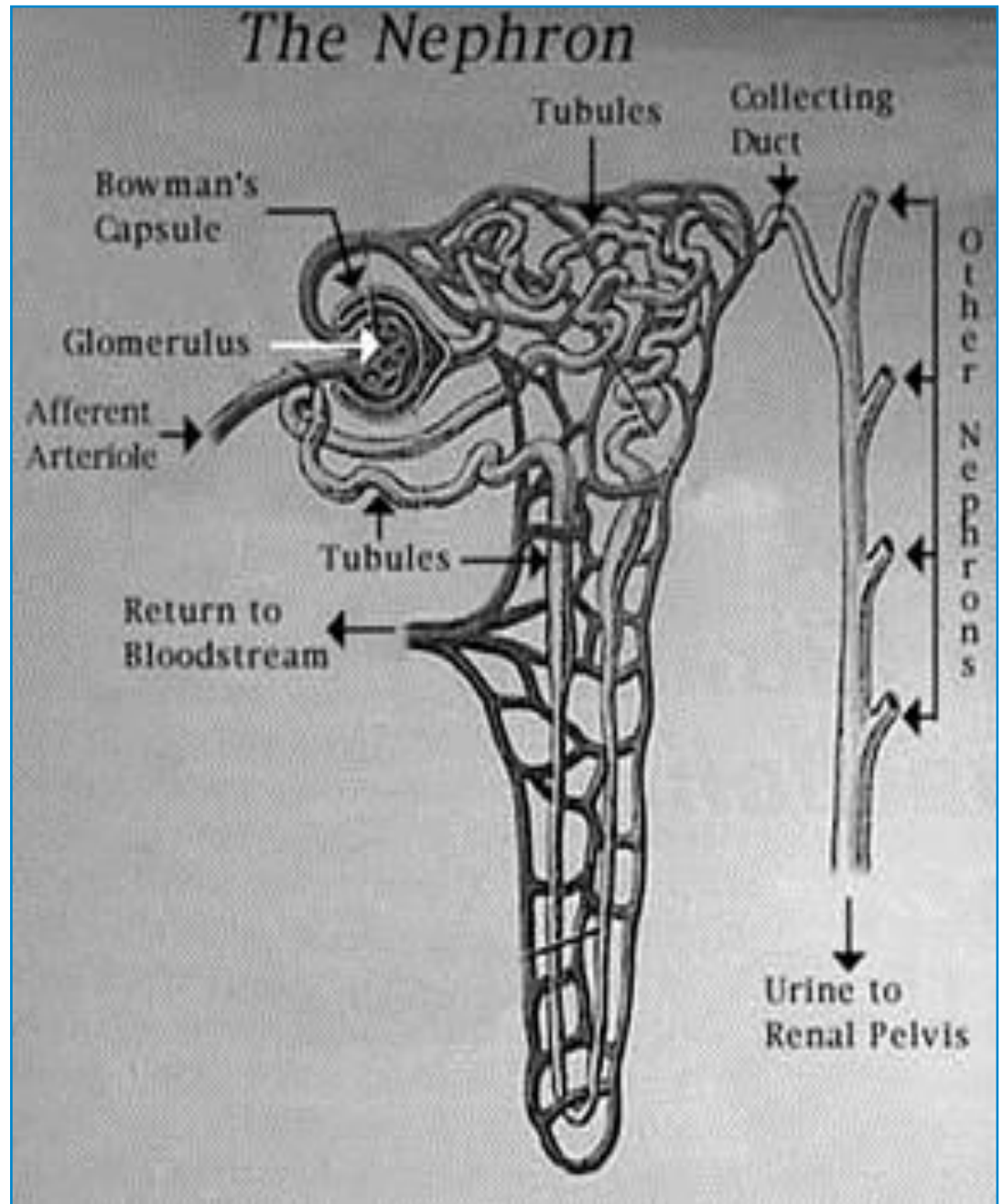
Blood Supply

Figure 16-4, Page 378

- Renal artery enters the kidney at the hilus
- Divides into smaller arteries and arterioles



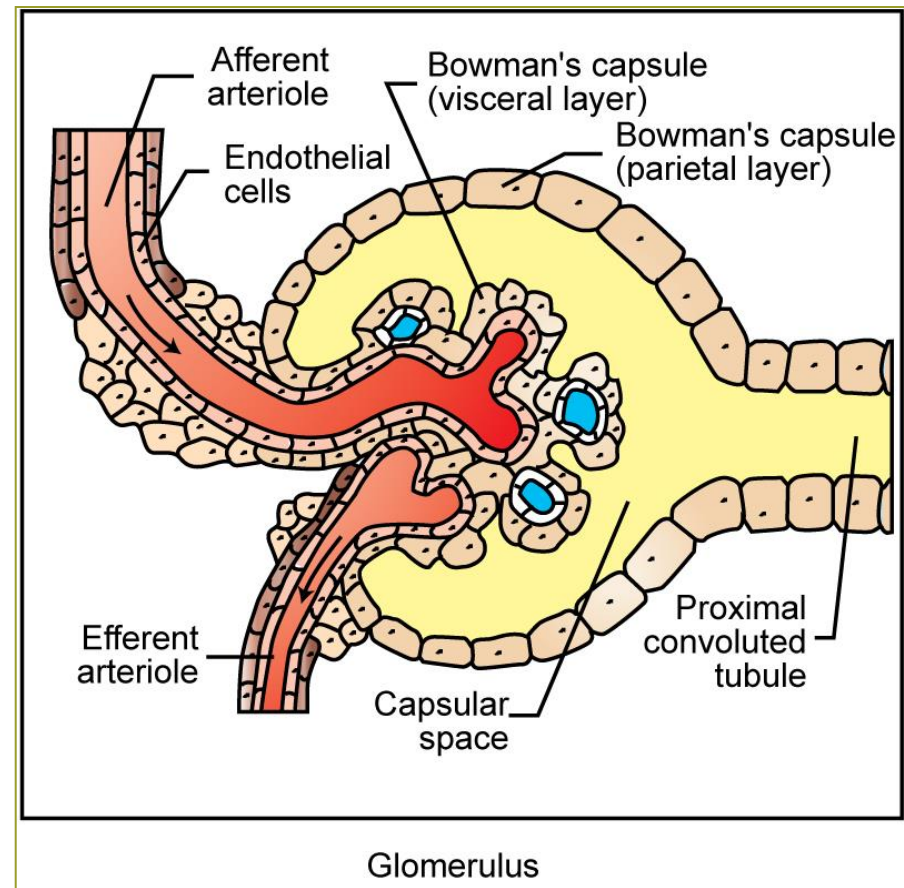
Look at That
Blood
Supply!



Blood Supply

Figure 16-4, Page 378

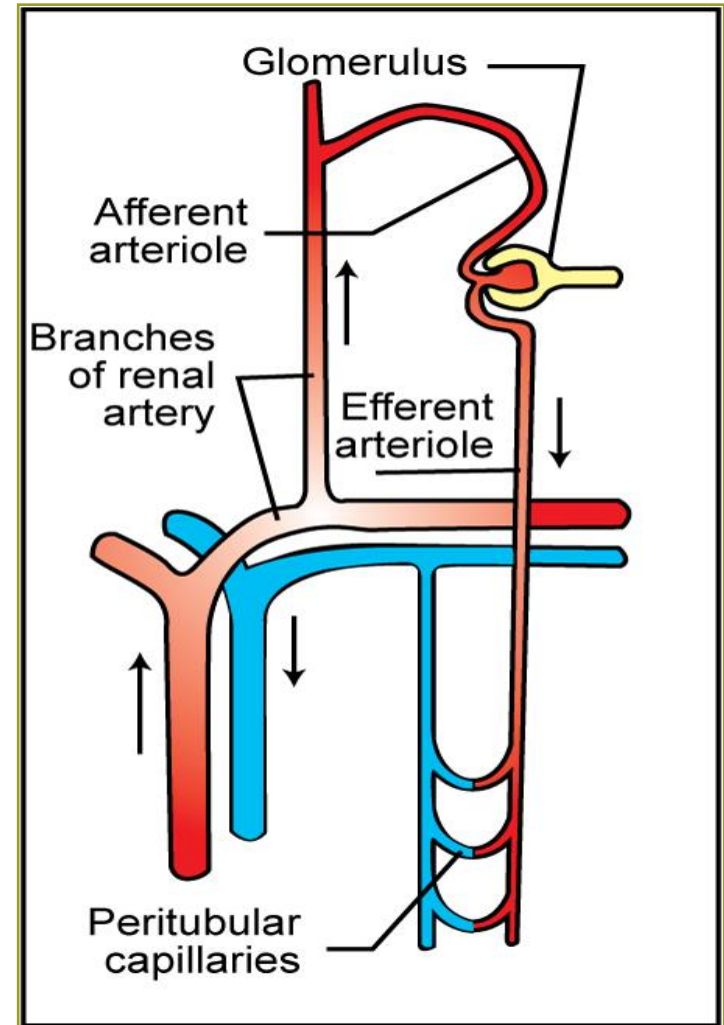
- Afferent glomerular arterioles carry blood into the glomerular capillaries of renal corpuscle
- Glomerular capillaries filter some of the plasma out of blood and put it in the capsular space of Bowman's capsule



Blood Supply

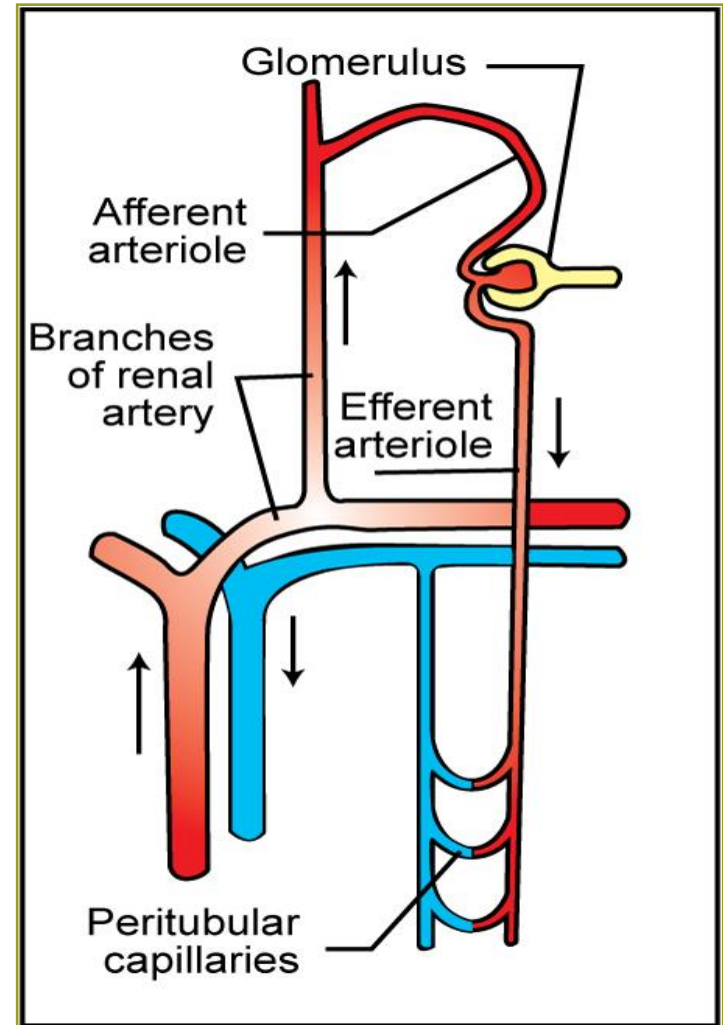
Figure 16-4, Page 378

- Efferent glomerular arterioles receive blood from glomerular capillaries



Blood Supply

- Efferent glomerular arterioles divide to form the peritubular capillaries
 - Surrounds the rest of the nephron
 - Oxygen transfer to the cells of the nephron takes place here
 - Tubular reabsorption and secretion also occurs here

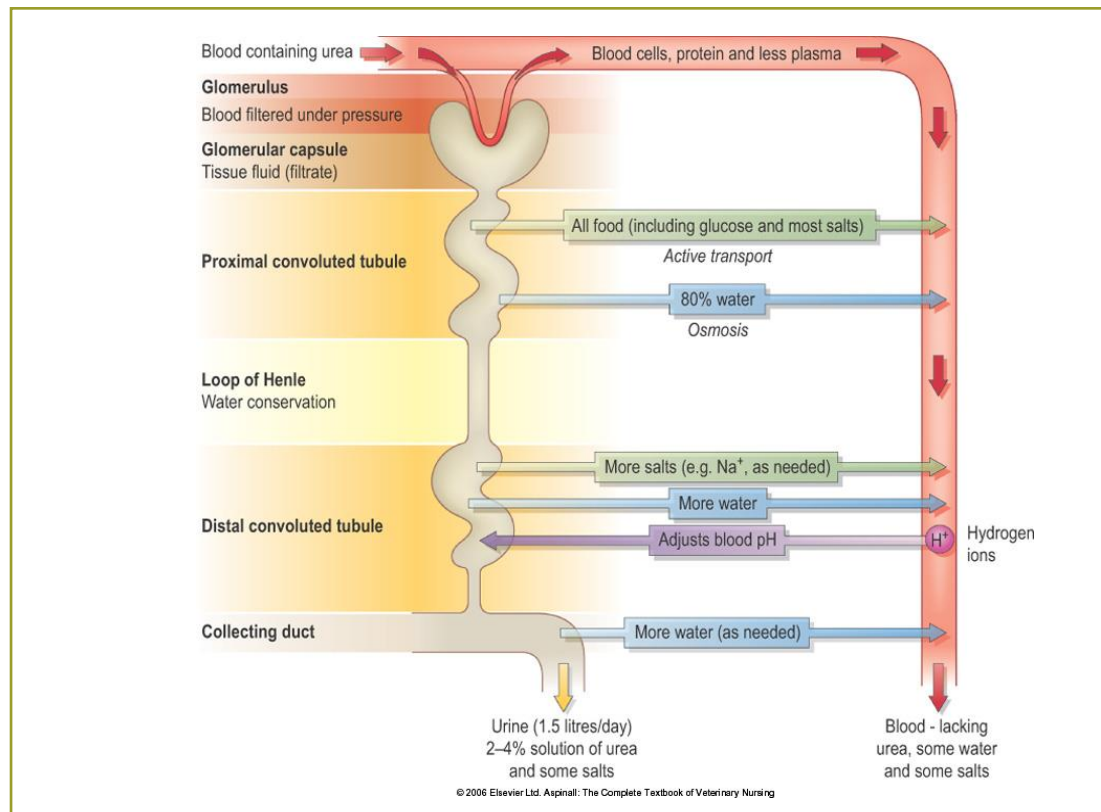


Blood Supply

- Peritubular capillaries converge to form venules, then larger veins, and finally the renal vein.
- The renal vein leaves the kidney at the hilus and joins the abdominal portion of the caudal vena cava.

Topic 4

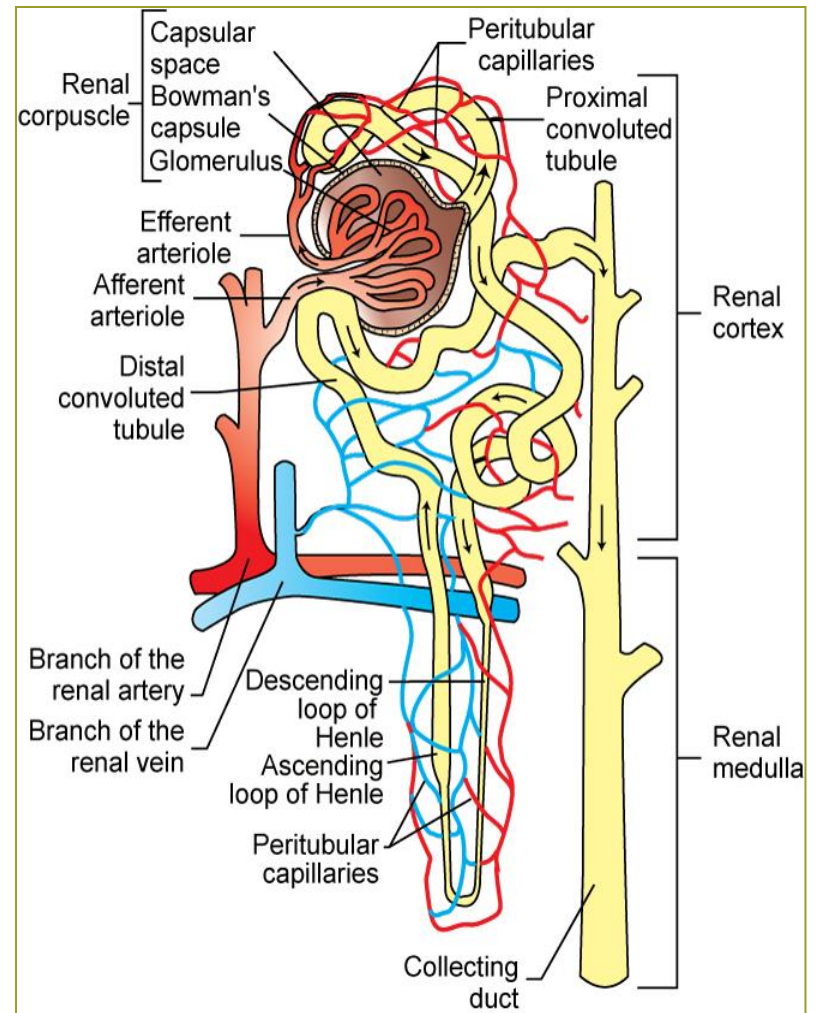
Discuss the 3 steps in the manufacture of urine in the nephron



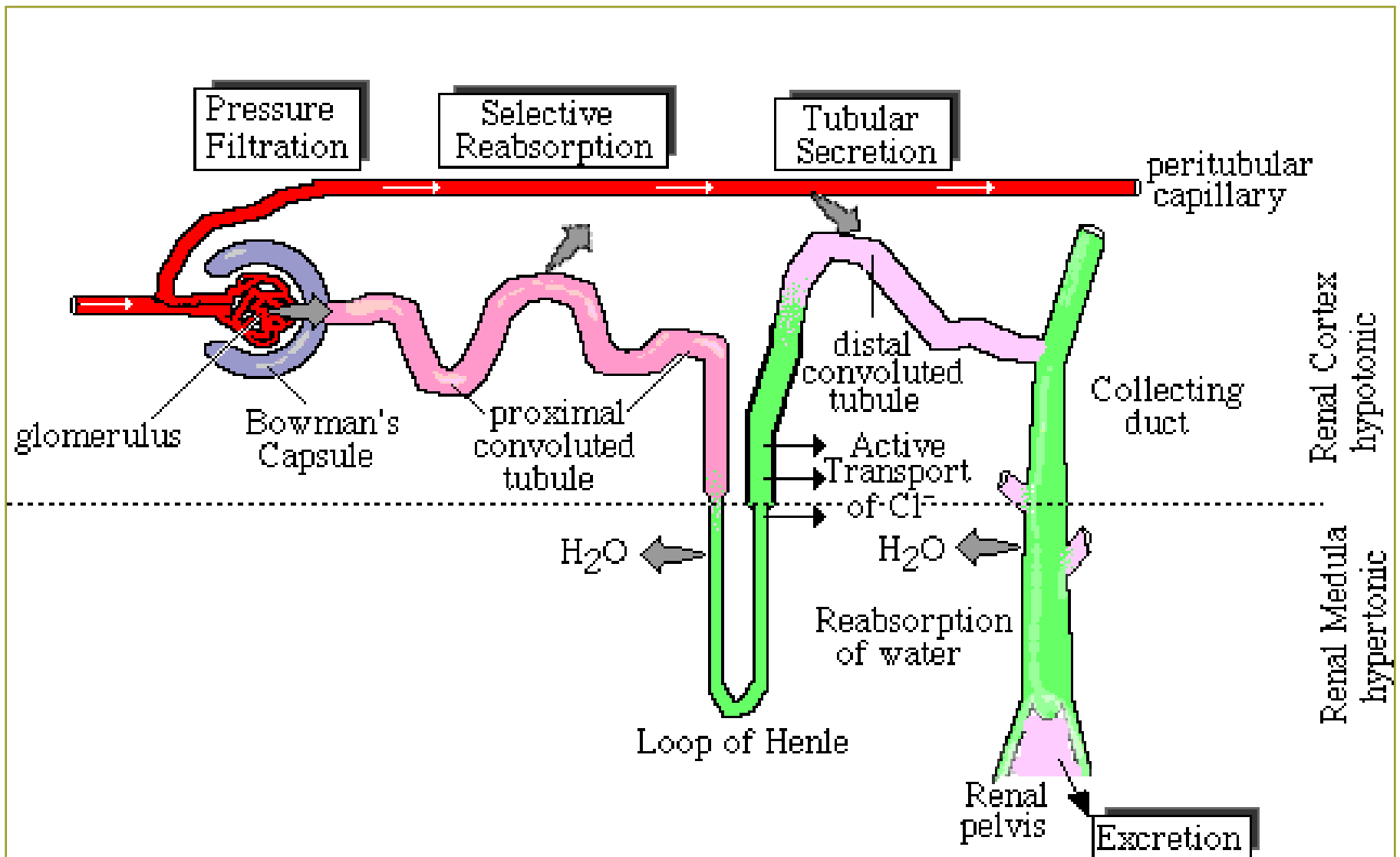
Urine Formation Review

Clinical Application – Pages 383-384

- Filtration – glomerulus
- Reabsorption – PCT
 - Na^+
 - H_2O
 - Glucose, amino acids
 - Other nutrients
- Secretion – DCT
 - Ammonium
 - H^+
 - Some antibiotics



Nephron Review



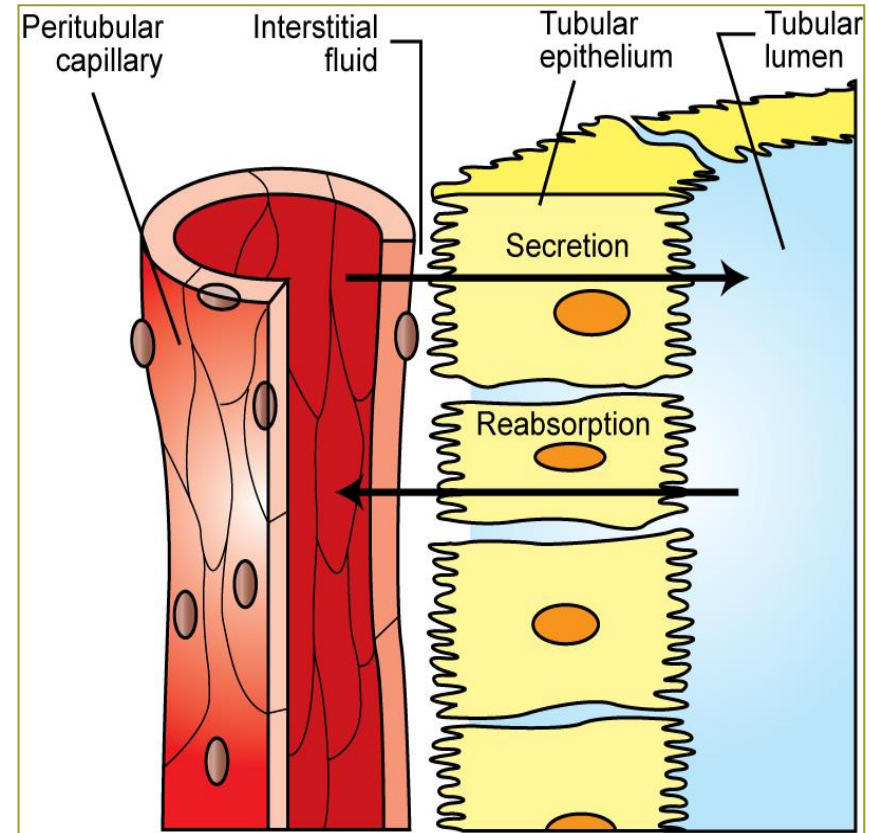
Filtration of Blood

- Glomerular capillaries contain many large fenestrations in capillary endothelium
 - Fenestrations **not large enough to allow blood cells or large proteins to pass through**
- High blood pressure in the glomerular capillaries forces some plasma out of the capillaries and into the capsular space of Bowman's capsule
- Glomerular filtration rate (GFR): how fast plasma is filtered through glomerulus

Reabsorption

Figure 16-5, Page 379

- Substances to be reabsorbed pass out of the tubular lumen through or between tubular epithelial cells
- Substances to be reabsorbed then enter interstitial fluid and pass through endothelium into peritubular capillaries

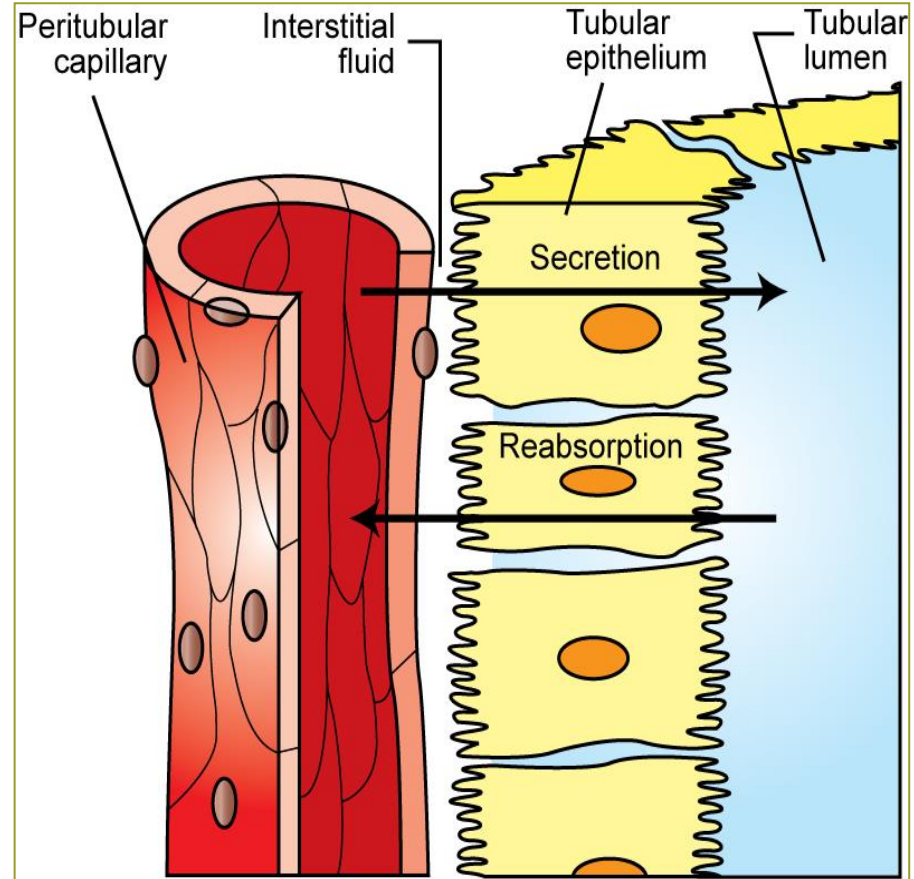


Sodium Reabsorption

- Sodium in tubular filtrate attaches to carrier protein that moves it into the cytoplasm of the PCT epithelial cell
- Glucose and amino acids attach to same carrier protein and follow sodium into the cell by **passive transport** (sodium co-transport)

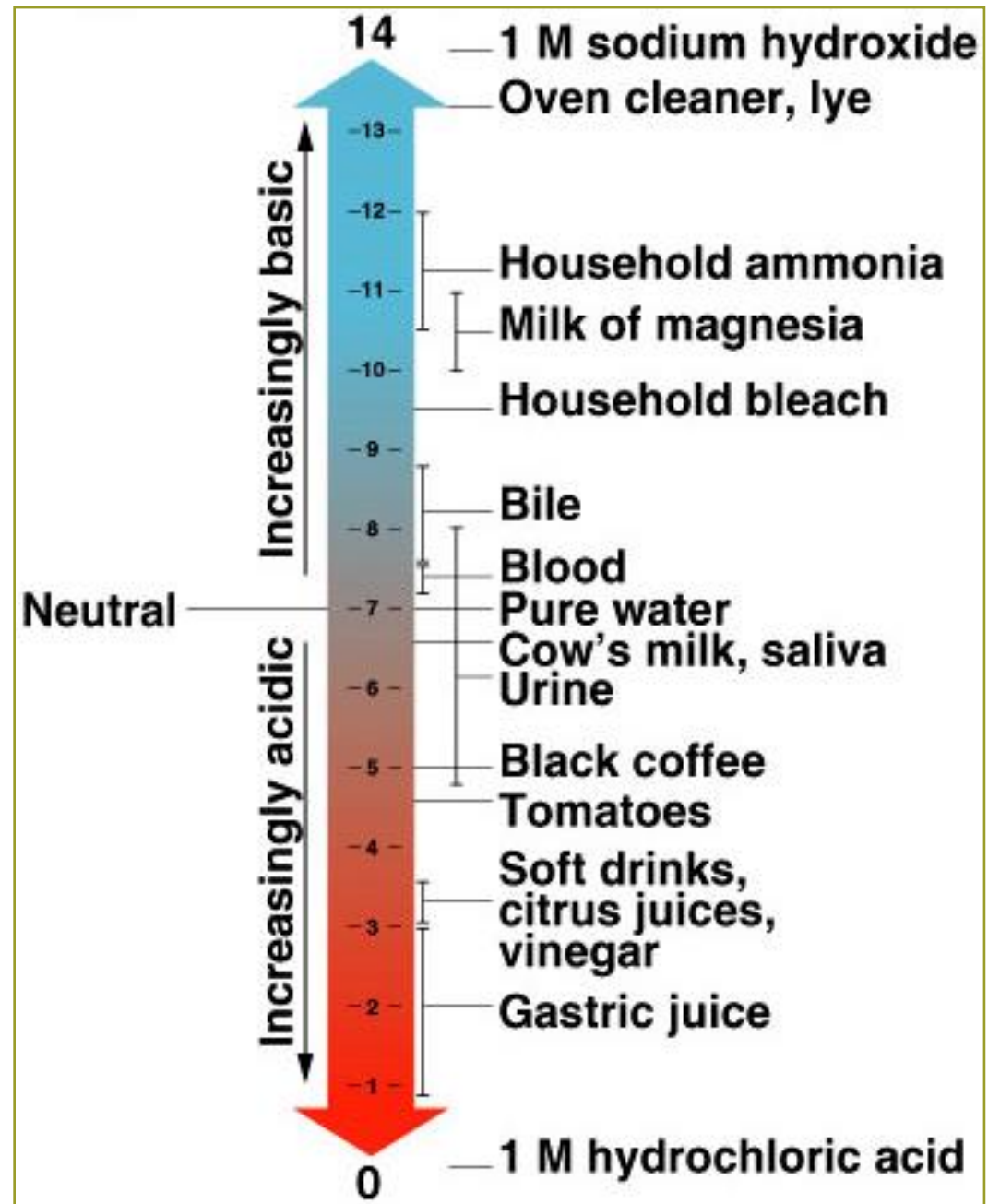
Secretion

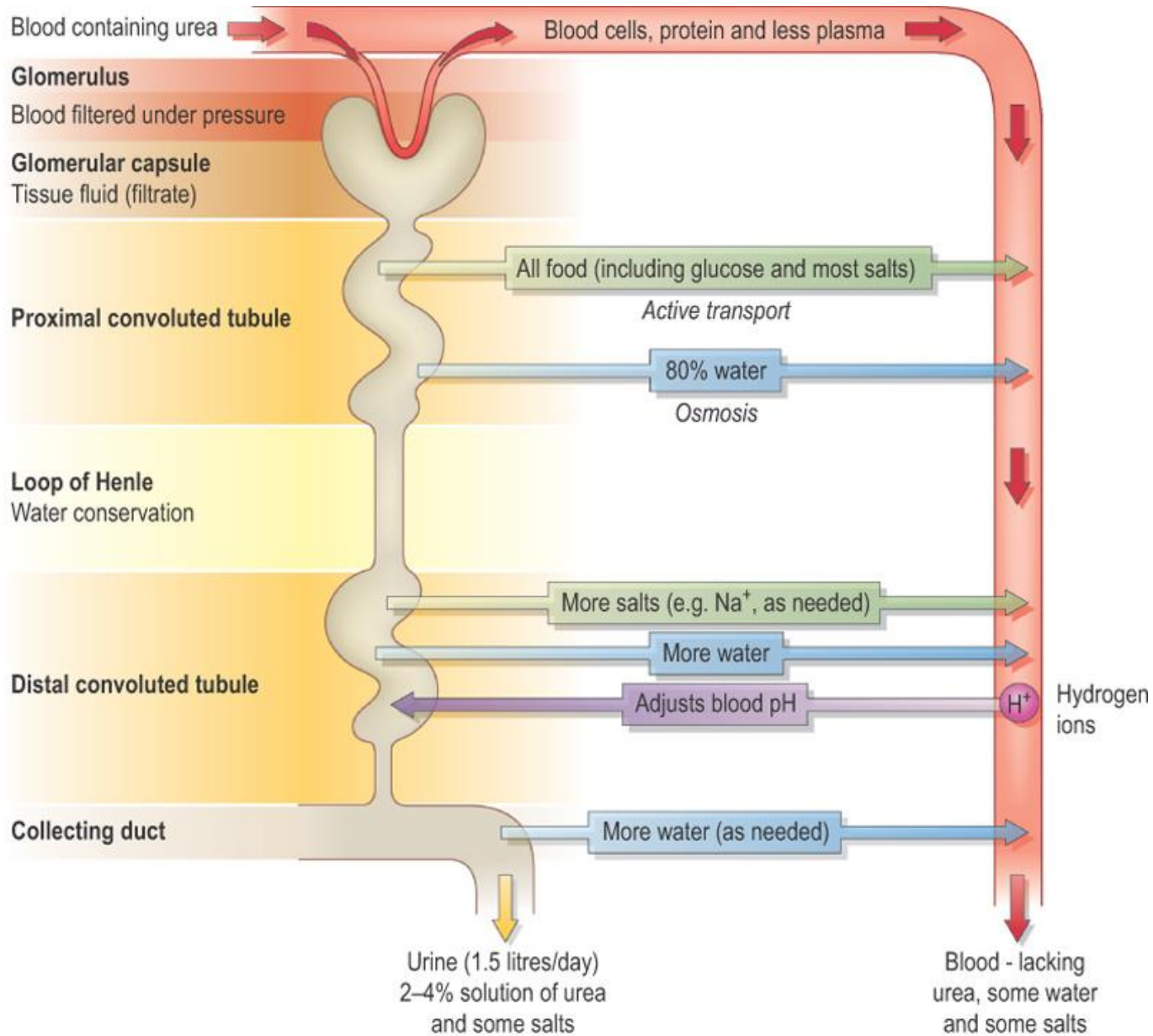
- Primarily occurs in the DCT
- Hydrogen, potassium, and ammonia are eliminated by secretion
- Some medications are also eliminated from the body by secretion



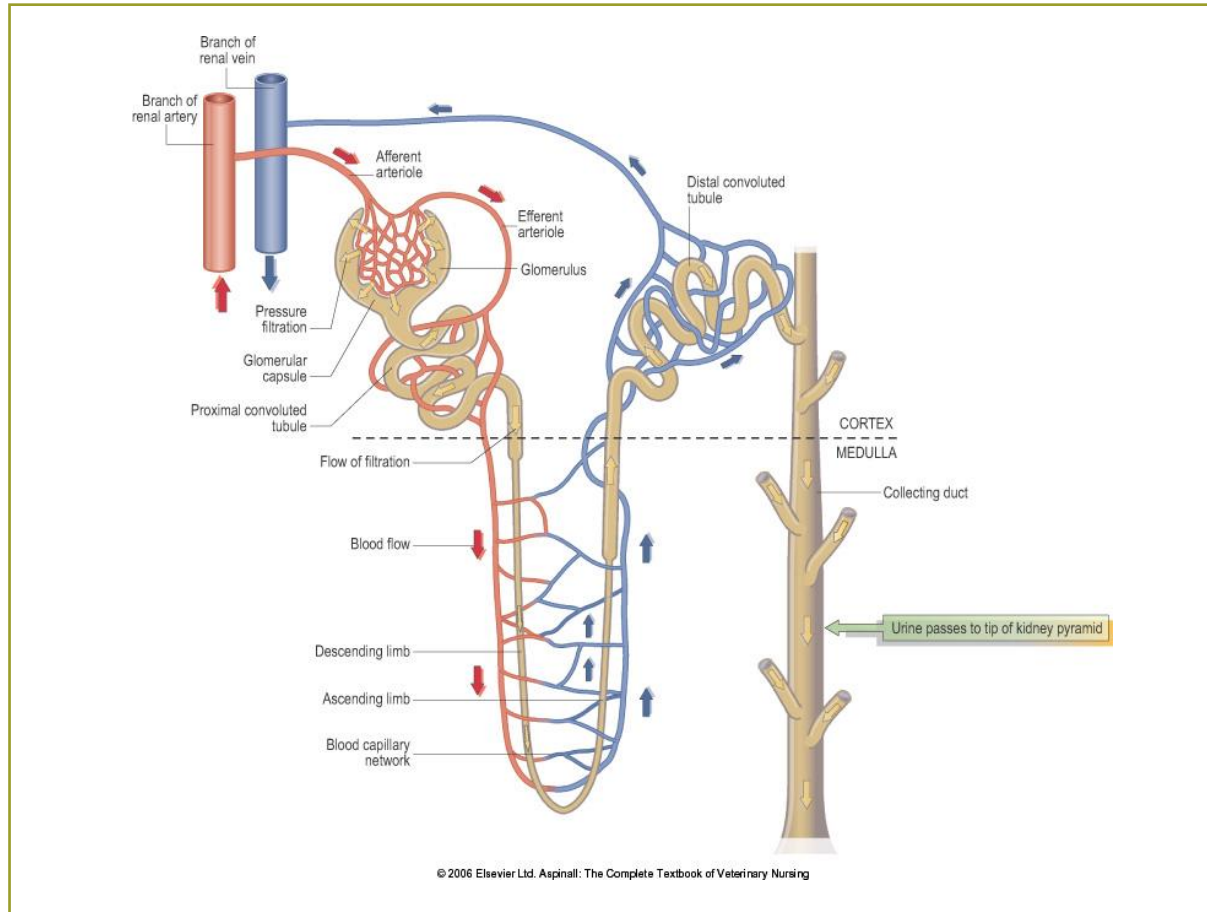
Urine pH

- What is pH?
- Plasma pH – 7.4
- Glomerular filtrate pH – 7.4
- Urine pH – “It depends” 😊
 - Carnivores
 - Herbivores



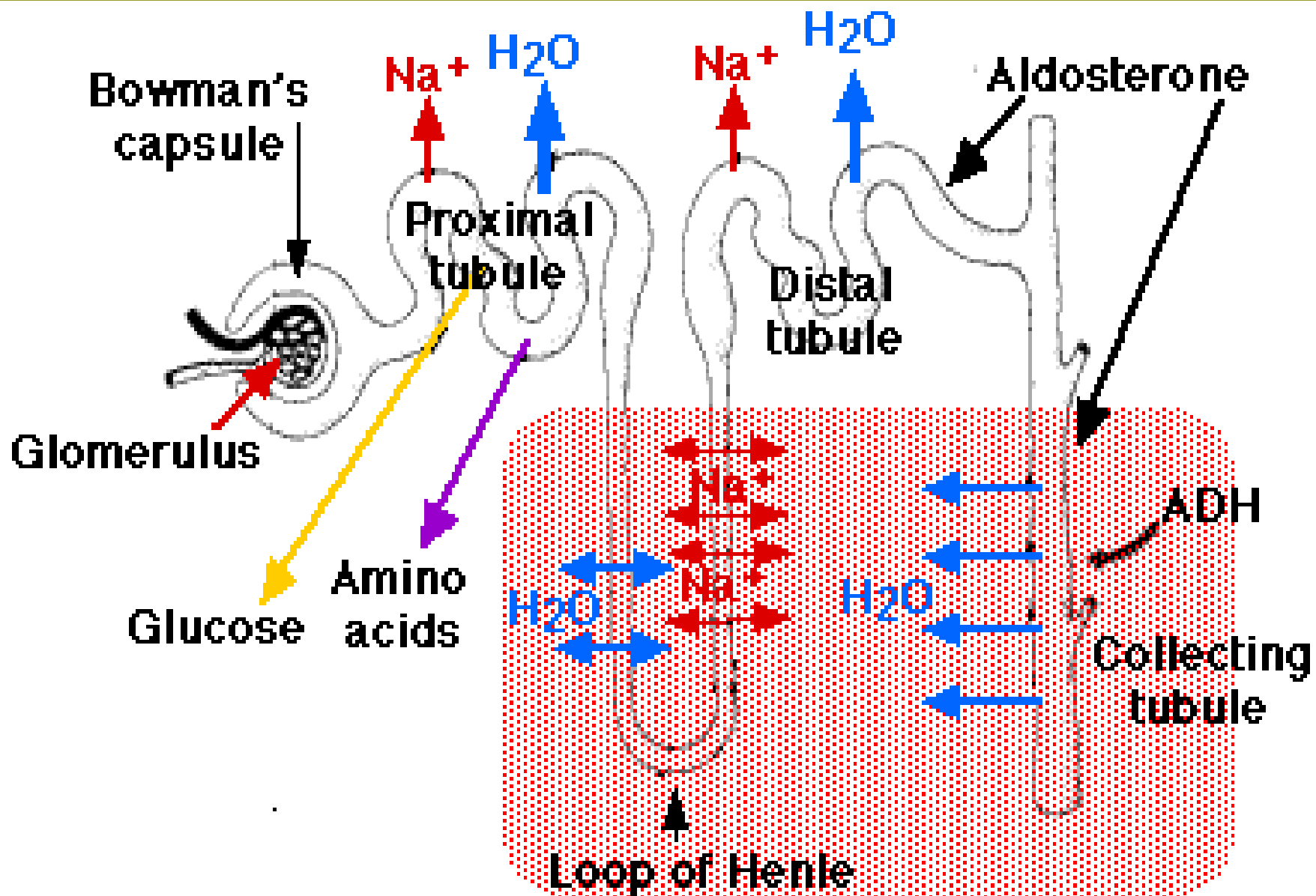


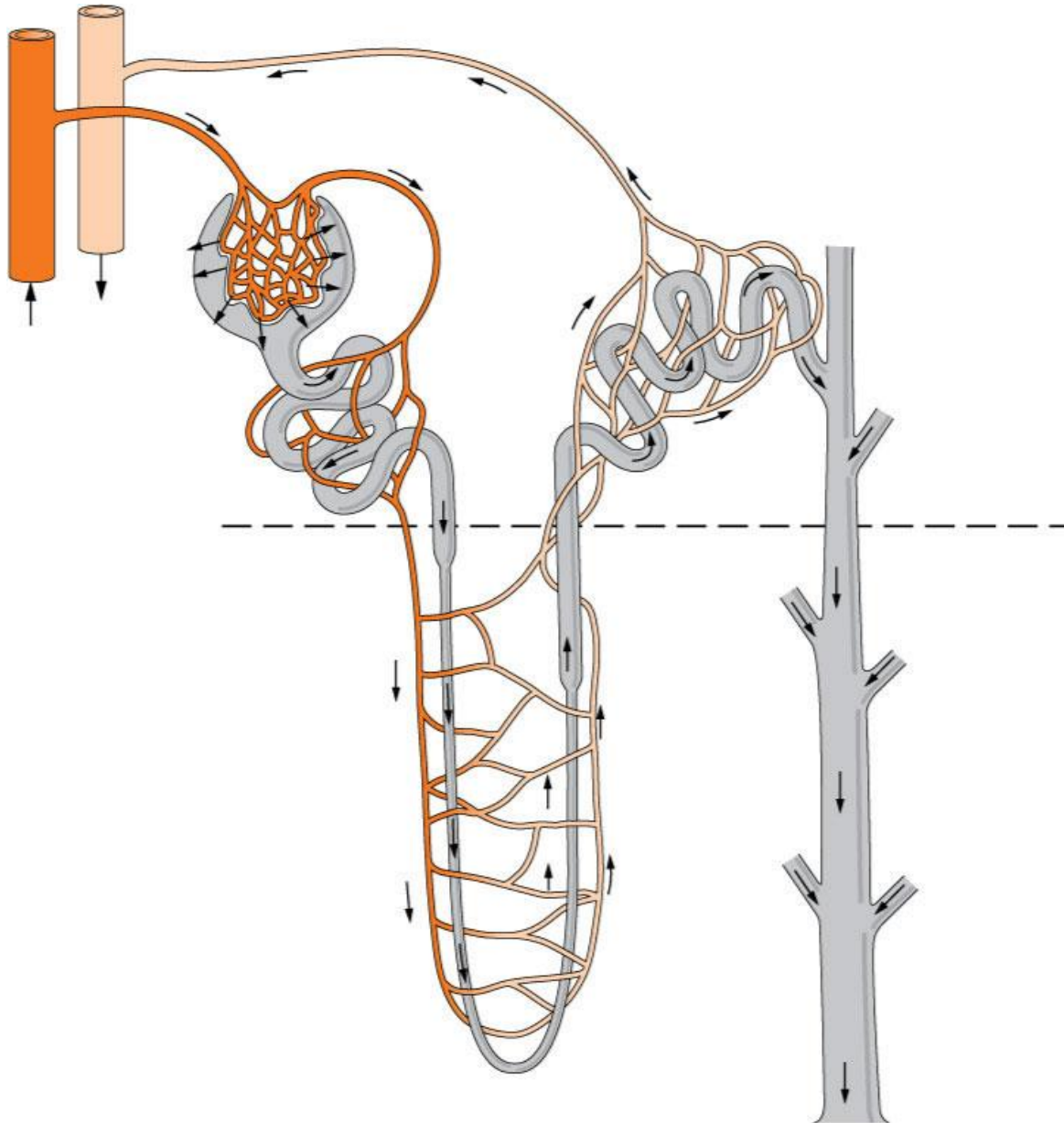
Summary – Through the Nephron



Urine Volume & Concentration

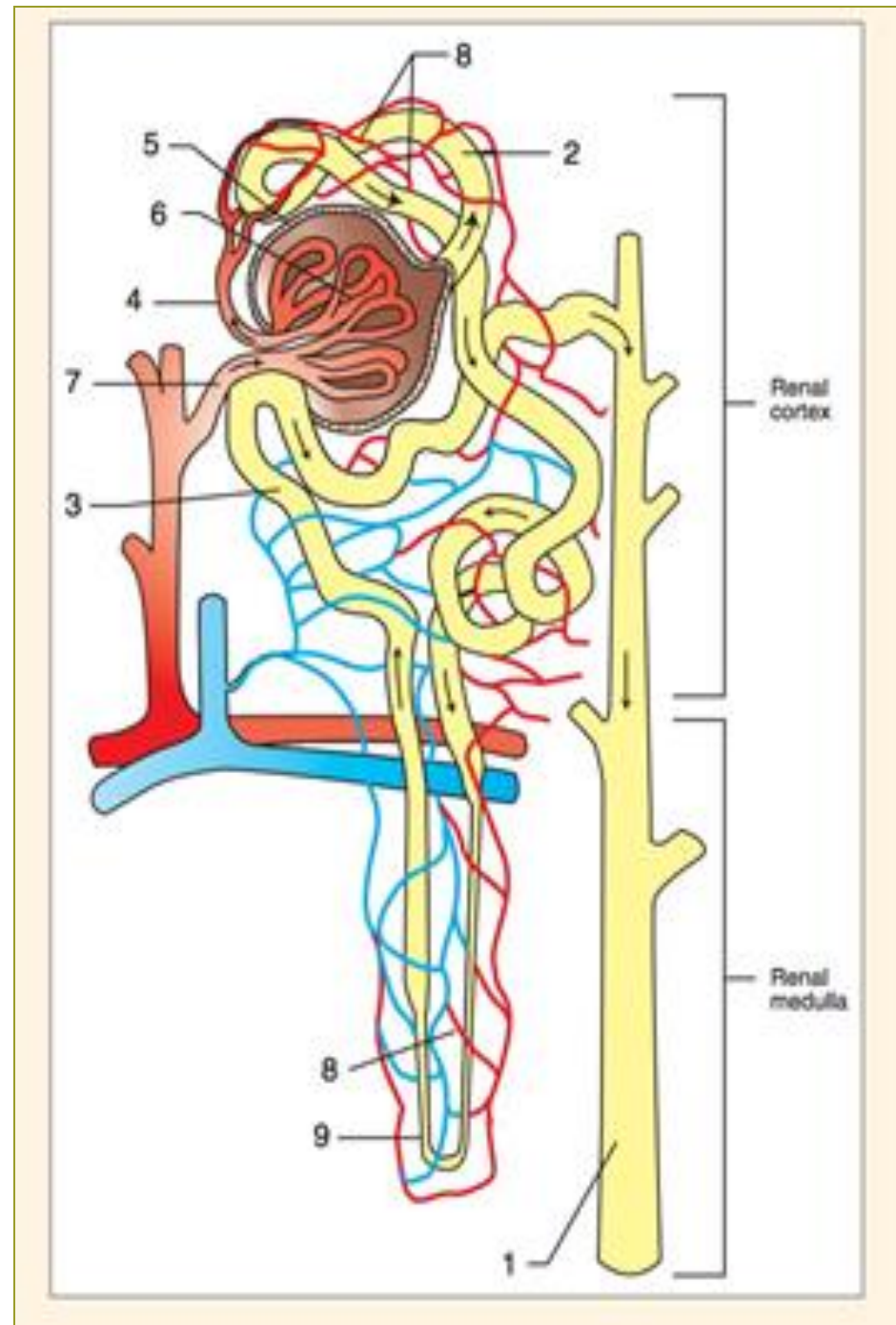
- Regulated a lot by hormones
- Antidiuretic hormone (ADH)
 - From pituitary gland
 - Increases reabsorption of water in PCT
 - Concentrates the urine, decreases volume
- Aldosterone
 - From adrenal gland
 - Increases reabsorption of Na^+ in PCT
 - Concentrates the urine, decreases volume





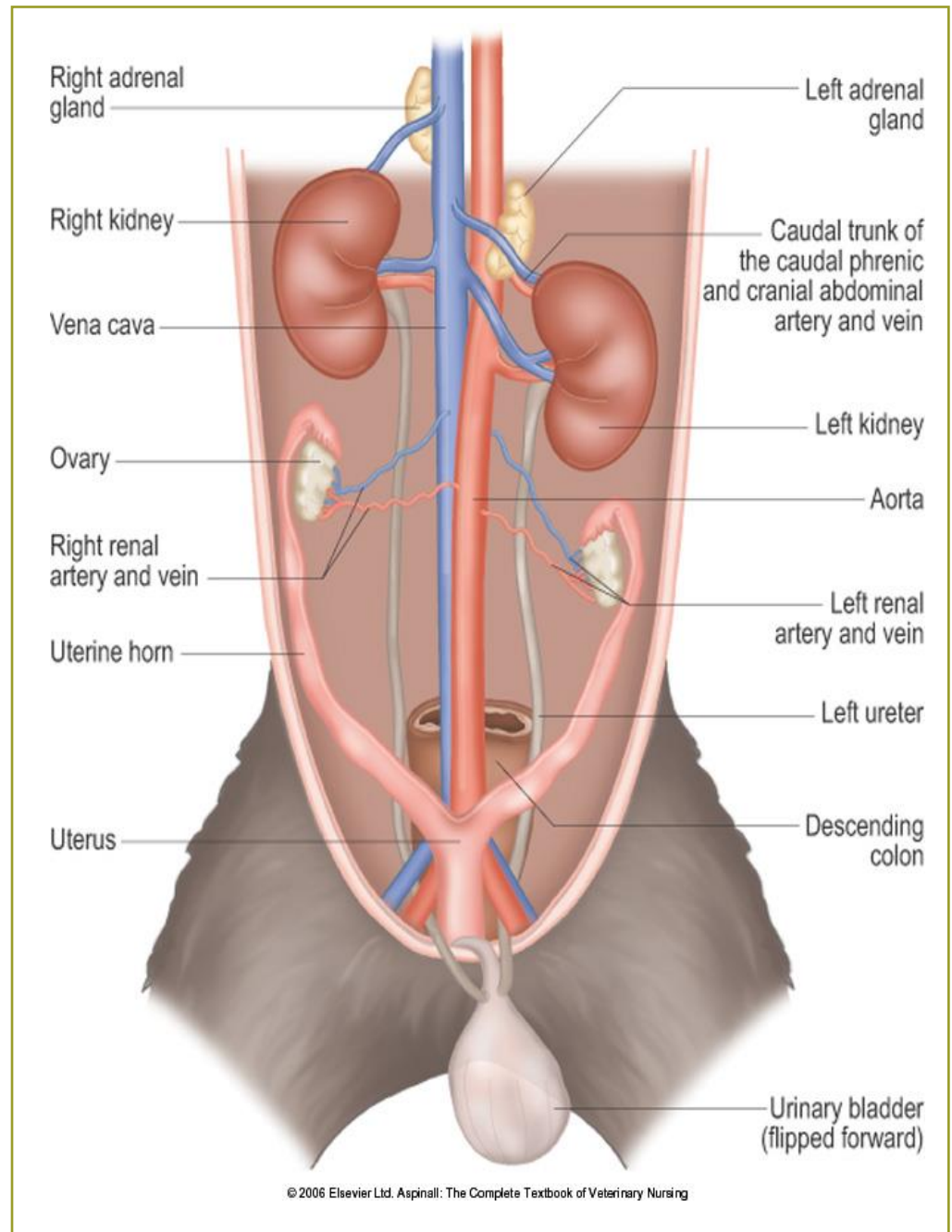
Identify the Structures of the Nephron

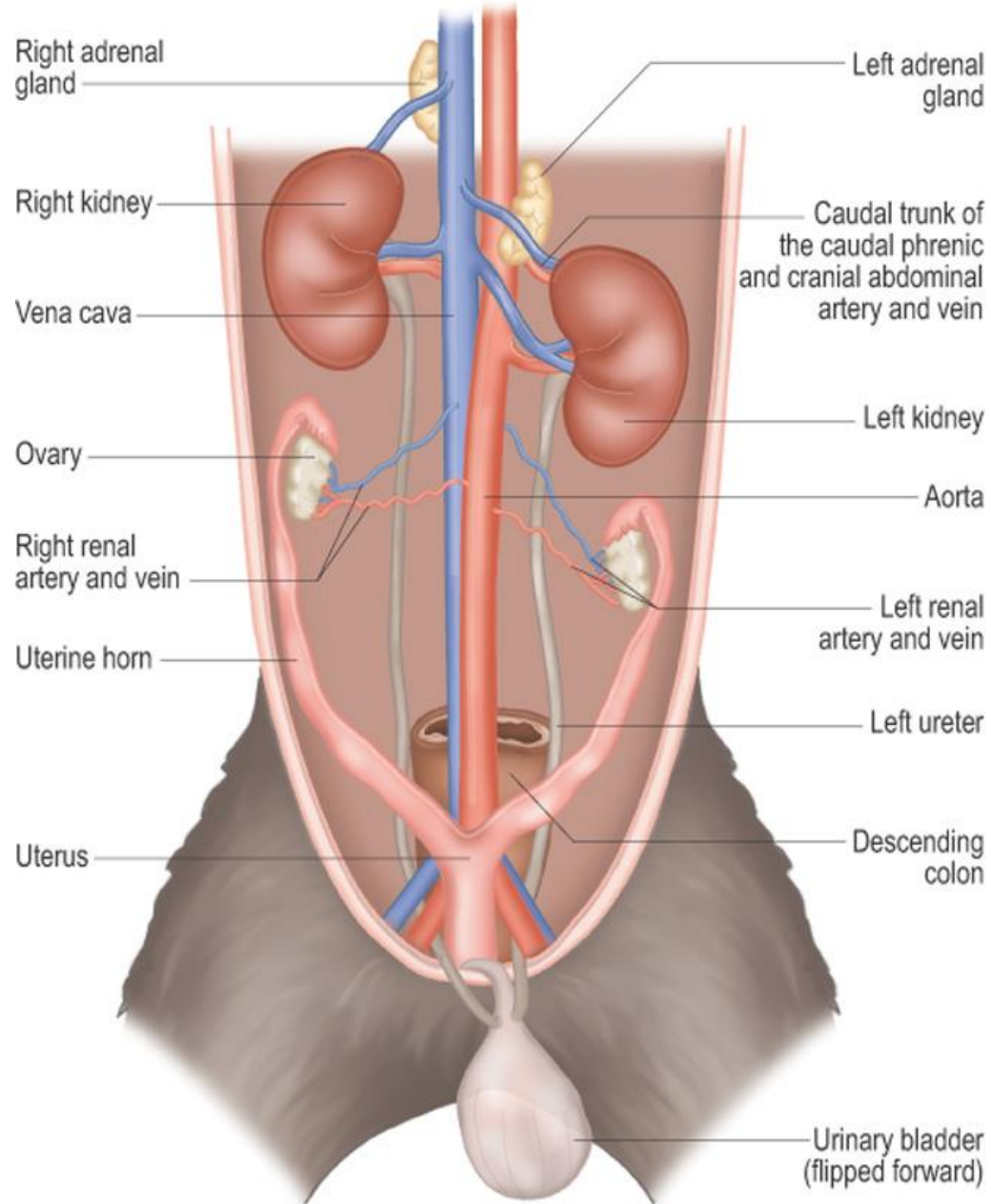
Bassett Lab Manual –
Page 407



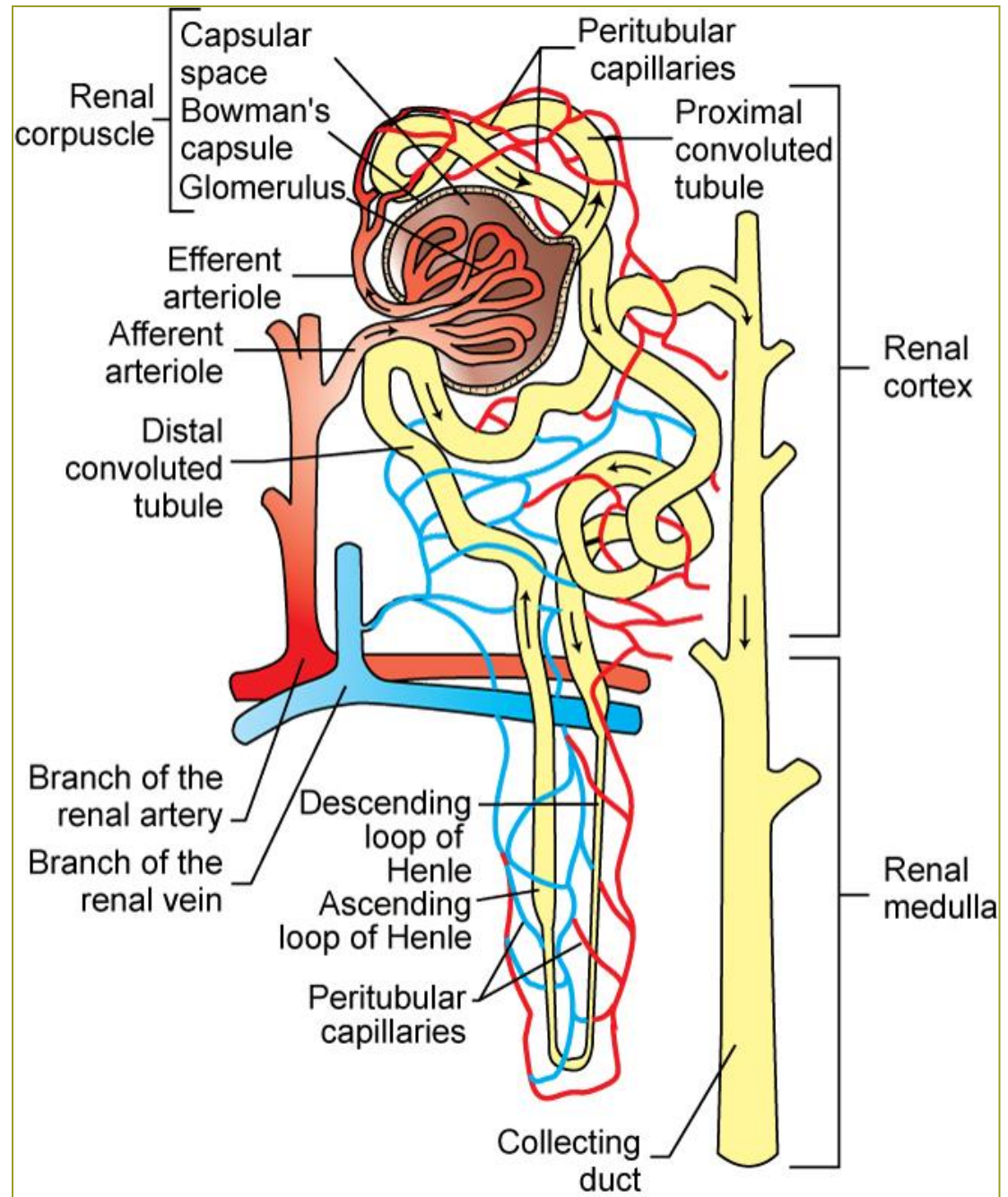
Topic 5

Trace a urea molecule through the urinary system

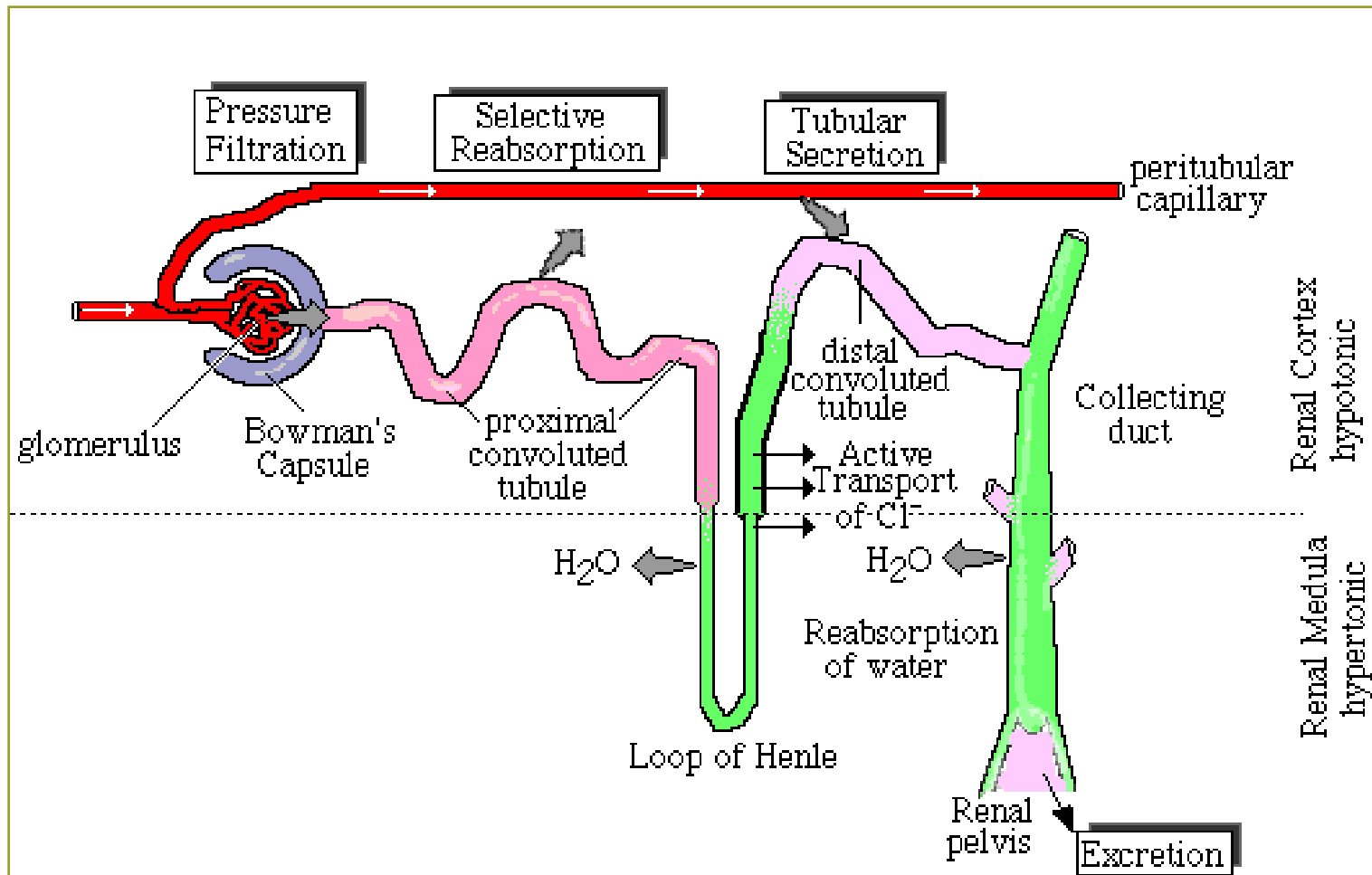


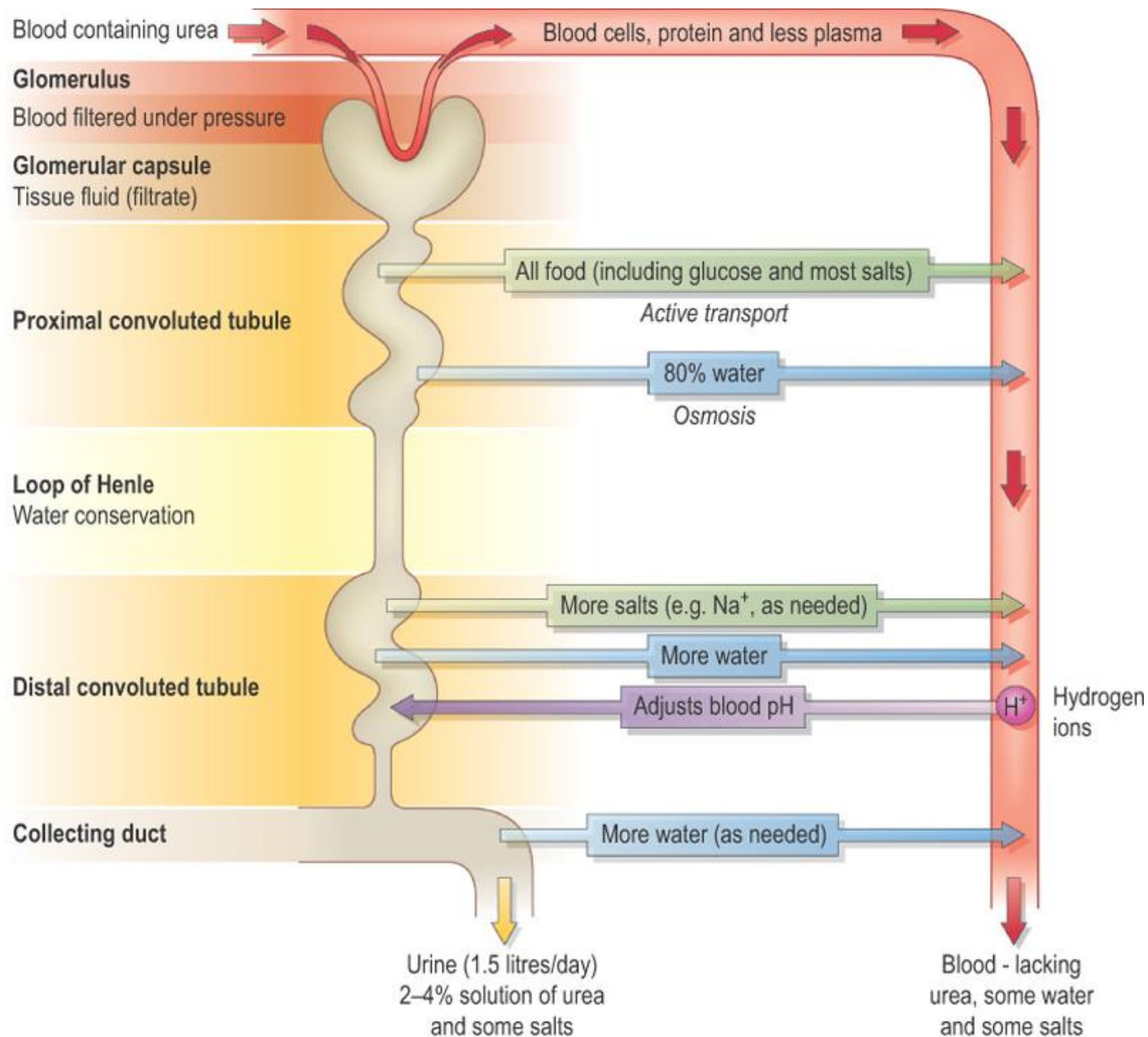


Through the Nephron

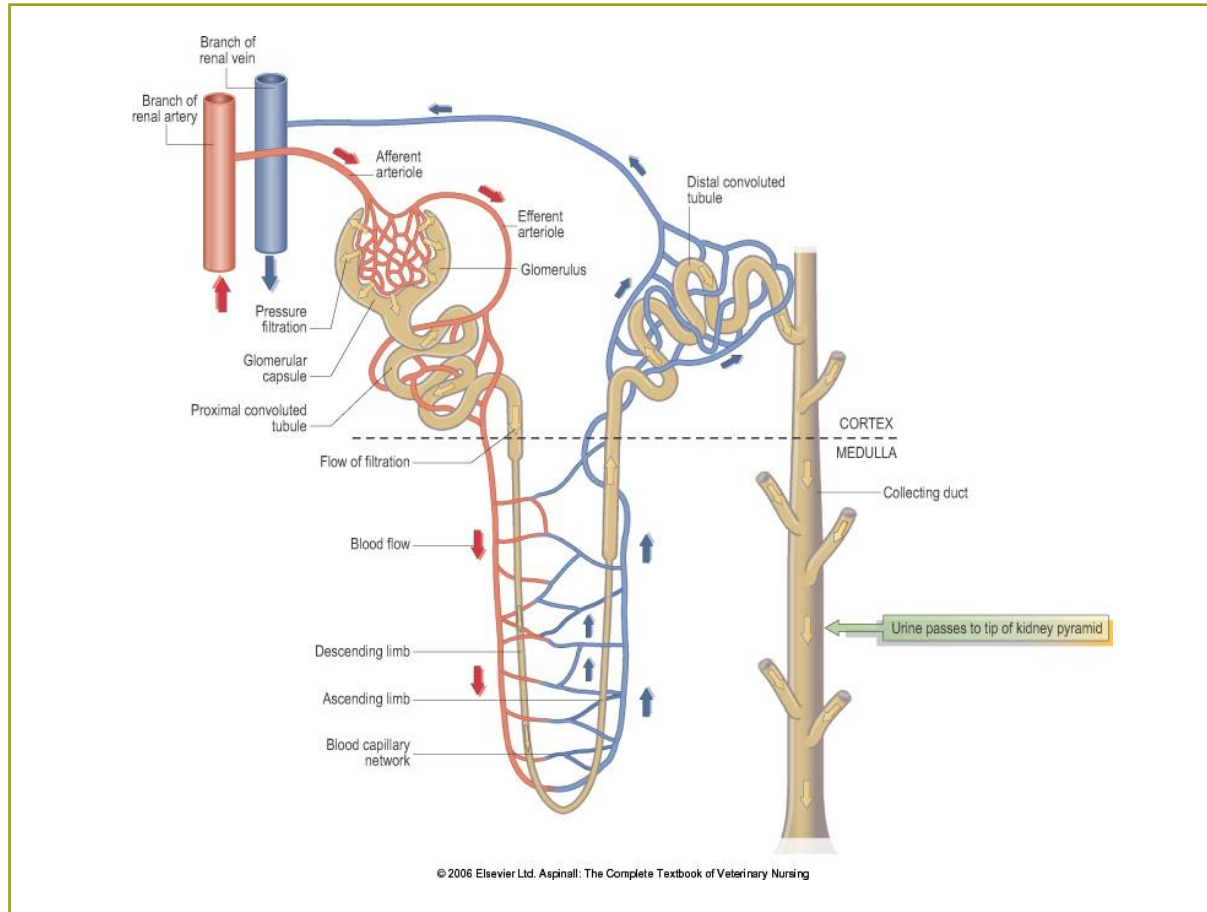


Nephron Review

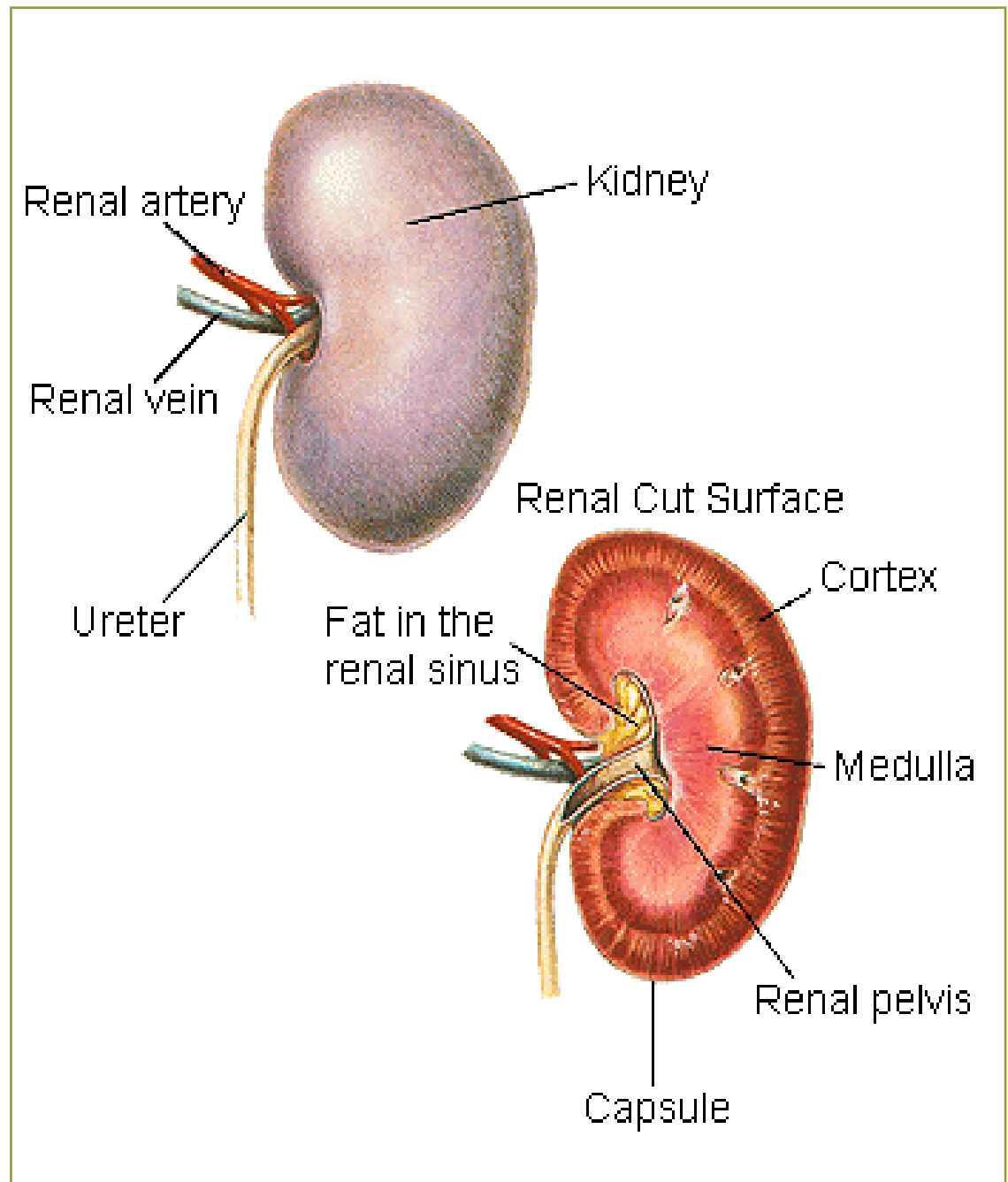


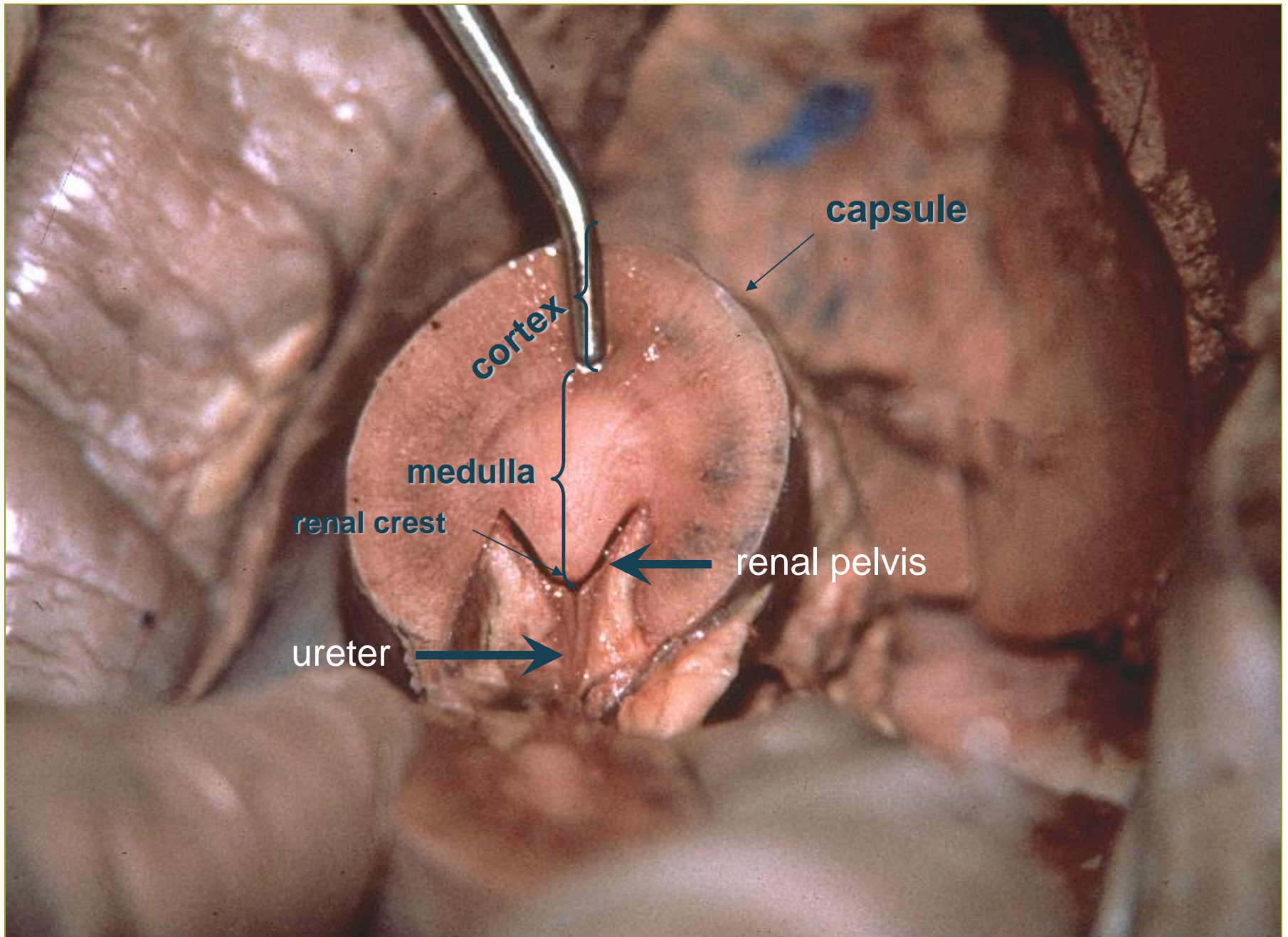


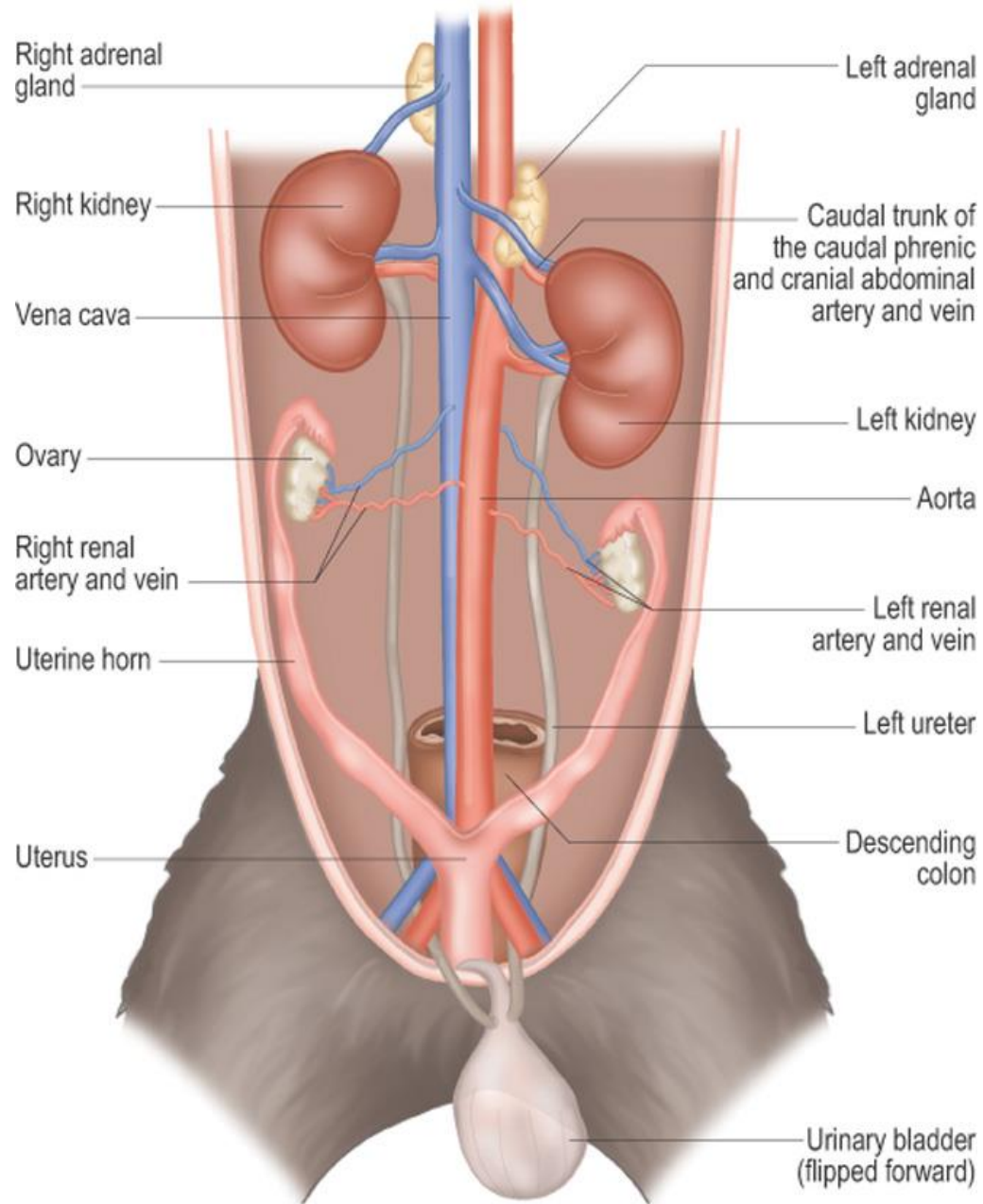
Summary – Through the Nephron



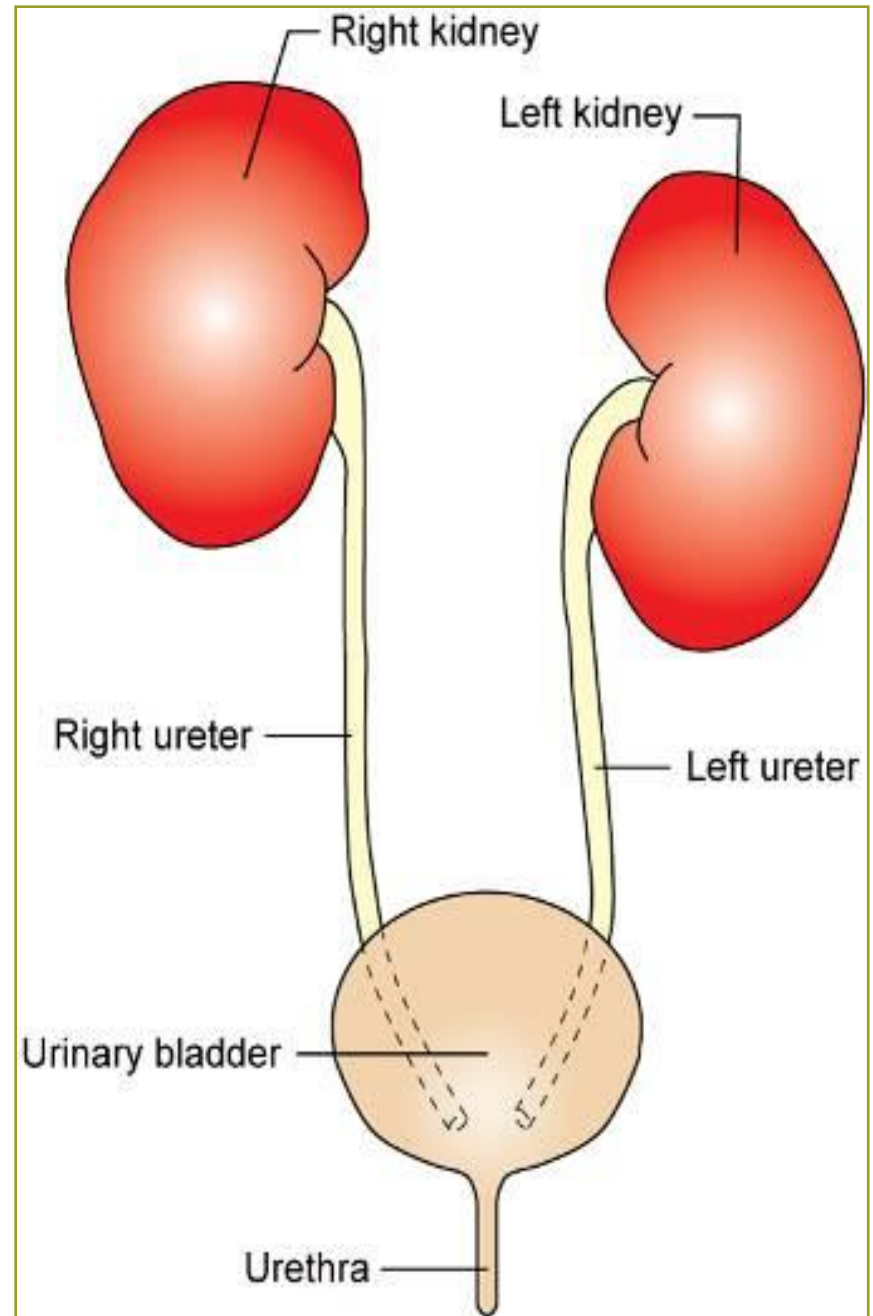
Through the
Renal Medulla
Collecting
Ducts → Renal
Pelvis → Ureter







To the Ureter →
Urinary Bladder
→ Urethra →
Urethral Orifice



Ureters & Urinary Bladder

- Ureters
 - Paired tubes from the kidneys to the urinary bladder
- Urinary bladder
 - Urine storage
 - Sphincter muscle (skeletal)
 - Joins the urethra



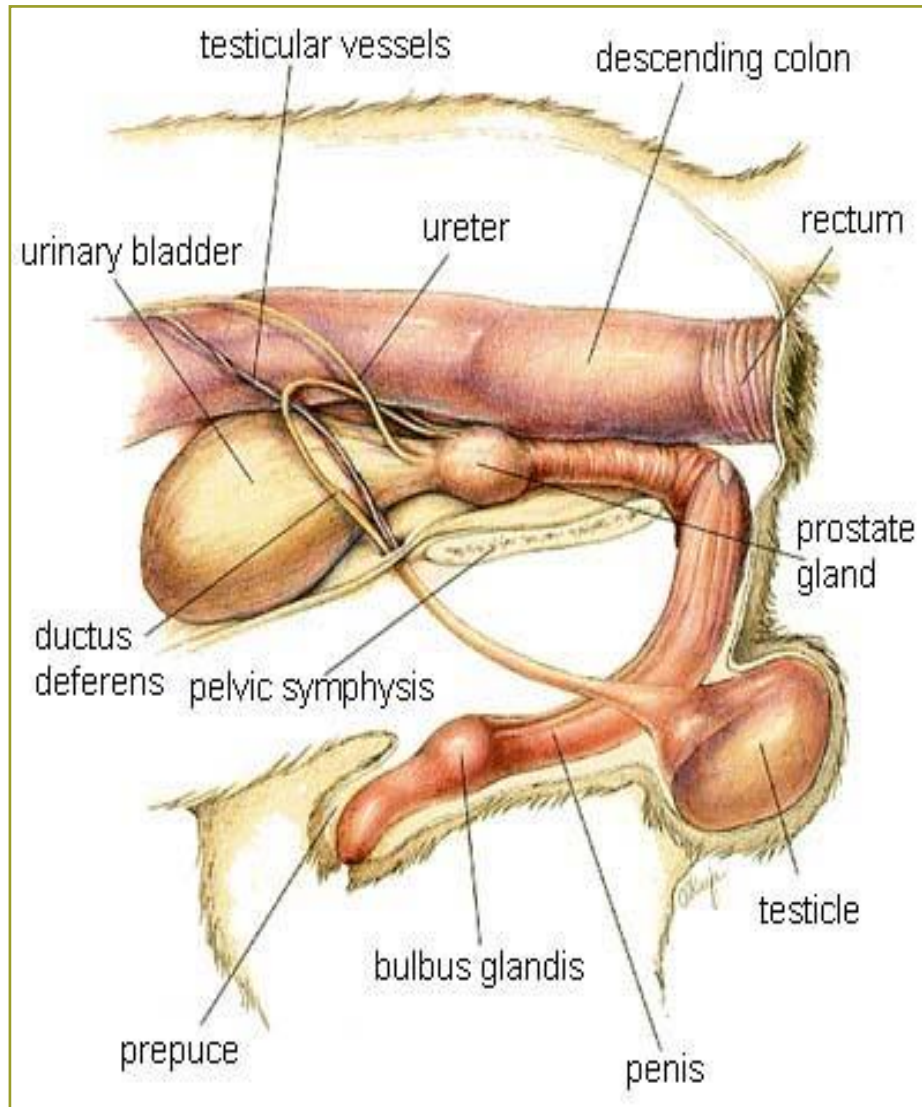
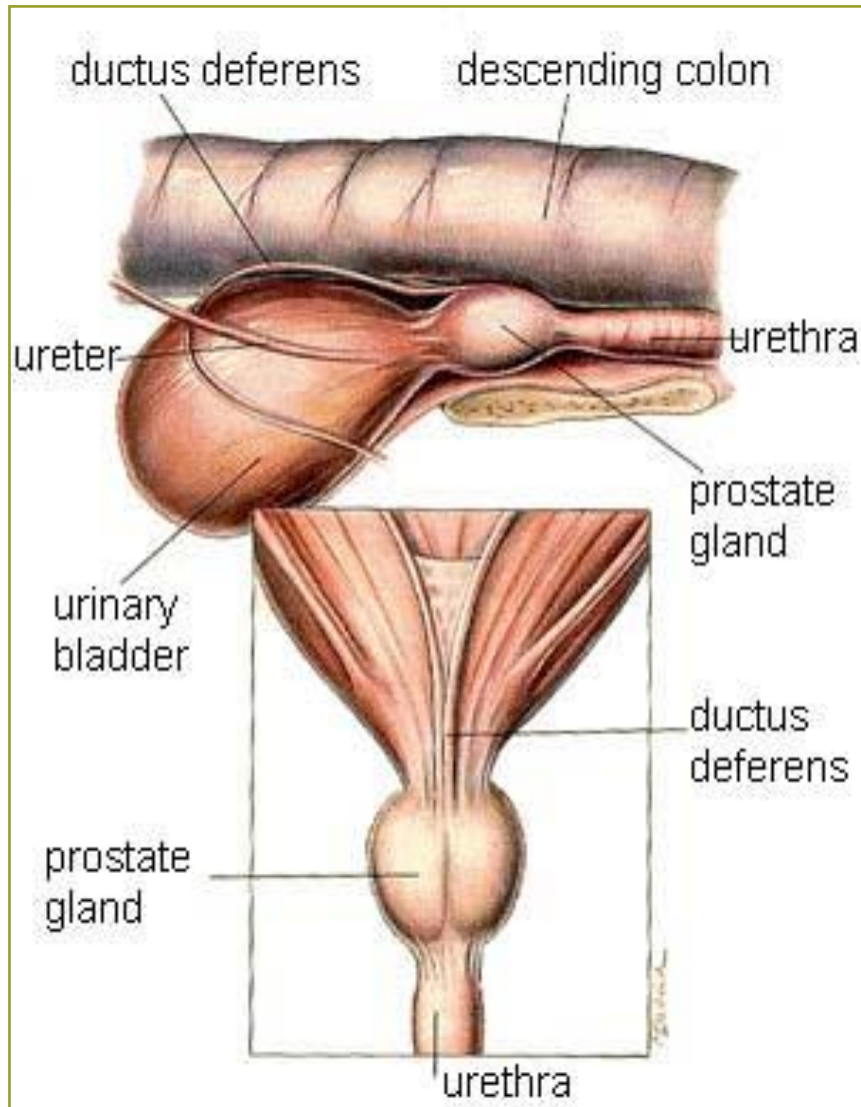
Urinary Bladder

- Lined with transitional epithelium that stretches as the bladder becomes filled with urine
- Wall of the urinary bladder contains smooth muscle bundles

Urethra

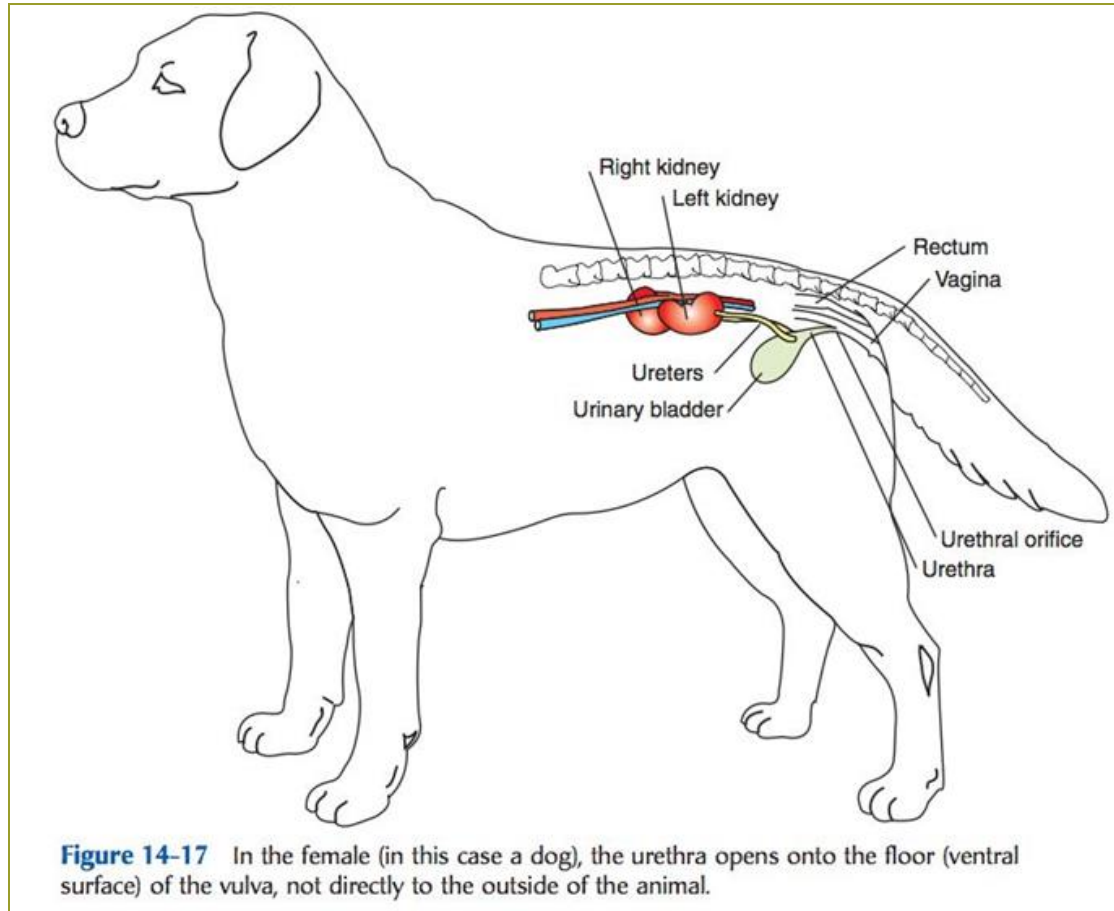
- The female urethra is shorter and straighter than the long, curved male urethra
 - In the female the urethra opens on the ventral portion of the vestibule of the vulva
- In the male the urethra runs down the center of the penis and also functions in the reproductive system

Canine Male Urethra

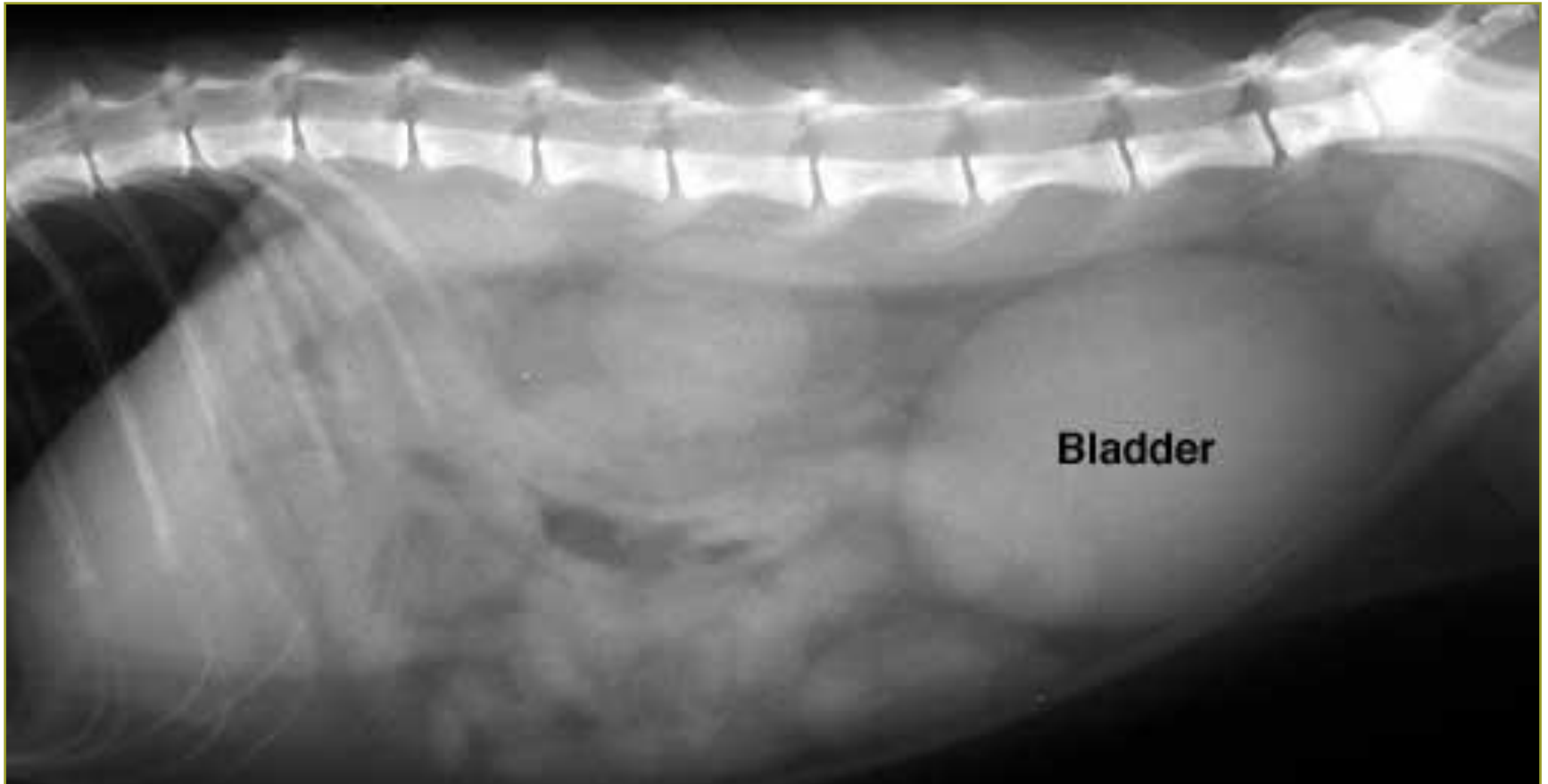


Canine Female Urethra

Bassert Lab Manual – Page 400



Kidneys, Urinary Bladder



Topic 6

List and discuss the steps in performing a total urinalysis



Urinalysis

Clinical Application – Page 375



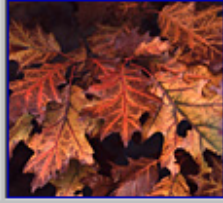
CLINICAL APPLICATION

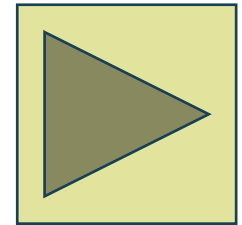
Urinalysis

Urinalysis (UA) is the laboratory examination and evaluation of a urine sample. It involves a gross (unmagnified) examination for color and clarity, a microscopic examination for formed elements, and a chemical analysis for dissolved substances. A lot of information about how well the kidneys are working and the state of an animal's health can be gleaned from looking at the composition of its urine. A urinalysis is often part of a routine physical examination. Normally urine is about 95% water. Nitrogenous wastes from protein breakdown, electrolytes (e.g., sodium, potassium, bicarbonate, ammonium), and pigments from red blood cell breakdown, foods, or drugs are dissolved in the water. Formed elements such as red blood cells, white blood cells, parasites, and crystals may be present in abnormal conditions.

Great Urinalysis Overview

<http://ahdc.vet.cornell.edu/clinpath/modules/index.htm>

<p><i>eClinPath</i> the on-line textbook</p> <p>Cornell University College of Veterinary Medicine</p> 	
<p>Hemogram Basics</p> <p>Presents the derivation and significance of the individual parameters reported on the routine hemogram (CBC)</p>	<p>Hematology Atlas</p> <p>Blood film examination; pictures and discussion of leukocyte and platelet morphology in various animal species</p>
<p>Routine Urinalysis</p> <p>Presents the derivation and significance of the individual parameters reported on the routine urinalysis (UA)</p>	<p>Urine Sediment Atlas</p> <p>Focuses on the microscopic features of the urinary sediment, including cells, casts, and infectious agents</p>
<p>Clinical Chemistry</p> <p>Reviews clinical chemistry tests (panels and individual tests), including variables affecting test results, reference interval determination and pattern recognition</p>	<p>Red Cell Morphology</p> <p>Artifacts, normal and abnormal red cell shapes, reticulocytes, inclusions, and parasites</p>
<p>Hemostasis</p> <p>Reviews the physiology and clinical assessment of hemostasis, as well as the pathophysiology and treatment of hemostatic disorders in domestic animals</p>	<p>Case of the month</p> <p>A Diagnostic Challenge Classic and interesting cases seen in Clinical Pathology</p>
<p>Copyright © Cornell University; TW French, JT Blue, & T Stokol</p>	



Great Urinalysis Overview

<http://library.med.utah.edu/WebPath/TUTORIAL/URINE/URINE.html>

Urinalysis



[Return to the tutorial menu.](#)

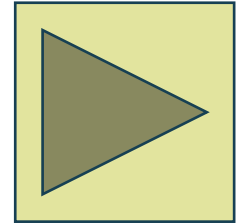
Images available as described below range in file size from 50 to 150k.

Urinalysis can reveal diseases that have gone unnoticed because they do not produce striking signs or symptoms. Examples include diabetes mellitus, various forms of glomerulonephritis, and chronic urinary tract infections.

The most cost-effective device used to screen urine is a paper or plastic dipstick. This microchemistry system has been available for many years and allows qualitative and semi-quantitative analysis within one minute by simple but careful observation. The color change occurring on each segment of the strip is compared to a color chart to obtain results. However, a careless doctor, nurse, or assistant is entirely capable of misreading or misinterpreting the results. Microscopic urinalysis requires only a relatively inexpensive light microscope.

MACROSCOPIC URINALYSIS

The first part of a urinalysis is direct visual observation. Normal, fresh urine is pale to dark yellow or amber in color and clear. Normal urine volume is 750 to 2000 ml/24hr.



Let's get a Urine Sample!



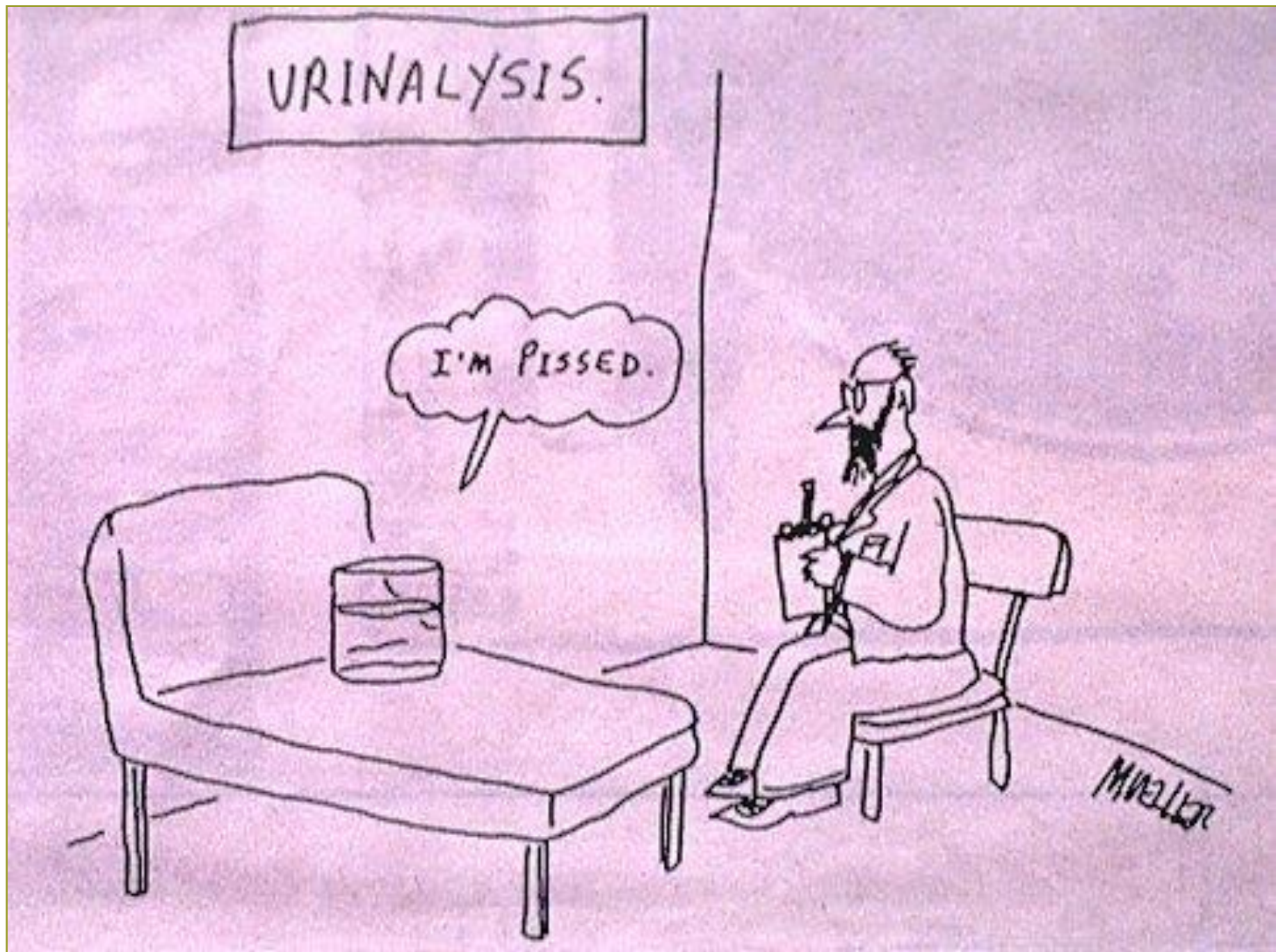


What do you think I'm doing? The Doctor told me to collect a mid-stream urine specimen!"

URINALYSIS.

I'M PISSED.

M. WALTER



What Is Urine?

- Definition - The waste product secreted by the kidneys that in mammals is a **yellow to amber-colored**
- Rich in **end products of protein metabolism** together with **salts** and **pigments**
- 95% water





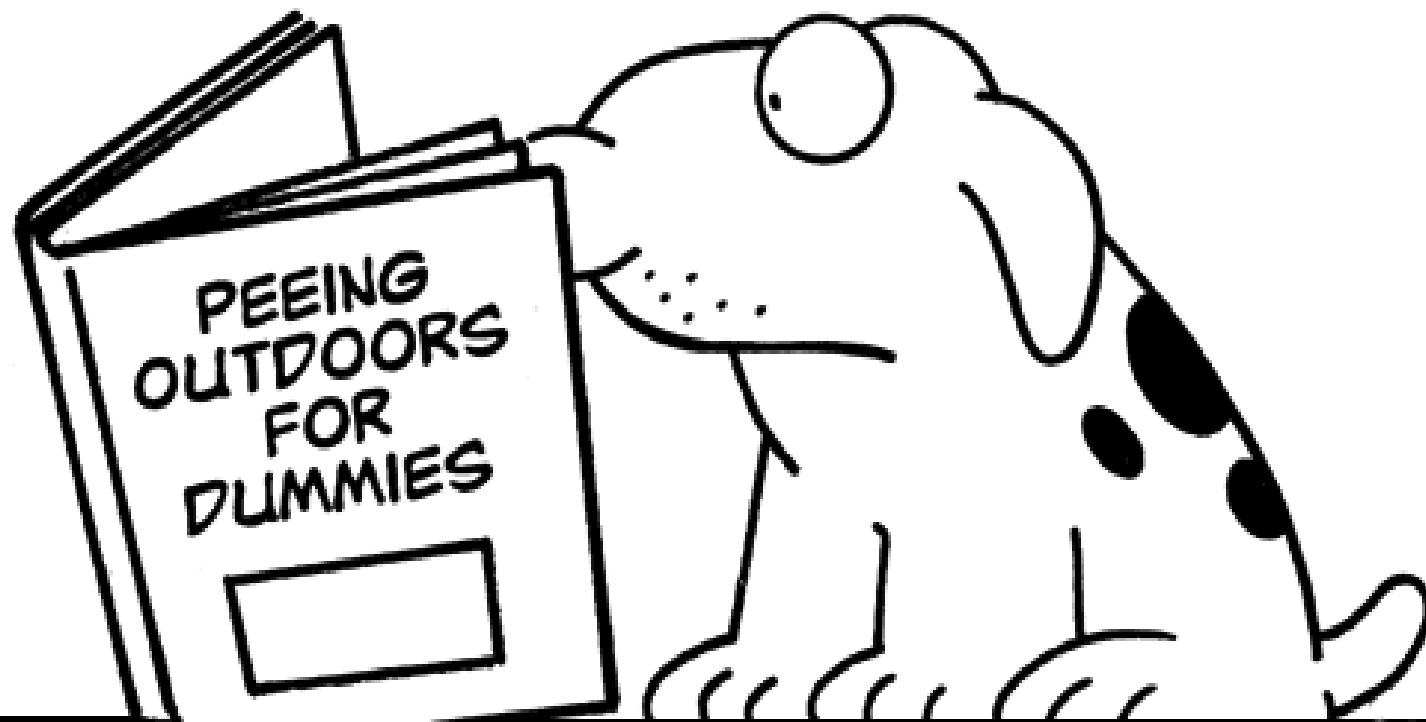
Urine

- 0.05% Ammonia
- 0.18% Sulphate
- 0.12% Phosphate
- 0.6% Chloride
- 0.01% Magnesium
- 0.015% Calcium
- 0.6% Potassium
- 0.1% Sodium
- 0.1% Creatinine
- 0.03% Uric acid
- 2% Urea

- 95% Water

Reasons for Urinalysis

- Routine diagnostic test
- Surgical patient
- Geriatric patient (part of “Geriatric Profile”)
- Suspected diseases
 - Renal disease
 - Cystitis
 - Diabetes mellitus
 - Neoplasia



Normal or Nuts? 😊



Total Urinalysis

Physical Examination

Chemical Examination

Microscopic Examination (“Urine Seds”)

Total Urinalysis

- Definition
 - Provides information on state of the kidneys
 - Provides information on animal's ability to filter & excrete metabolites
- Physical examination of urine
- Chemical examination of urine
- Microscopic examination of urine

Urinalysis Report

URINALYSIS

Name: _____ Date: _____

Appearance: _____ Blood: _____

Color: _____ Bilirubin: _____

Protein: _____ Ketones: _____

Spec Grav: _____ Glucose: _____

Sediment: _____ Urobilinogen: _____

Bacteria: _____ RBC: _____

WBC: _____ Crystals: _____

Casts: _____ Epithelium: _____

pH: _____ Notes: _____

UAL AN415

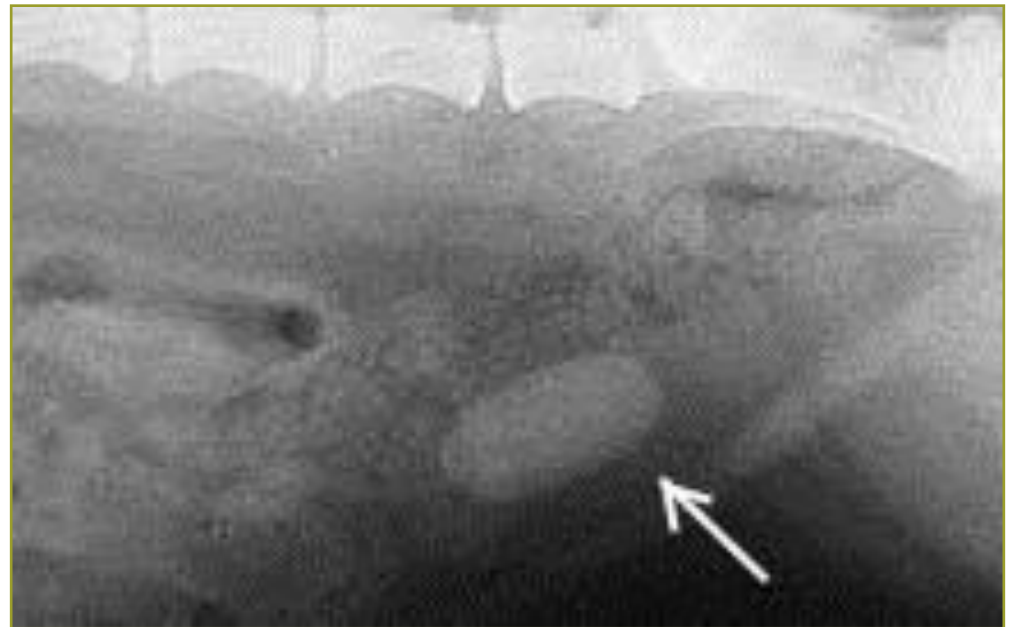
Observe Colors of Urine

Normal or pathology?



Topic 7

List and describe clinical applications and diseases of the urinary system



A close-up photograph of a woman's chest and neck. She is wearing a dark blue t-shirt with white text. A green lanyard is attached to her shirt with a black clip. She is also wearing a thin gold necklace with a small pendant and large black earrings. The background shows a dimly lit interior with blue seats.

I'M CONFUSED

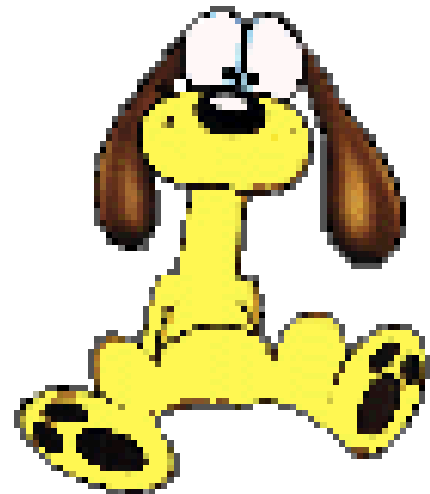
...wait, maybe I'm not.

Clinical Applications

- Urinalysis (Page 375)
- Renal threshold of glucose (Page 380)***
- Urine production review (Pages 381-382)
- Renal dysfunction & uremia (Page 385)
- Uroliths & urolithiasis (Page 386)
- Feline lower urinary tract disease (FLUTD) (Page 385)

Clinical Terms

- Diuresis
- Micturition
- Express the bladder
- Cystocentesis
- Cystotomy
- Pneumocystogram
- Perineal urethrostomy (PU)



Micturition

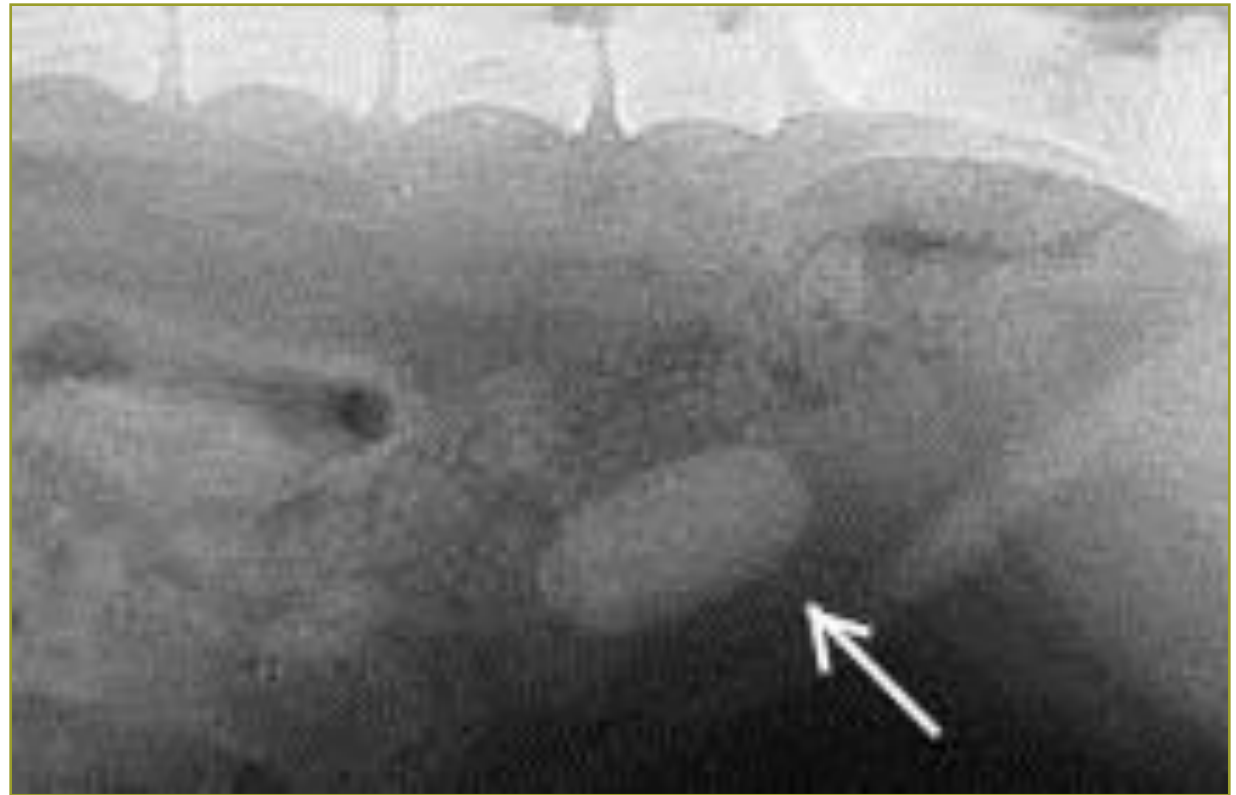
- Micturition or uresis: expulsion of urine from the urinary bladder into the urethra
- Urine accumulates until pressure of the filling bladder activates stretch receptors in bladder wall

Urinary System Pathology

- Hematuria
- Uremia
- Anuria
- Oliguria
- Cystitis
- “Blocked cats”
- Nephritis
 - Renal failure
- Ethylene glycol poisoning



Urinary Bladder Stones

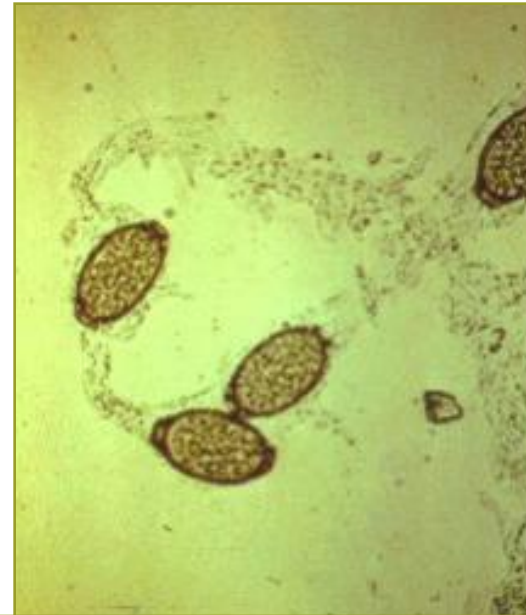


BIG Stone! 😊

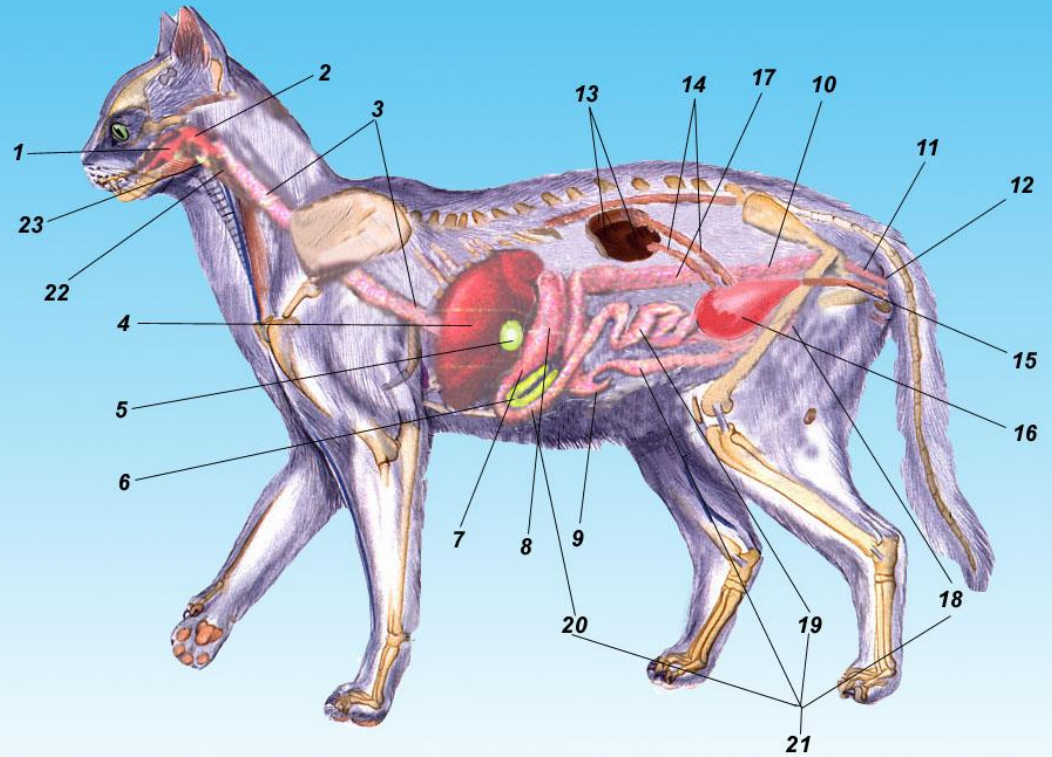


Parasites of the Urinary Tract

- *Capillaria plica* – bladder worm
 - Eggs in urine – bipolar plugs
- *Dioctophyma renale* – giant kidney worm
 - HUGE eggs in urine



Digestive & Urinary Systems



Review of Urinary System

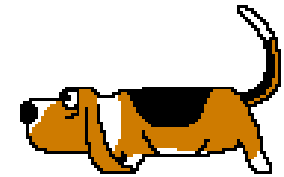
- | | | |
|-----------------|---------------------|---------------------|
| 1. Tongue | 9. Cecum | 17. Large Intestine |
| 2. Pharynx | 10. Colon | 18. Ileum |
| 3. Esophagus | 11. Rectum | 19. Jejunum |
| 4. Liver | 12. Anus | 20. Duodenum |
| 5. Gall Bladder | 13. Kidneys | 21. Small Intestine |
| 6. Pancreas | 14. Ureters | 22. Trachea (cut) |
| 7. Pylorus | 15. Urethra | 23. Epiglottis |
| 8. Stomach | 16. Urinary Bladder | |

Test Yourself
KNOW THESE IN EVERY CHAPTER!

Pages 378, 383, 383, 384, 386

Clinical Applications

Pages 375, 380, 381, 381-382, 385, 385, 386



The Reproductive System

Chapter 17



Pages 387-404

Textbook Learning Objectives

Chapter 17 – Page 387

- Differentiate between meiosis and mitosis
- Describe the processes of spermatogenesis and oogenesis
- Describe the structure of spermatozoa
- List the components of the male reproductive system and describe the functions of each
- List the characteristics and functions of the accessory structures of the male reproductive system
- List the components of the female reproductive system and describe the functions of each
- Describe the events that occur during the ovarian cycle
- List the stages of the estrous cycle and describe the events that occur during each stage
- Differentiate between monoestrous, diestrous, polyestrous, and seasonally polyestrous estrous cycle intervals

Topic 8

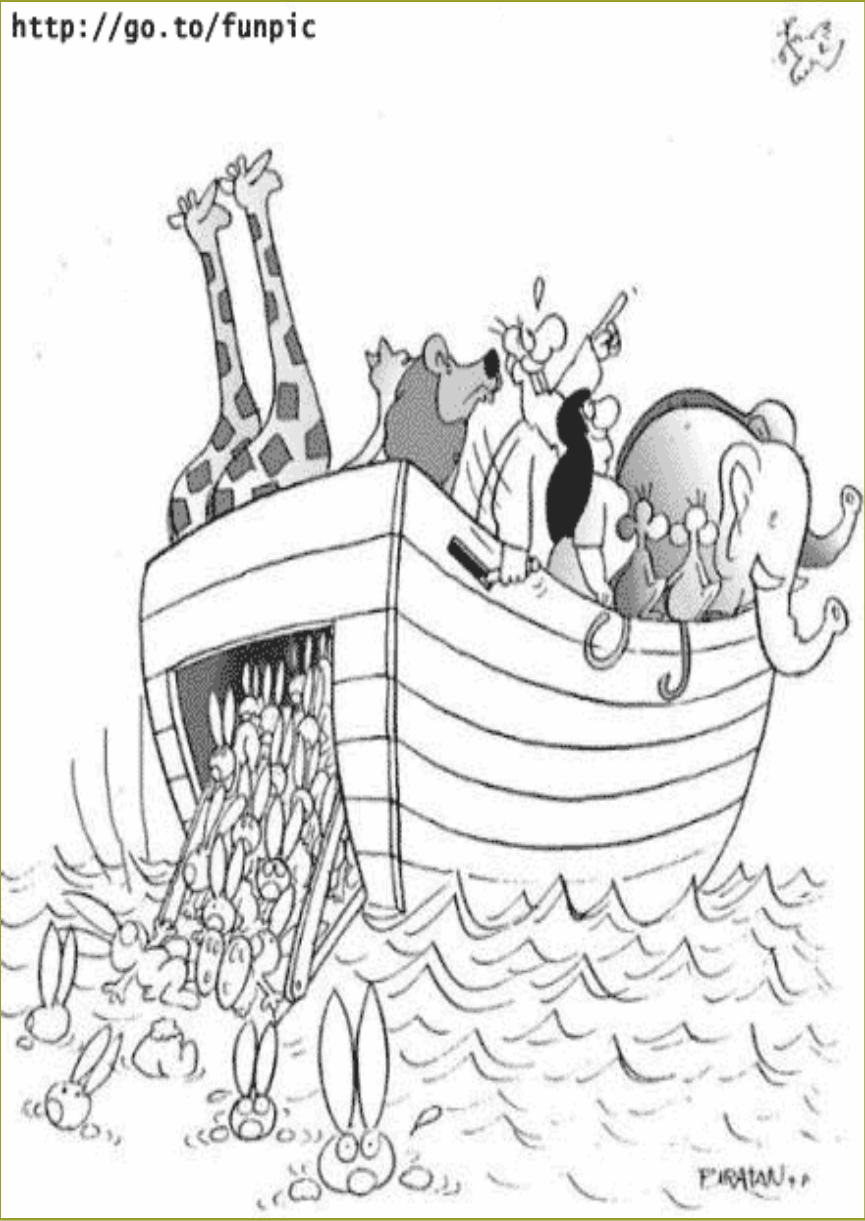
Discuss an overview of the reproductive systems in animals

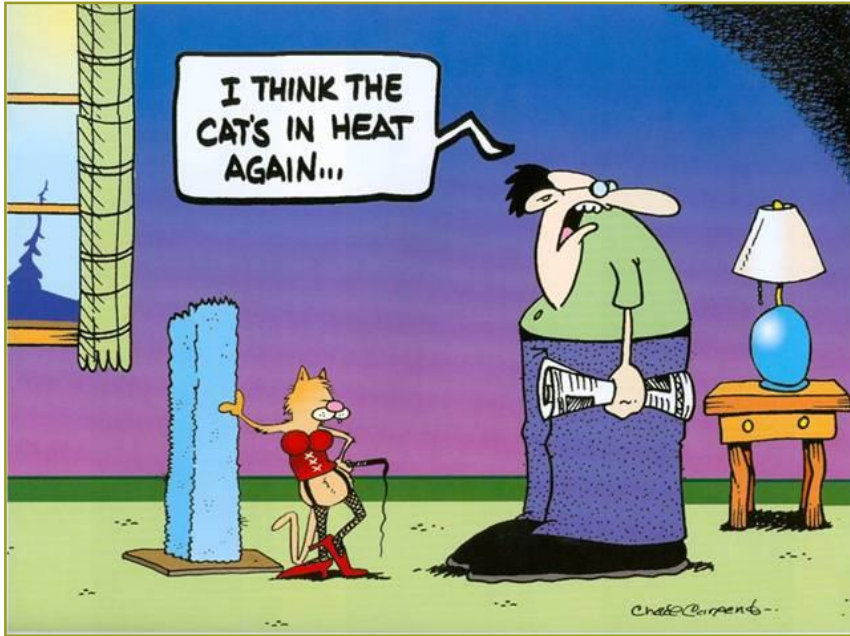


Putting Things in
Perspective! 😊



“Ha ha ha, Biff. Guess what?
After we go to the drugstore and the post office,
I'm going to the vet's to get tutored.”





BIZARRO

What would it cost if I sent my husband in to get the dog neutered and you pulled a last-minute switch-a-rooney?



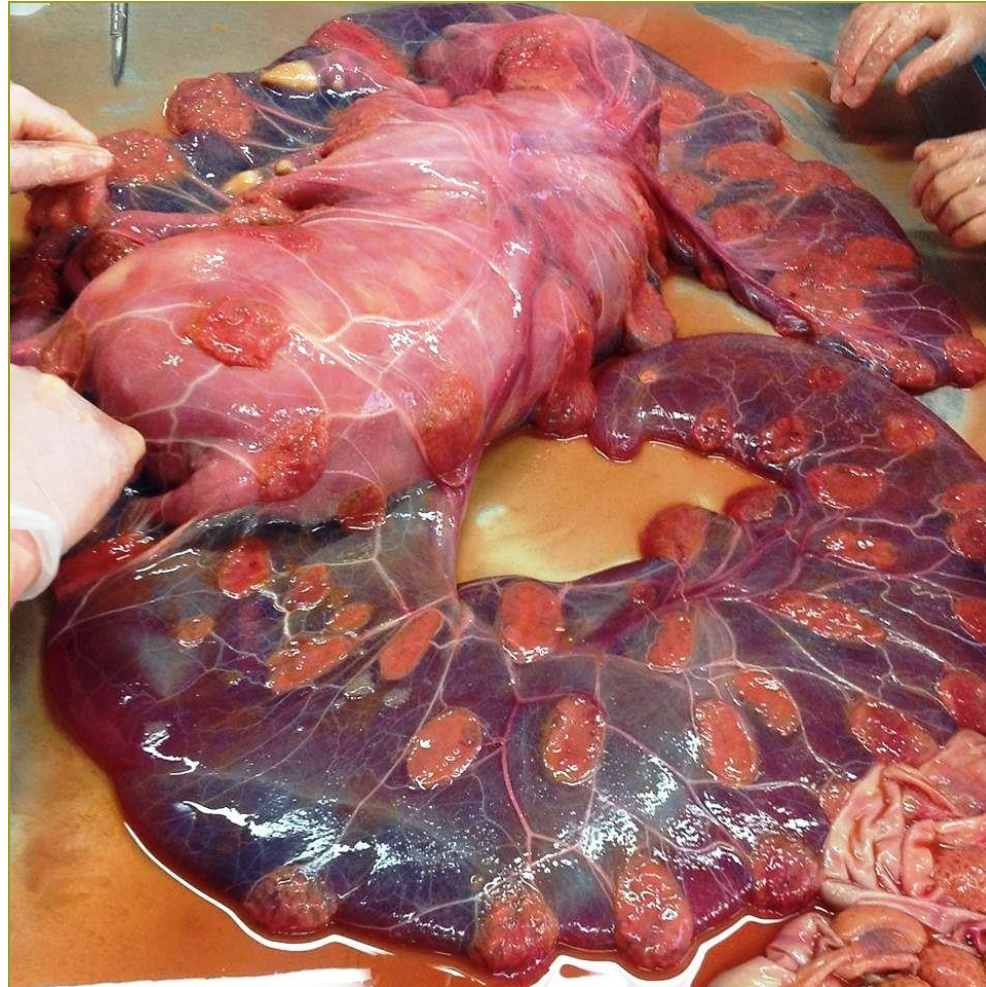
Ever Happen to You? 😊



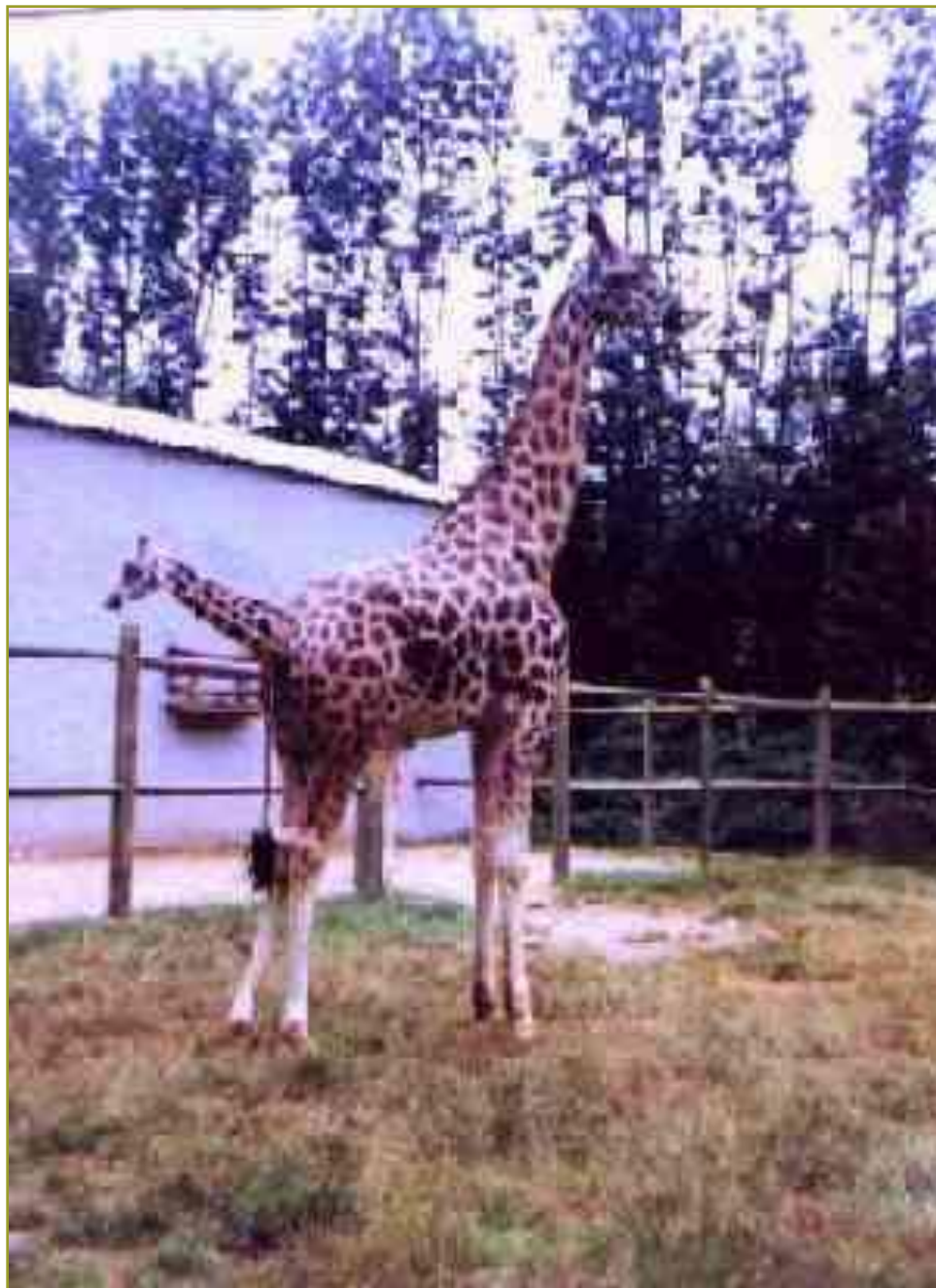
Anybody Know What She Is Doing?



Ruminants – Cotyledonary Placenta







Prolapsed Uterus?



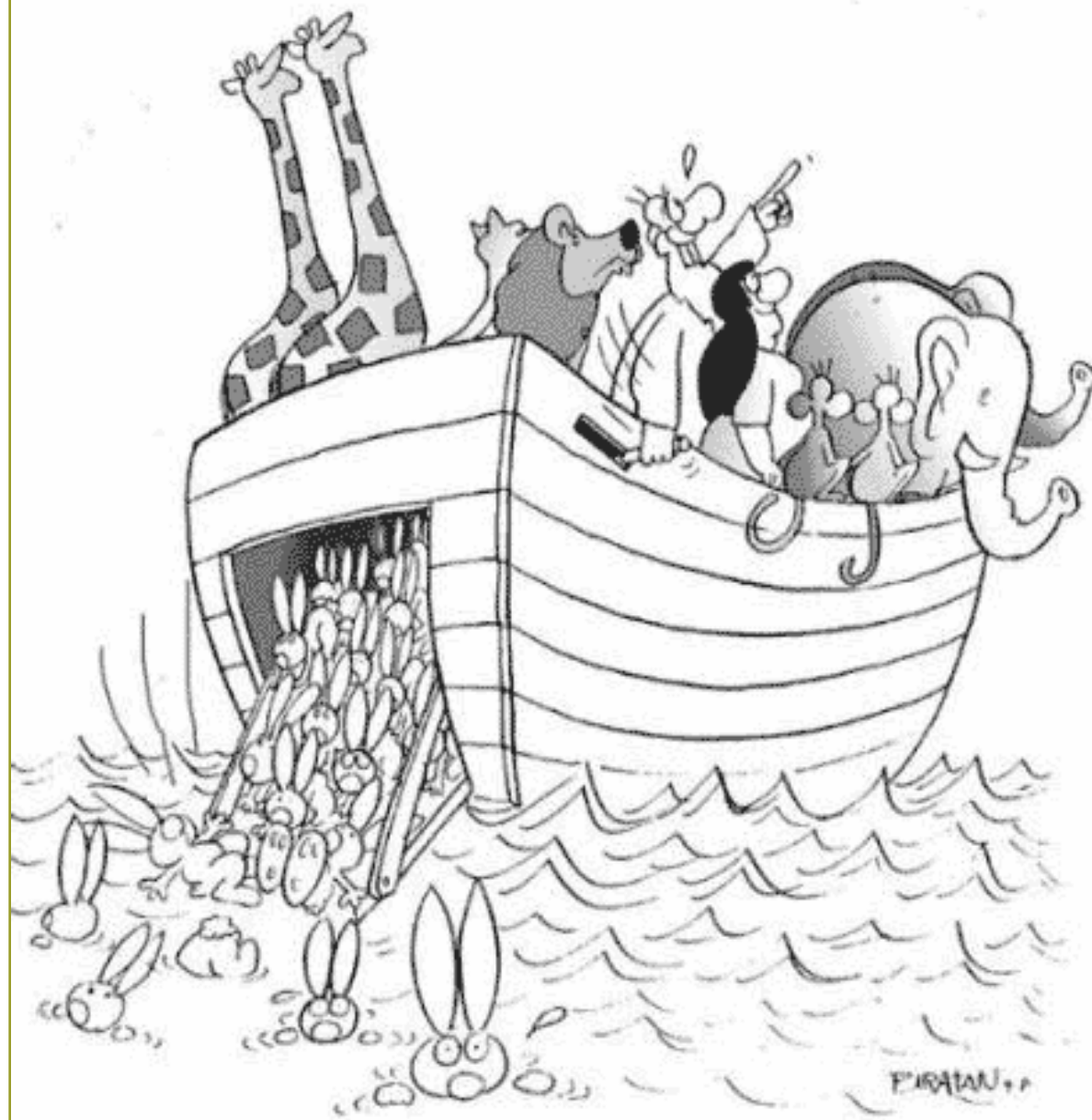
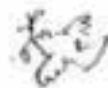
OHE – Uterine Horns



Why Are There So Many Rabbits?? ☺



<http://go.to/funpic>



Overview – Sexual Reproduction

- Survival of the species
 - All other body systems are about the survival of the individual animal
- Economic system for agricultural species
 - Dairy
 - Beef
 - Equine (horse racing)
 - Pork
- Sexual reproduction
- Asexual reproduction

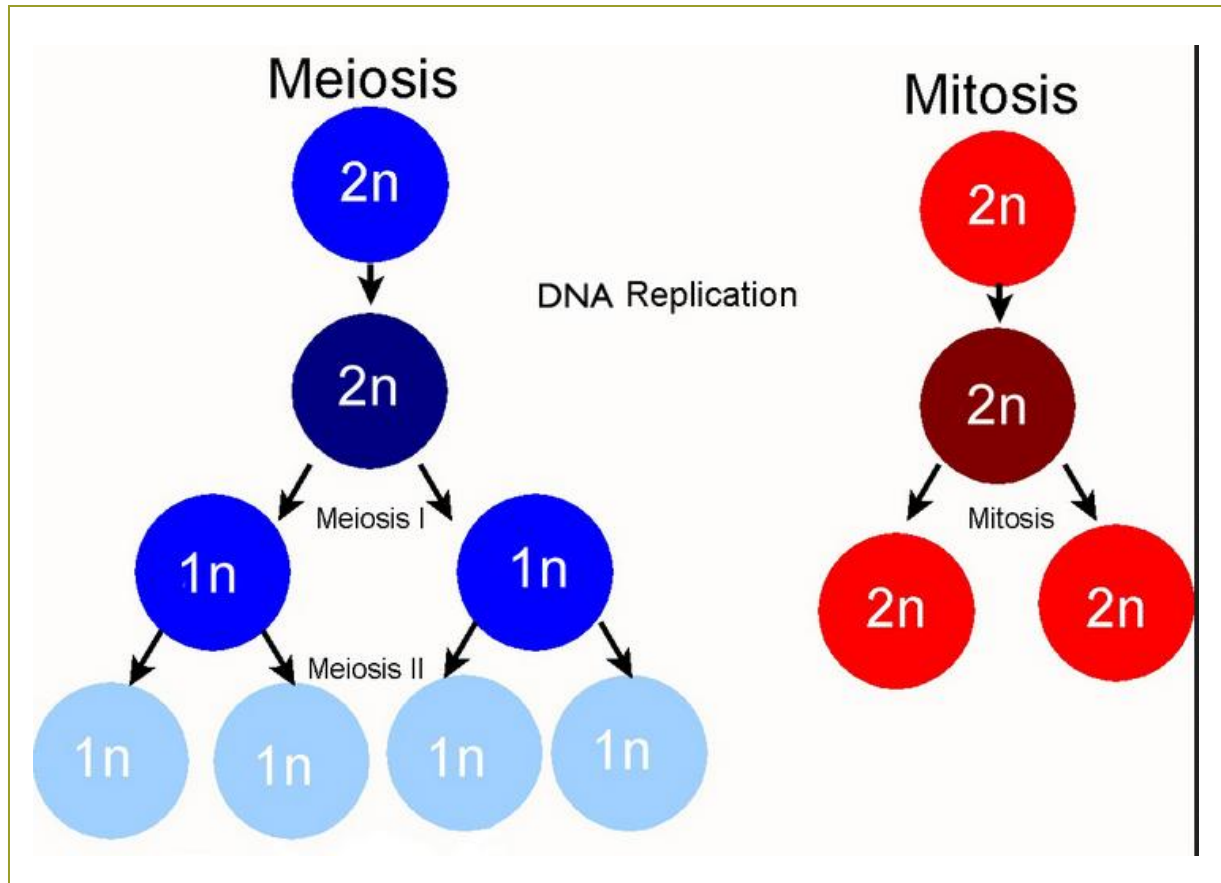


Why Sex?

- Asexual reproduction – massive numbers of “offspring” in short period of time, all organisms with same DNA
 - Bacteria, protozoans, cloning
- Sexual reproduction – fewer numbers of offspring, all organisms with different DNA
 - Increased genetic diversity (larger gene pool)
 - Increased survival of the species
 - Most multicellular organisms

Topic 9

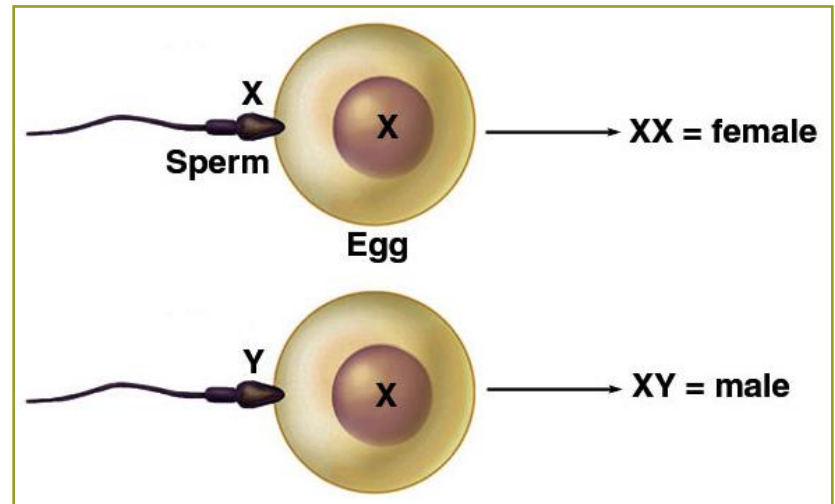
Differentiate between meiosis and mitosis



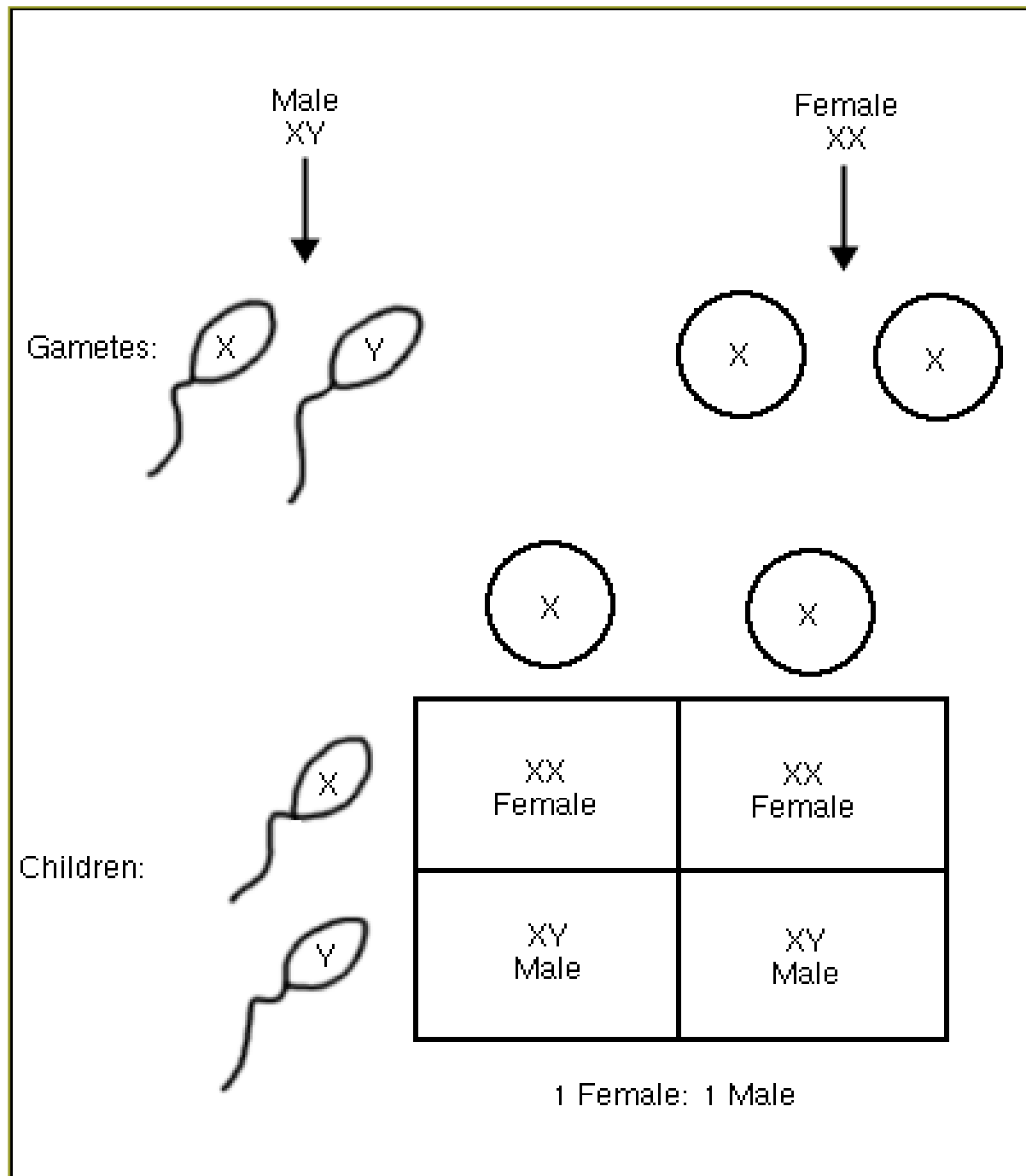
Cellular Reproduction

Table 17-1, Page 388

- Mitosis – diploid chromosome number ($2n$)
 - Production of all cells in body except gametes
- Meiosis – haploid chromosome number (n)
 - Production of gametes (sex cells)
- Fertilization
 - Sperm (n) + ovum (n)
= zygote ($2n$)



The Genetics of Sex



Chromosomes

- Coiled masses of DNA in the nuclei of cells
- Each cell in an animal's body (except spermatozoa or ova) contains paired, identical chromosomes
- Diploid chromosome number
 - Total number of chromosomes in the nucleus of each body cell is the same (except for reproductive cells)
 - Always an even number – chromosomes occur in pairs

Sex Chromosomes

- Designated as either "X" chromosomes or "Y" chromosomes
- If both of the sex chromosomes are X chromosomes (XX), the individual is genetically female
- If one is an X and the other is a Y (XY), the individual is genetically male

Mitosis

- Most body cells divide after the cell first makes a duplicate copy of its chromosomes
- Half the chromosomes go to one daughter cell and half go to the other
- Genetic makeup of the two daughter cells is exactly the same as each other and as the parent cell

Meiosis

- Chromosomes do not produce duplicate copies of themselves before daughter cells divide
- Half of the total chromosomes (one from each diploid chromosome pair and one sex chromosome) go to each daughter cell
- Which chromosomes go to which daughter cell is entirely random

Haploid Chromosome Number

- Reduction division – total number of chromosomes in each of the daughter cells is reduced to half the number of the parent cell
- Ensures that the fertilized ovum from the union of spermatozoa and the ova has diploid number
- Haploid chromosome number in the reproductive cells results from meiosis

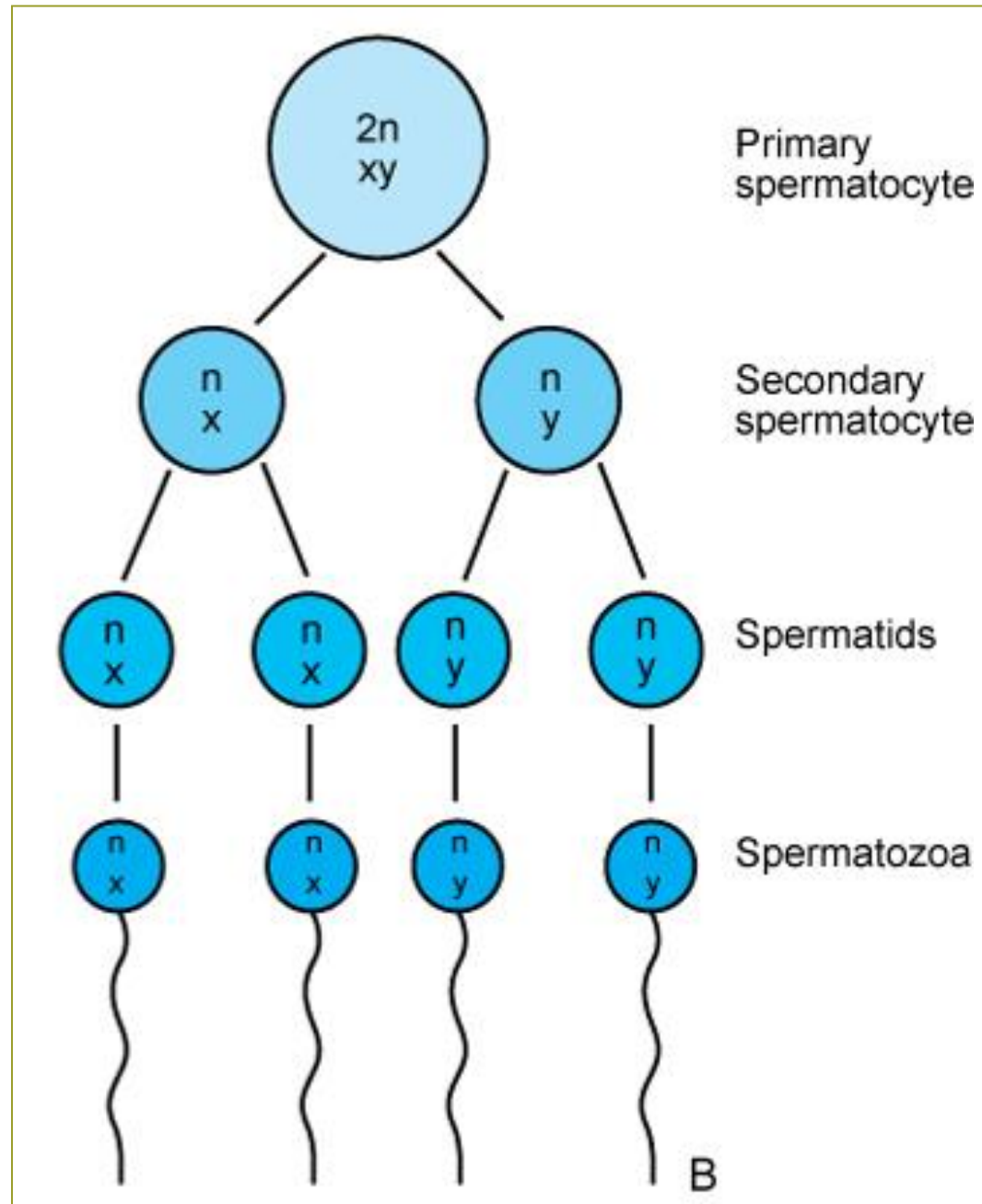
Meiosis – Gamete Formation

Figure 17-1, Page 390

- Diploid number → haploid number of chromosomes
- Spermatogenesis in male animal
 - 1 spermatogonium → 4 mature sperm
- Oogenesis in female animal
 - 1 oogonium → 1 mature egg (ovum) + 3 polar bodies

Topic 10

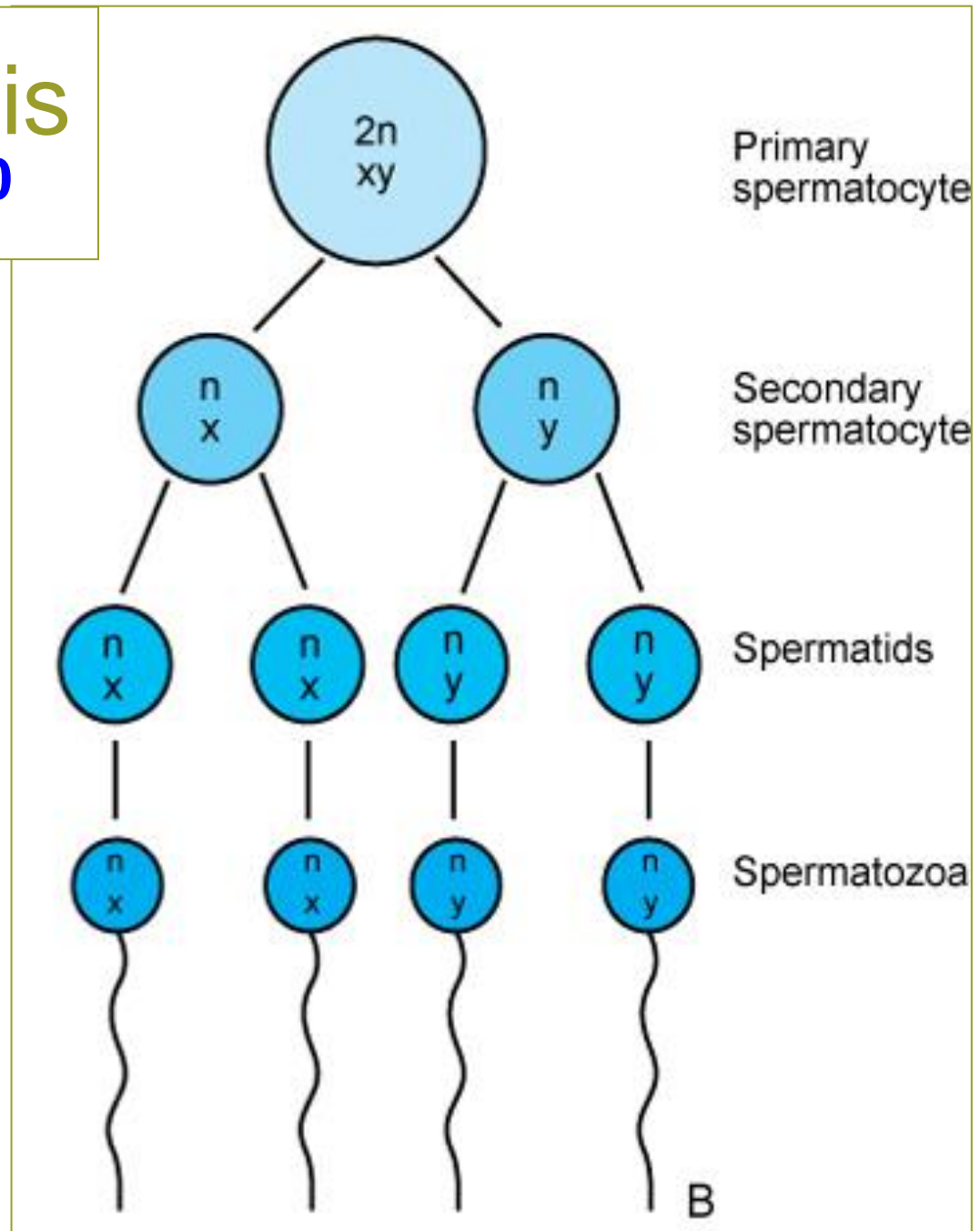
Compare the processes of spermatogenesis and oogenesis



Spermatogenesis

Figure 17-1B, Page 390

- Production of male sex cells
- Occurs in seminiferous tubules of testes
- Produced continuously and in very large numbers



Spermatogenesis

- Primary spermatocyte divides by meiosis into secondary spermatocytes – haploid number
- The secondary spermatocytes divide by mitosis into four spermatids
- Spermatids grow tails and undergo other physical changes that convert them to spermatozoa.

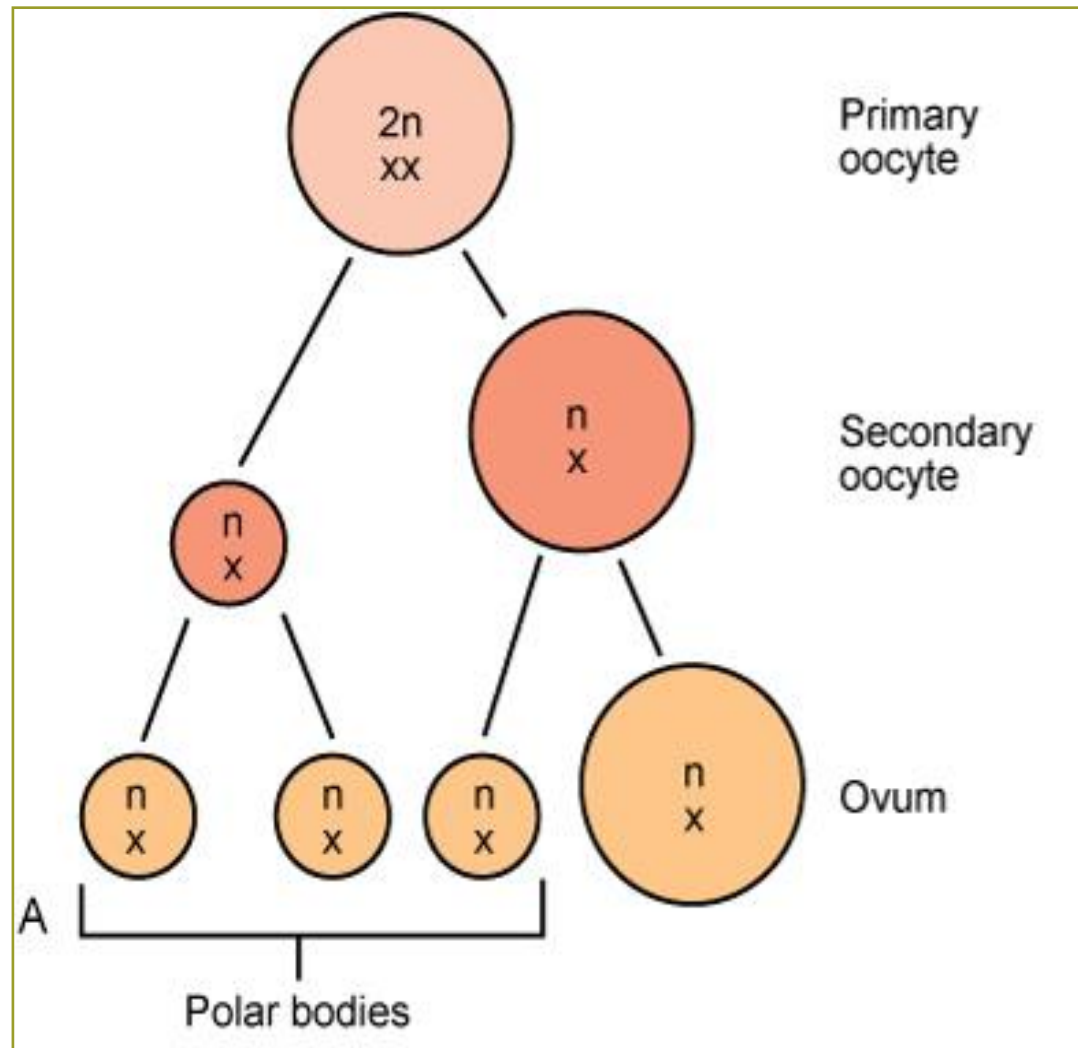
Spermatogenesis

- When the spermatozoa are fully developed, they detach and are carried to the epididymis for storage before ejaculation
- Half of the spermatozoa produced have an X sex chromosome, and half have a Y sex chromosome

Oogenesis

Figure 17-1A, Page 390

- Production of female sex cells
- Occurs in ovarian follicles
- Female has fixed number of primary oocytes at or soon after birth
- Oogenesis produces small numbers of ova at a time

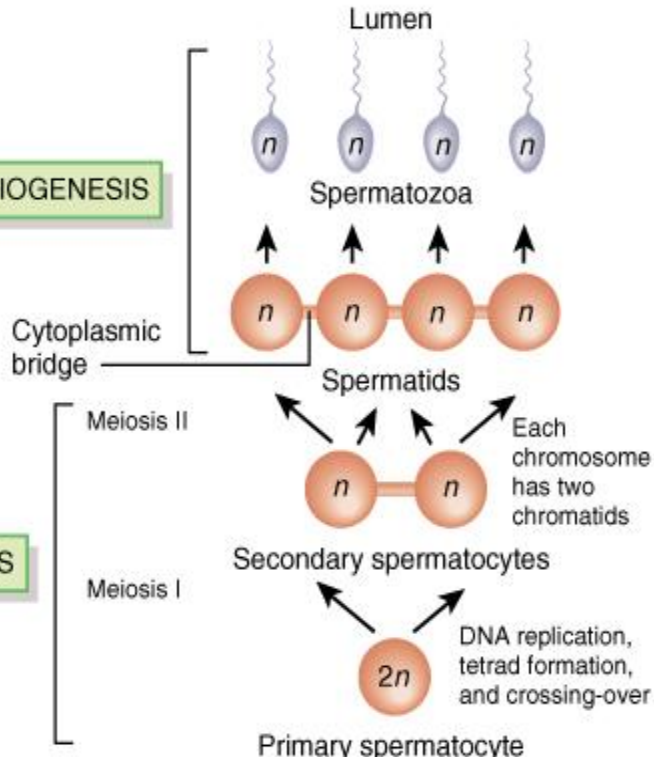


Oogenesis

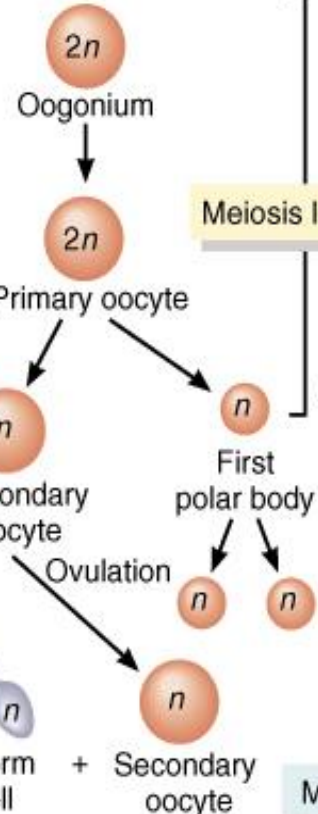
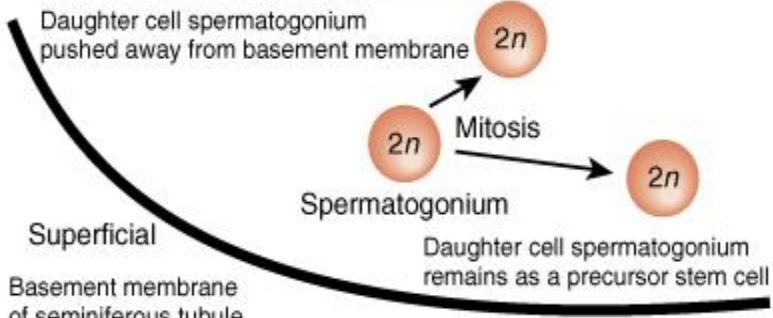
- Primary oocyte divides by meiosis into a large secondary oocyte and a small "polar body"
- Each has the haploid chromosome number
- Secondary oocyte and the first polar body divide by mitosis into an ovum and three polar bodies

Deep

SPERMIOGENESIS



MEIOSIS



During fetal development meiosis I begins but stops in prophase.

After puberty, primary oocytes complete meiosis I, which produces a secondary oocyte and a first polar body that may or may not divide again.

The secondary oocyte begins meiosis II but stops in metaphase.

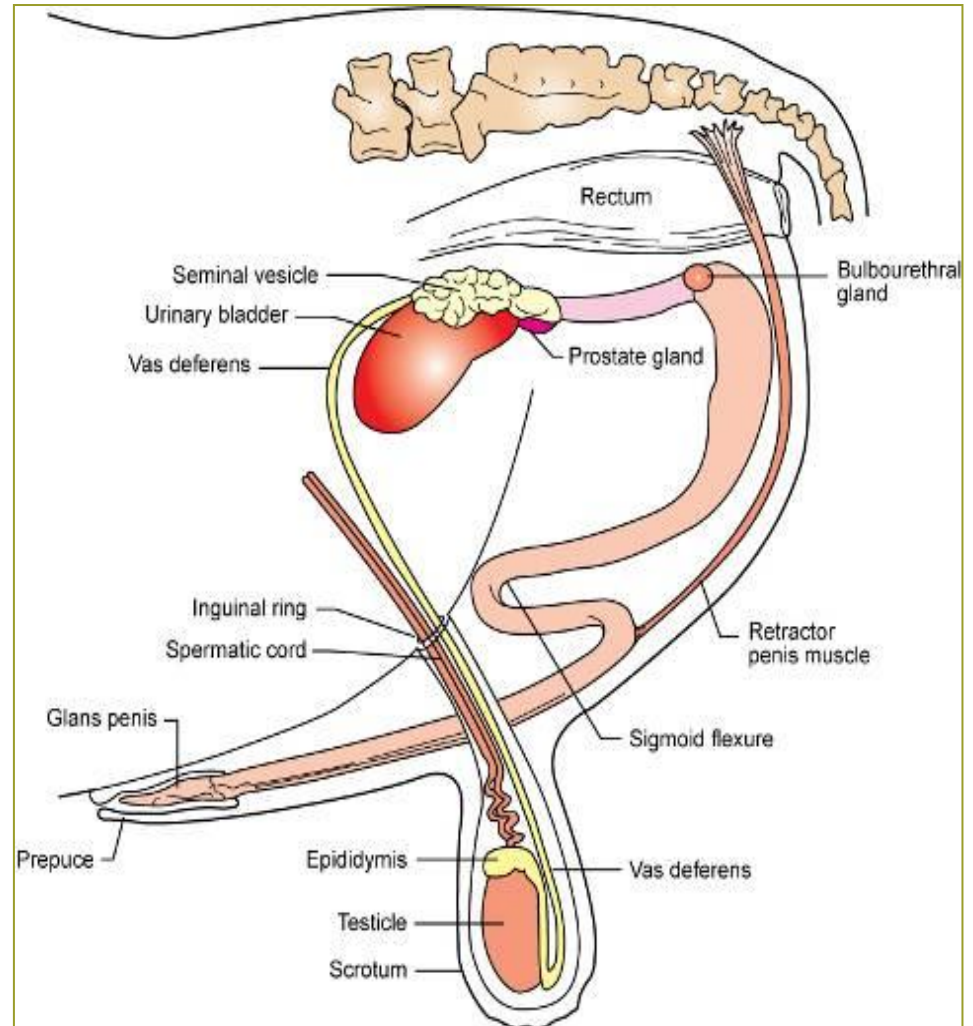
A secondary oocyte (and first polar body) is ovulated.

After fertilization, meiosis II resumes. The oocyte splits into an ovum and a second polar body.

The nuclei of the sperm cell and the ovum unite, forming a diploid ($2n$) zygote.

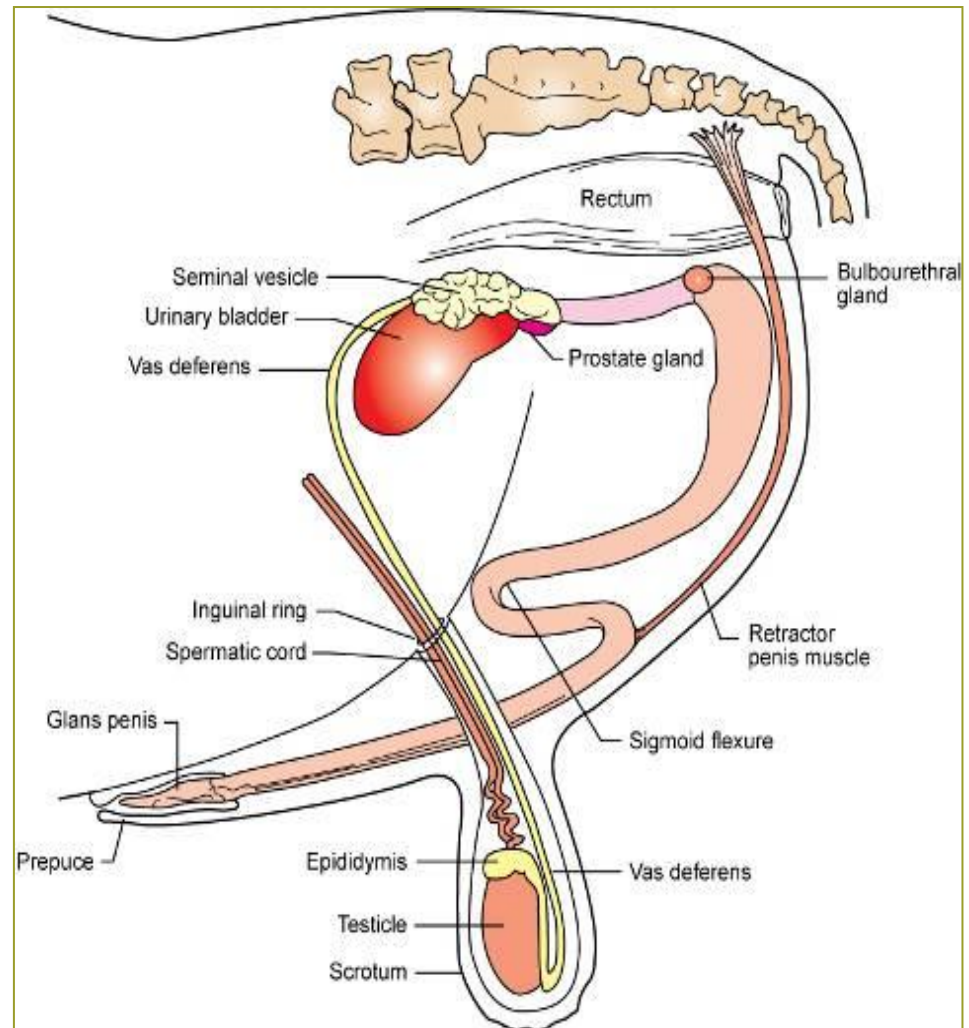
Topic 11

List the structures and functions of the male reproductive system



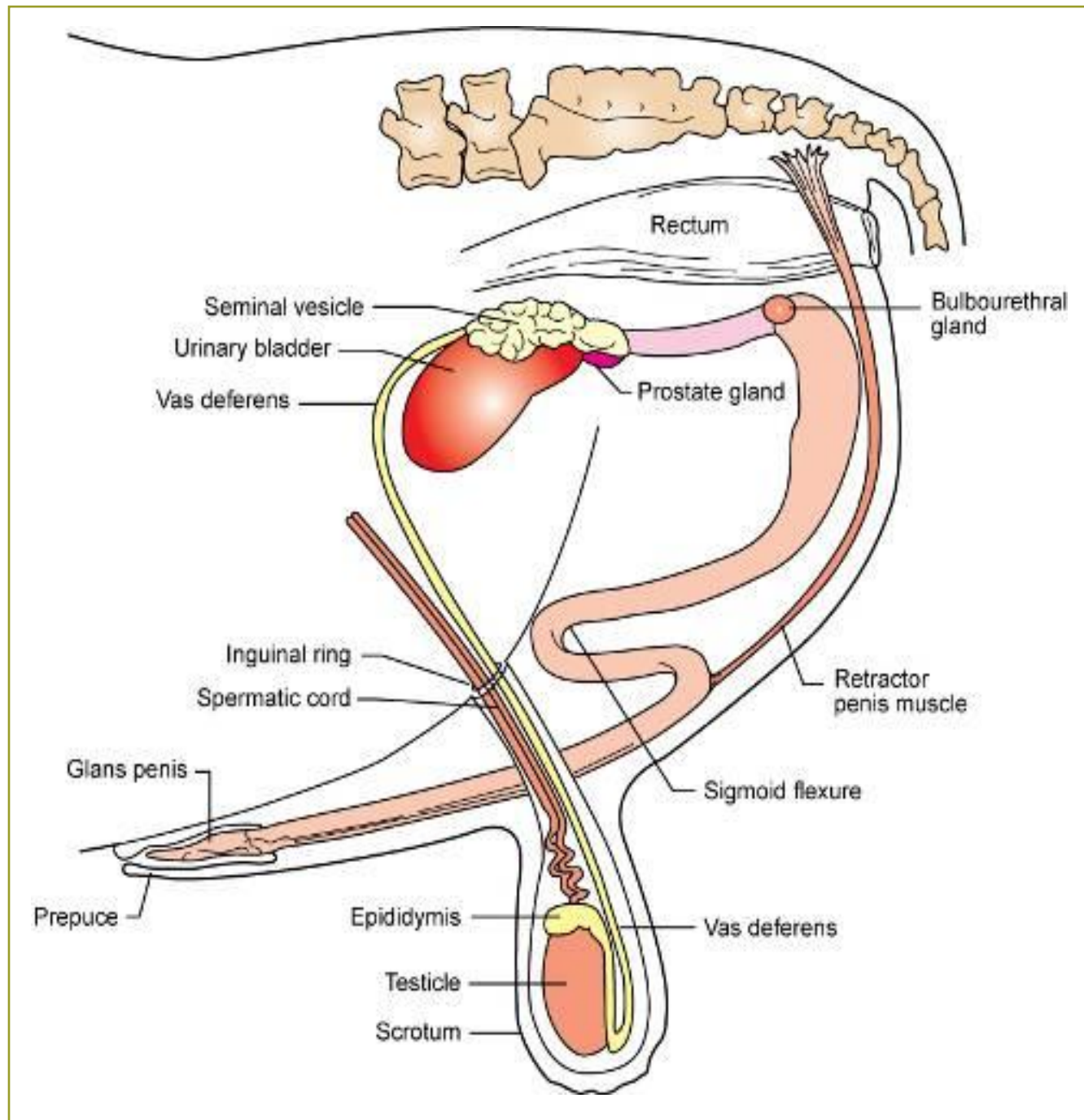
Male Reproductive System Functions

- Produces male sex hormones
- Develops spermatozoa
- Deliver the spermatozoa to the female system at the appropriate time

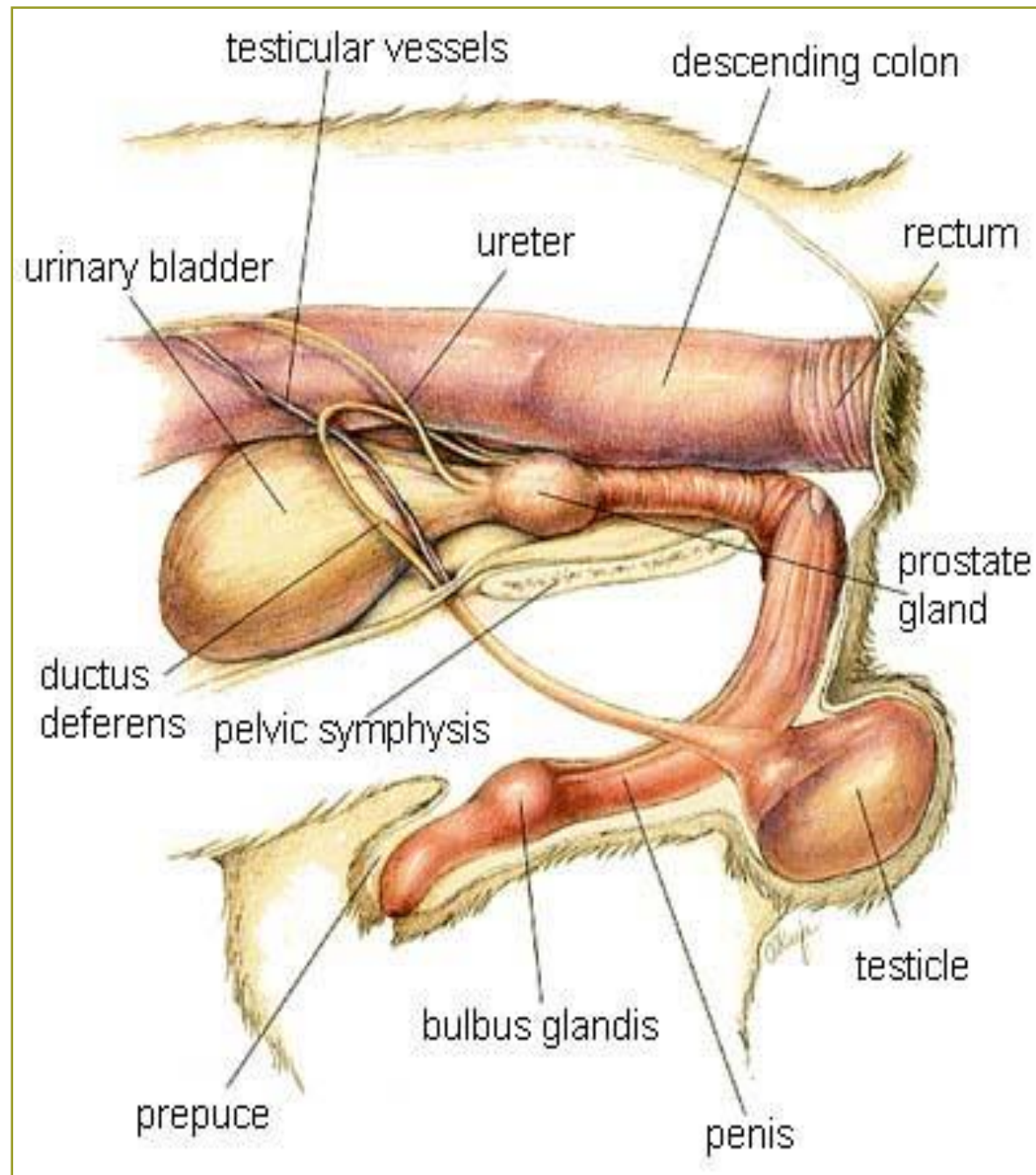


Trace a Sperm Cell (Bovine)

Figure 17-2,
Page 391

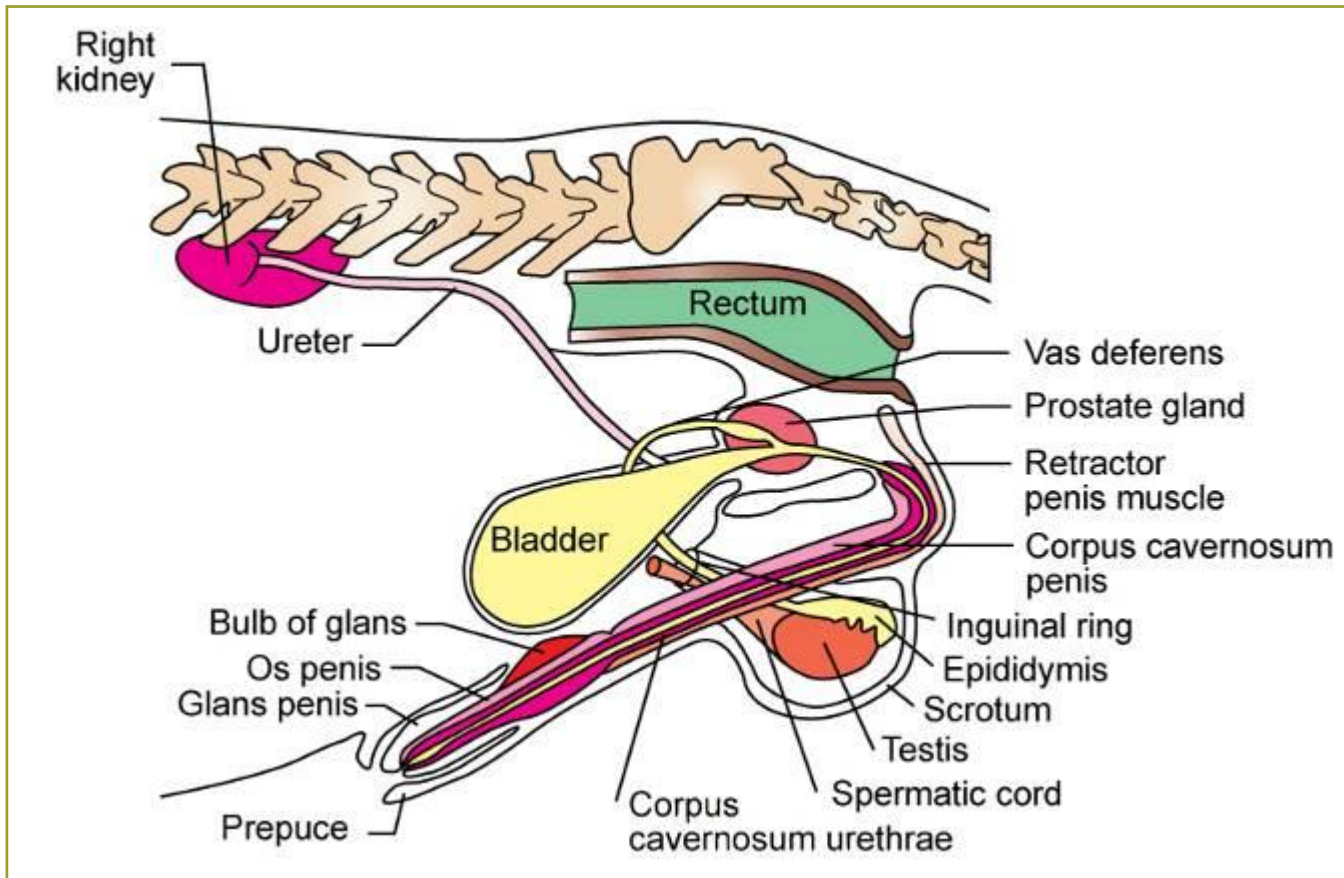


Comparative Anatomy (Canine)

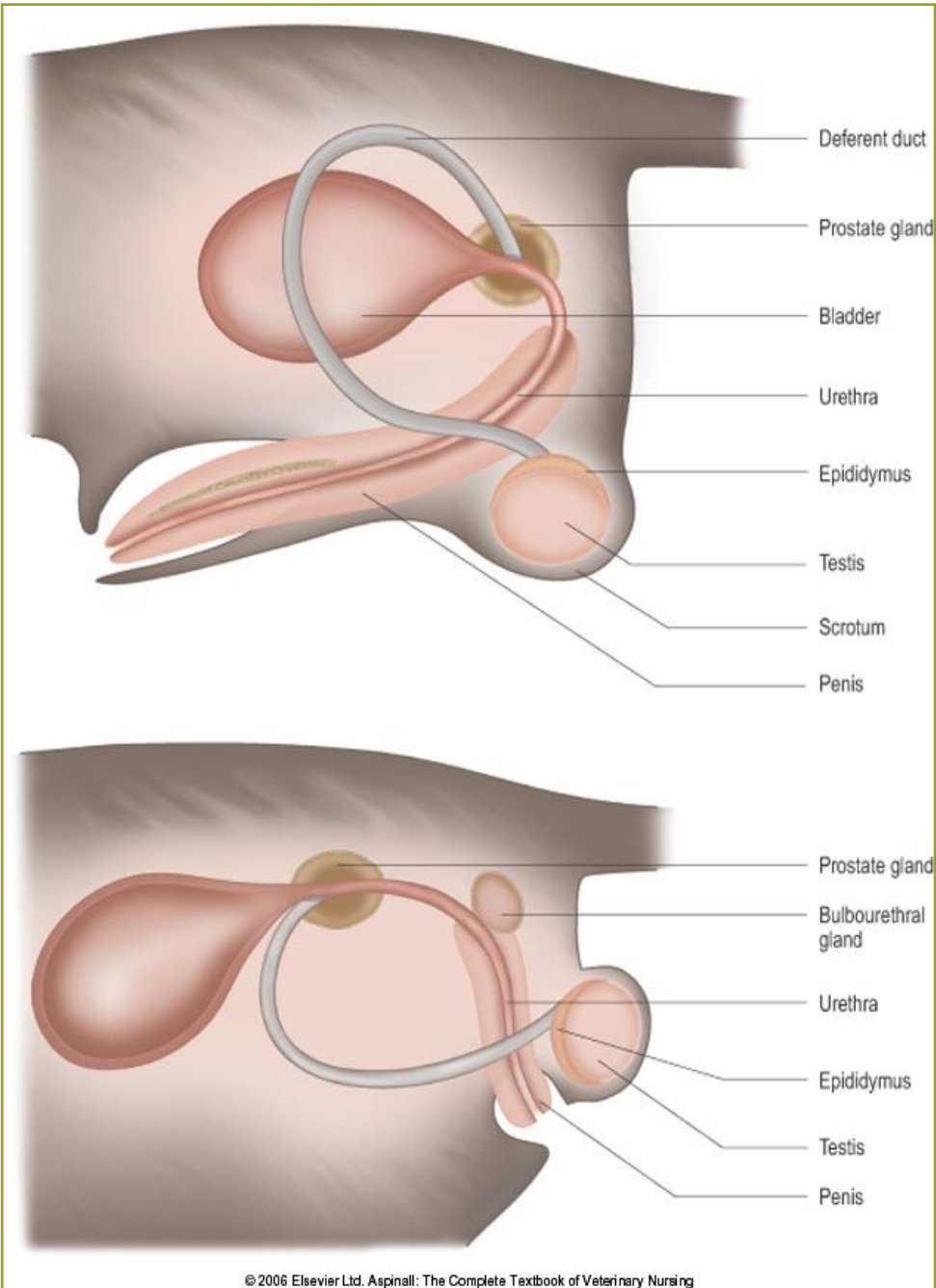


Male Canine Urogenital System

Figure 17-3, Page 392



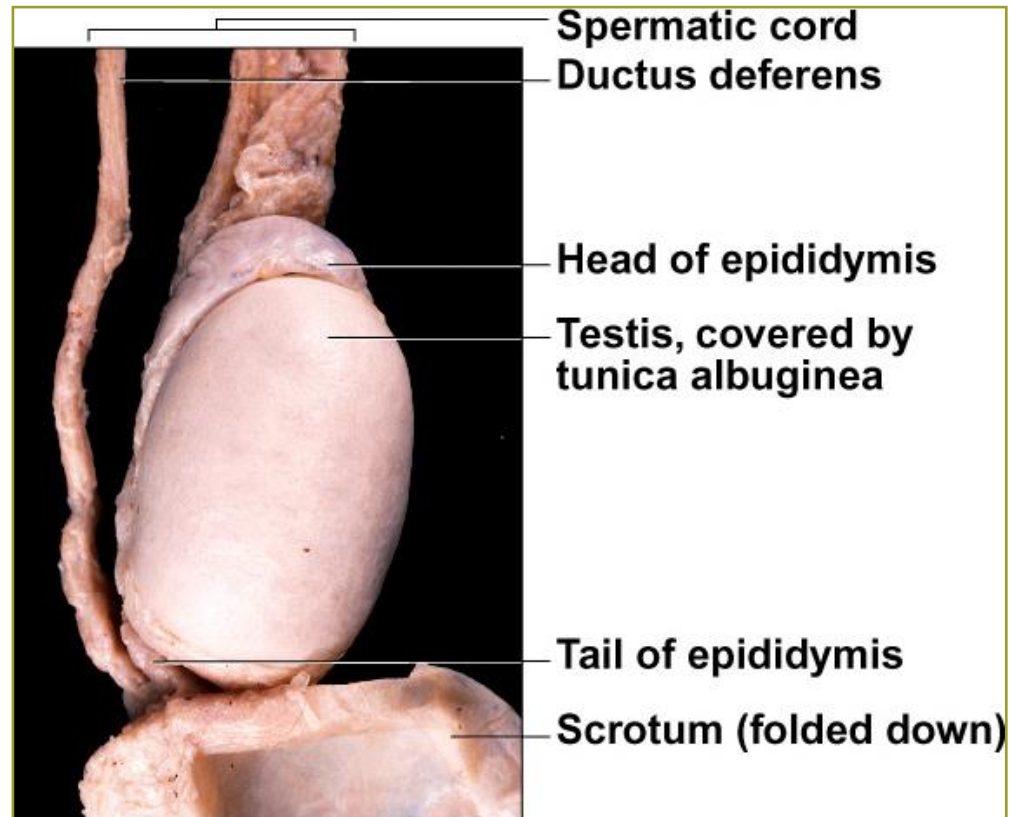
Comparative Anatomy – Male Dog & Cat



Male Reproductive System

Figures 17-2 to 17-6 – Pages 391 & 392

- Scrotum
 - Cremaster muscle
 - Tunica albuginea
- Testicles (testes)
- Epididymis
- Spermatic cord
 - Ductus deferens (vas deferens)
 - Testicular vessels



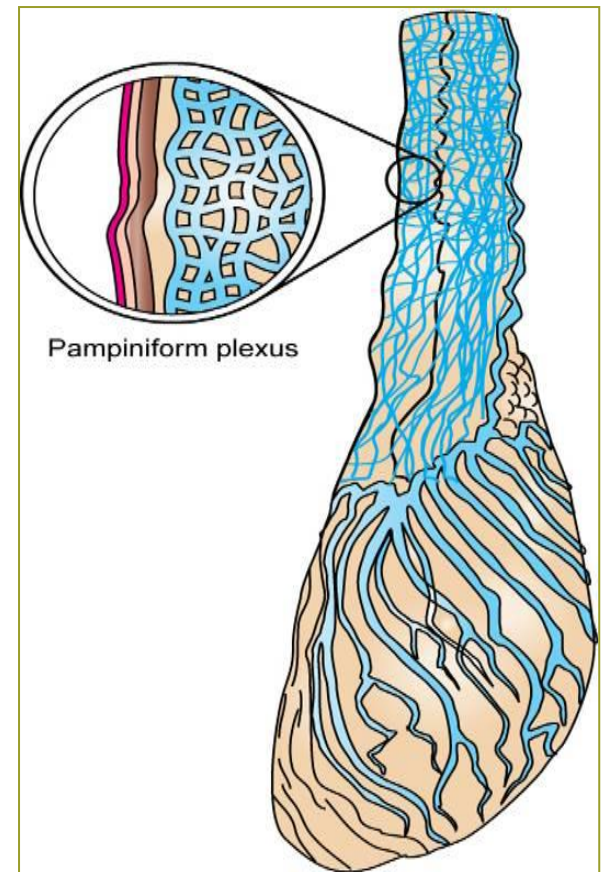
Scrotum

- Sac of skin that houses the testes
- **Helps regulate temperature of testes**
 - Testes must be kept slightly cooler than body temperature
- **Cremaster** muscle passes down through the inguinal ring and attaches to the scrotum.
 - Adjusts the position of the testes relative to the body depending on temperature

Spermatic Cord

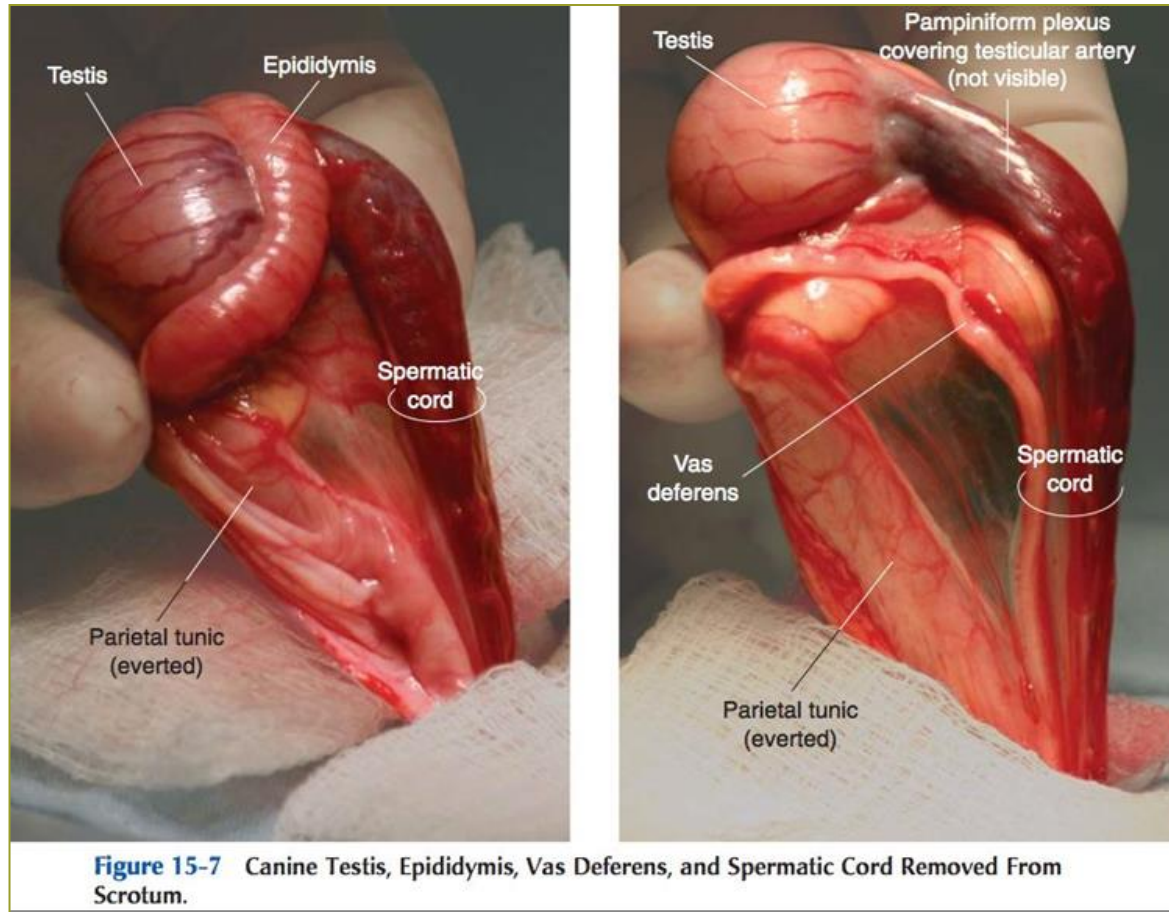
Figure 17-9, Page 394

- Blood and lymphatic vessels, nerves, and the vas deferens
- Pampiniform plexus – meshwork of veins that surrounds testicular artery
 - Maintains testes at a temperature slightly lower than body temperature
 - Warms blood back to body temperature before it returns to the abdomen



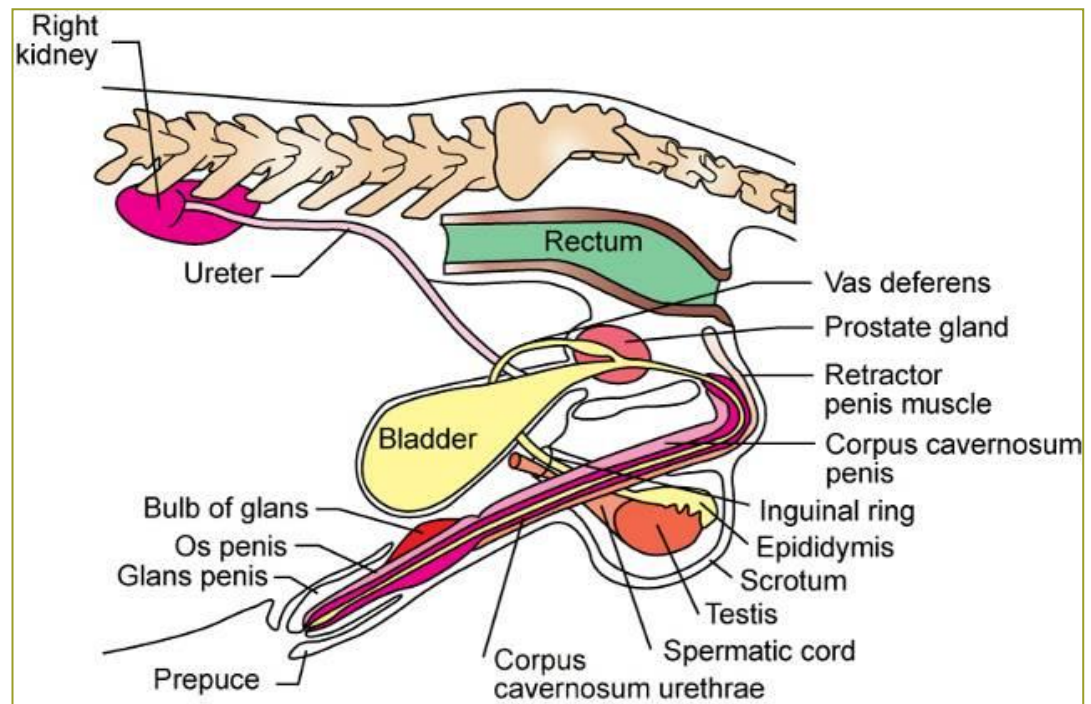
Canine Reproductive System

Bassett Lab Manual – Page 419

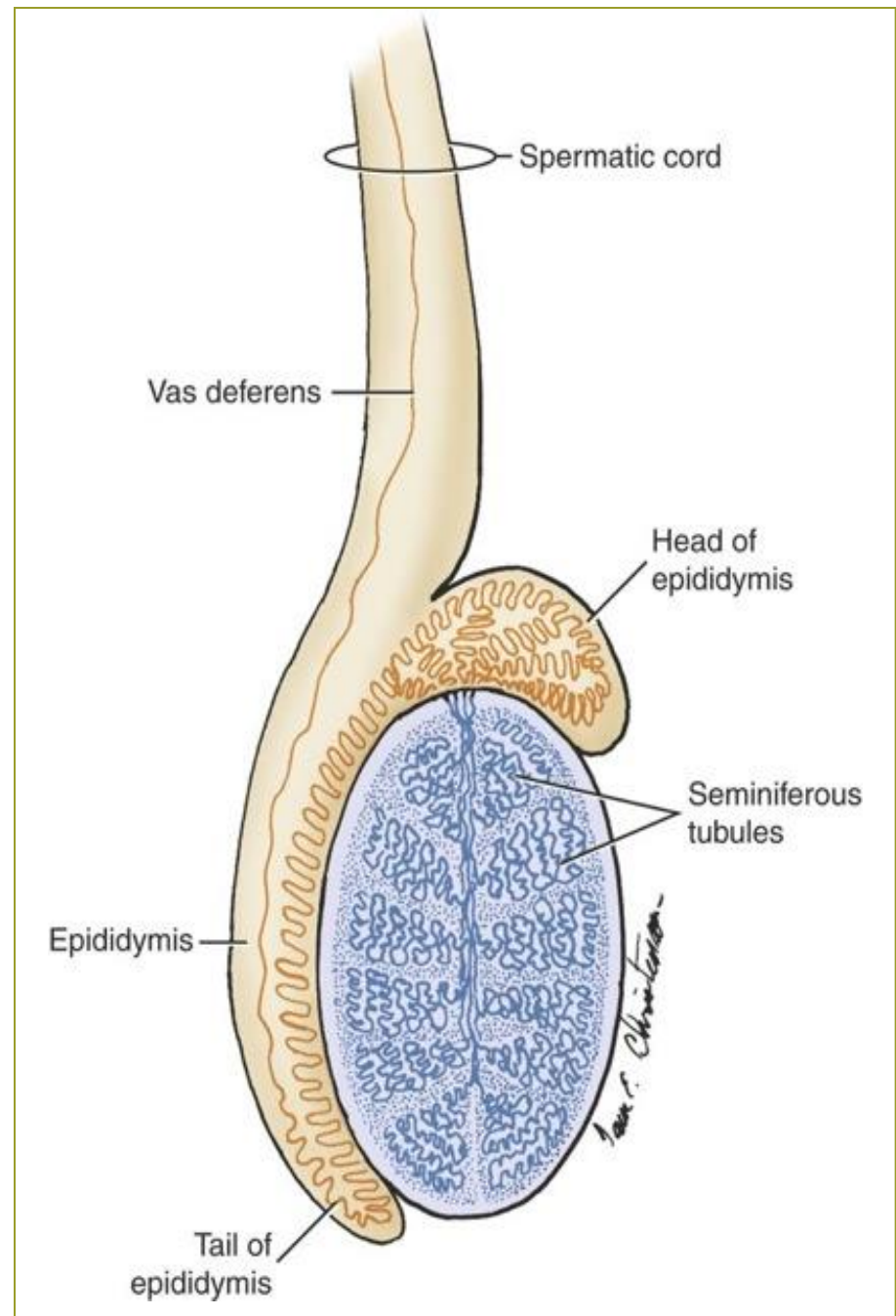


Testes (Testicles)

- Produce sperm and hormones
- Located outside the abdomen in the inguinal region
- Housed in a sac of skin – the scrotum



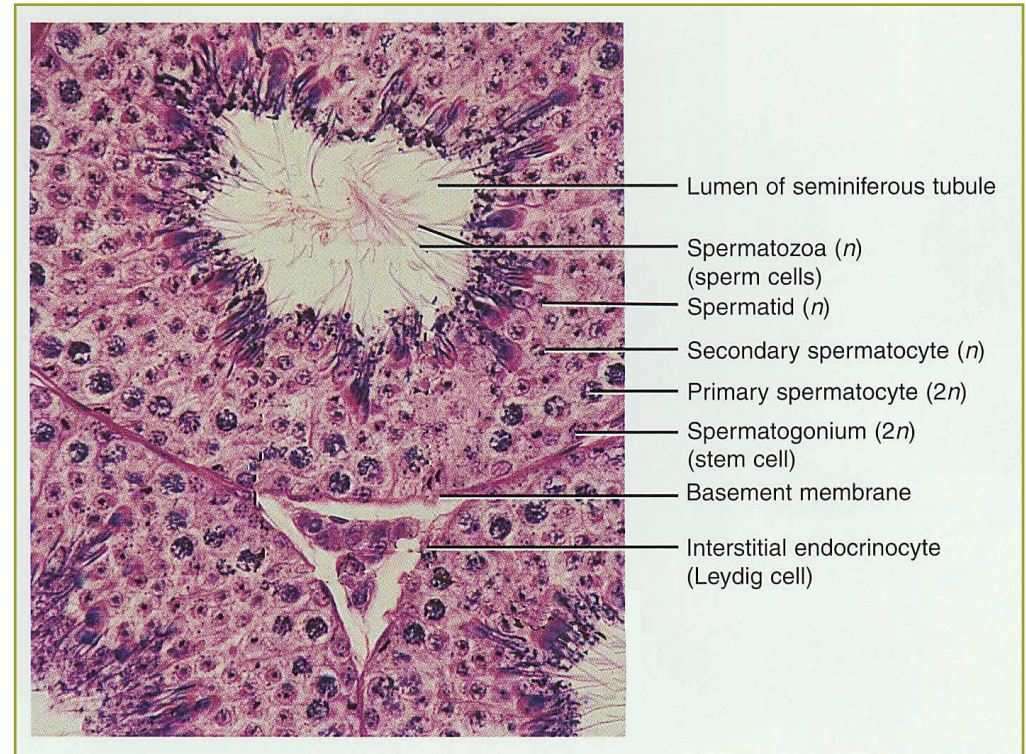
Testis (Cross Section)



Histology of Testicle

Figure 17-6, Page 392

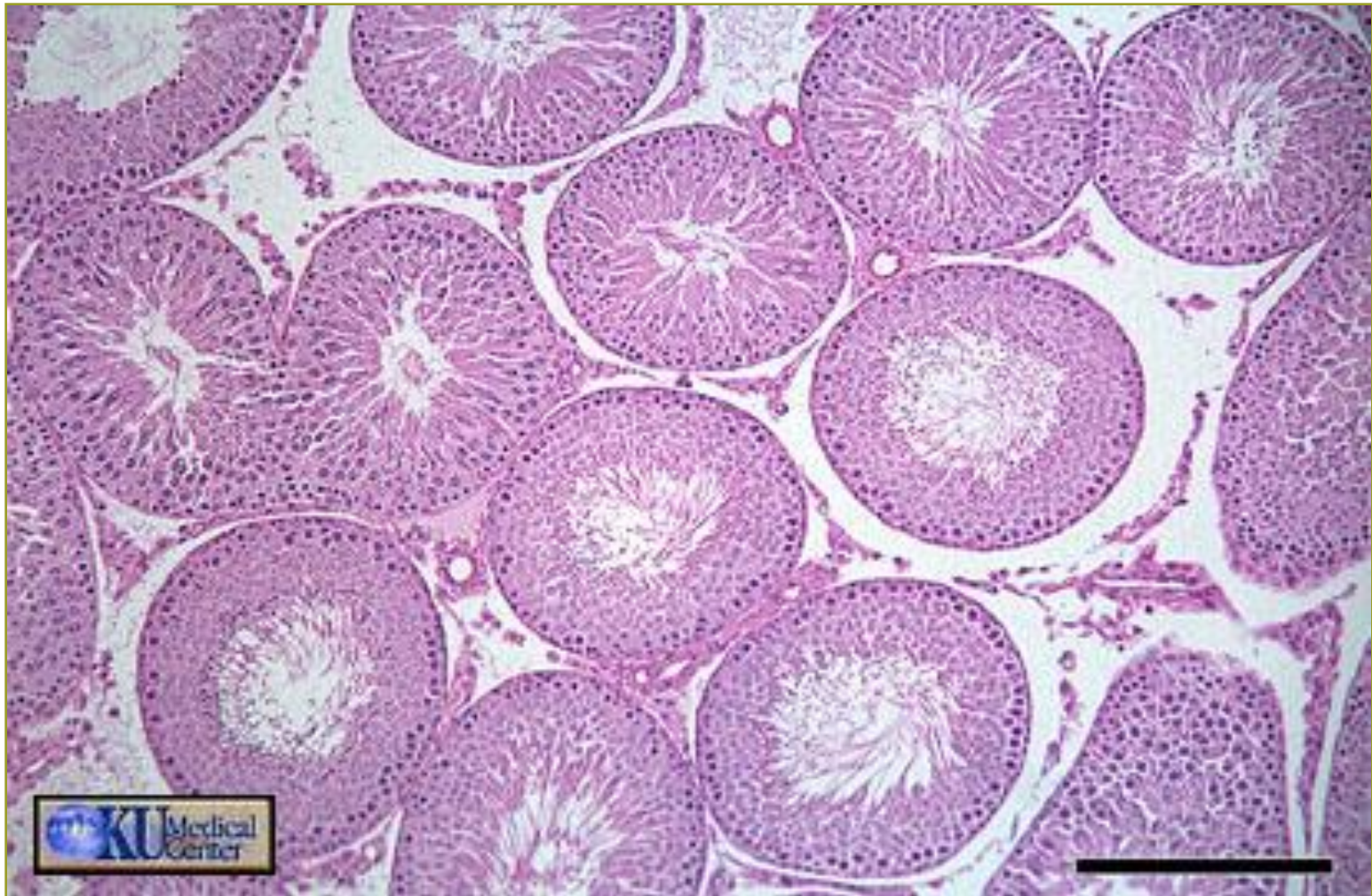
- Seminiferous tubules
 - Produce sperm (spermatogenesis)
- Interstitial cells (Cells of Leydig)
 - Produce testosterone



Seminiferous Tubules

- Site of spermatogenesis
- Long, convoluted U-shaped tube attached at both ends to system of ducts (rete testis)
- Interstitial cells – endocrine cells between the seminiferous tubules -produce androgens
- Sertoli cells – Support developing spermatids

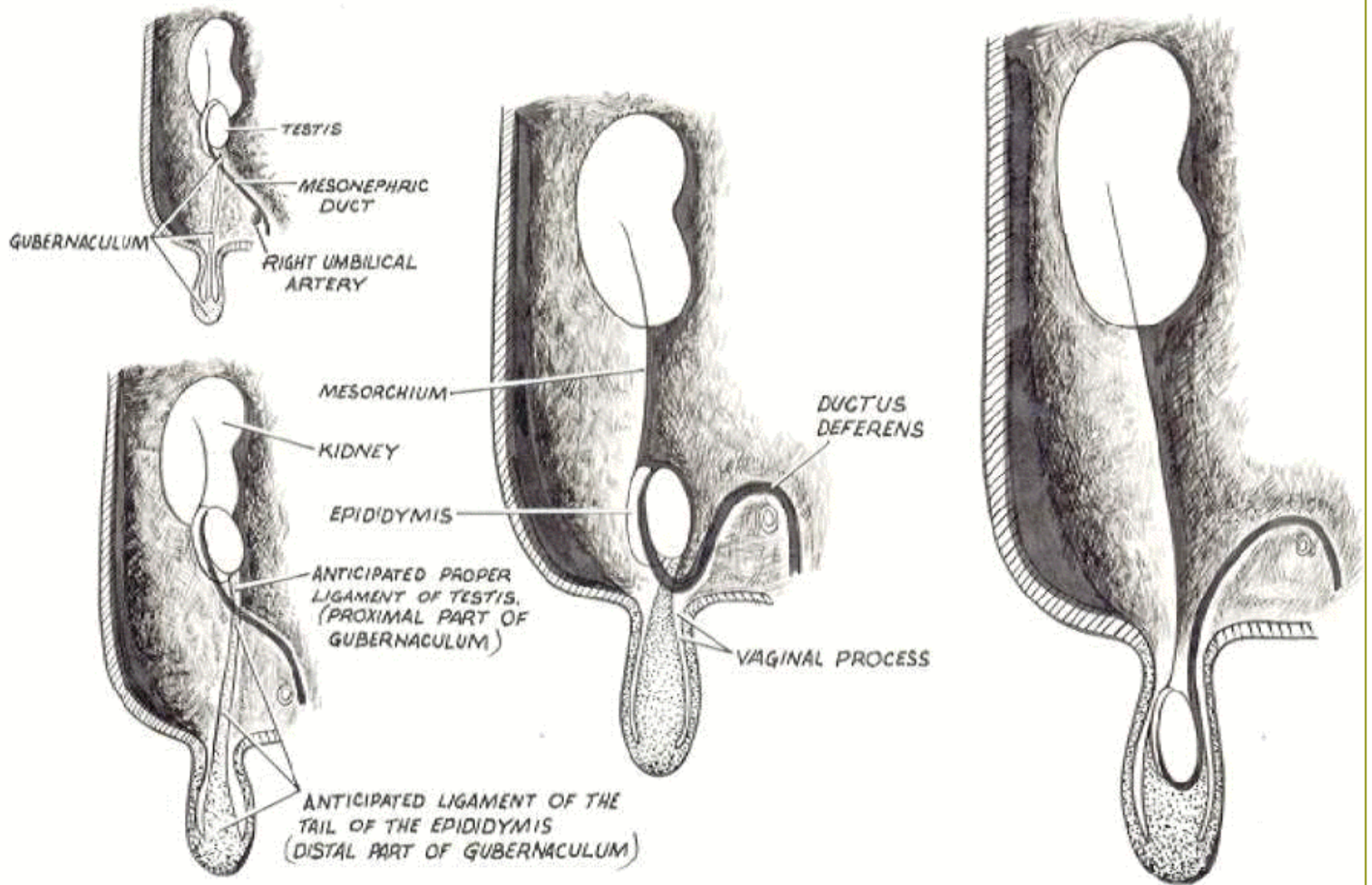
Seminiferous Tubules



Testicle Development

Figure 17-7, Page 393

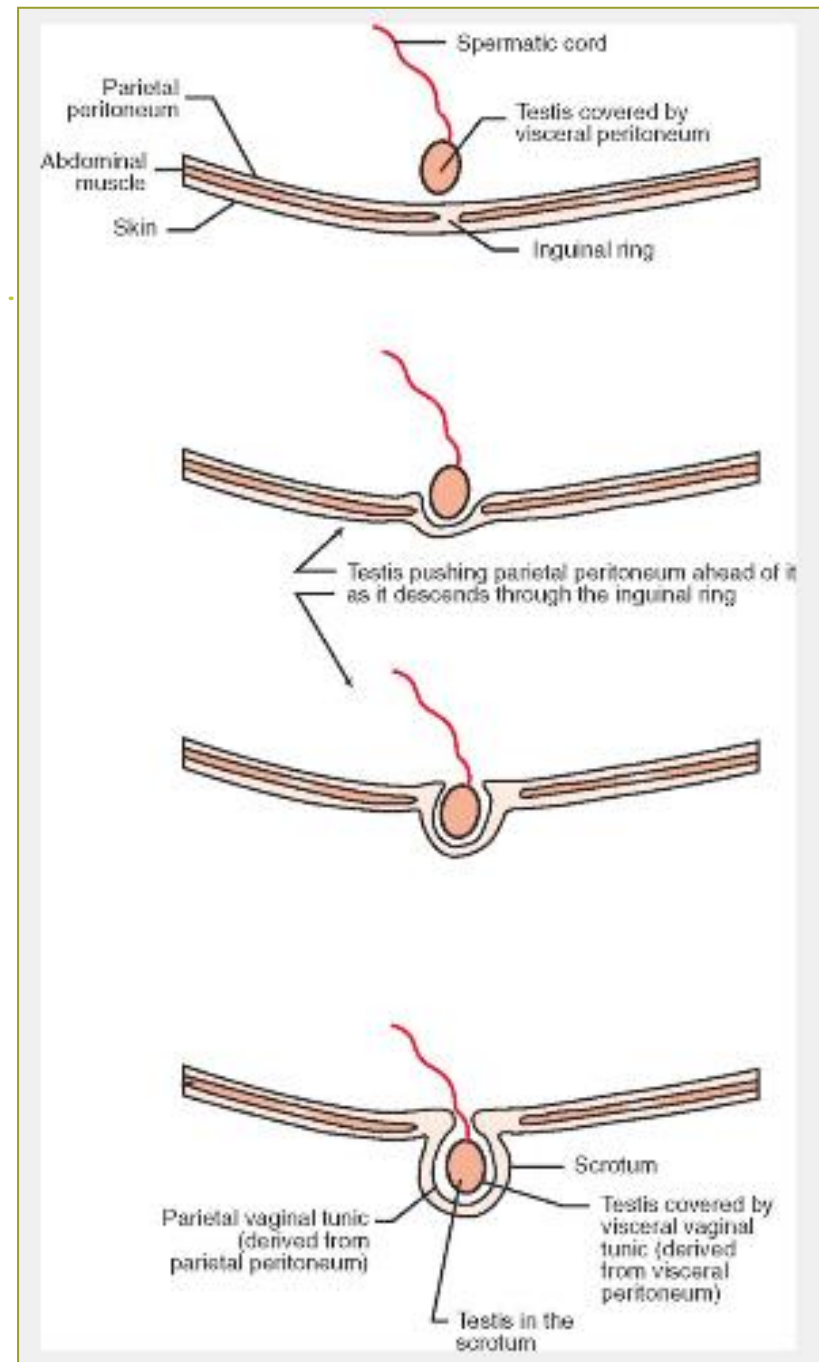
- Develop just posterior to kidneys
- Descends into scrotum by passing through inguinal canal
- Gubernaculum (cordlike structure containing muscle) extends from the testicle to the inner lining of scrotum
 - It shortens, and guides the testicle to the scrotum



A SCHEMATIC DIAGRAM OF THE DESCENT OF THE TESTIS.

Descent of Testes

Figure 17-7, Page 393



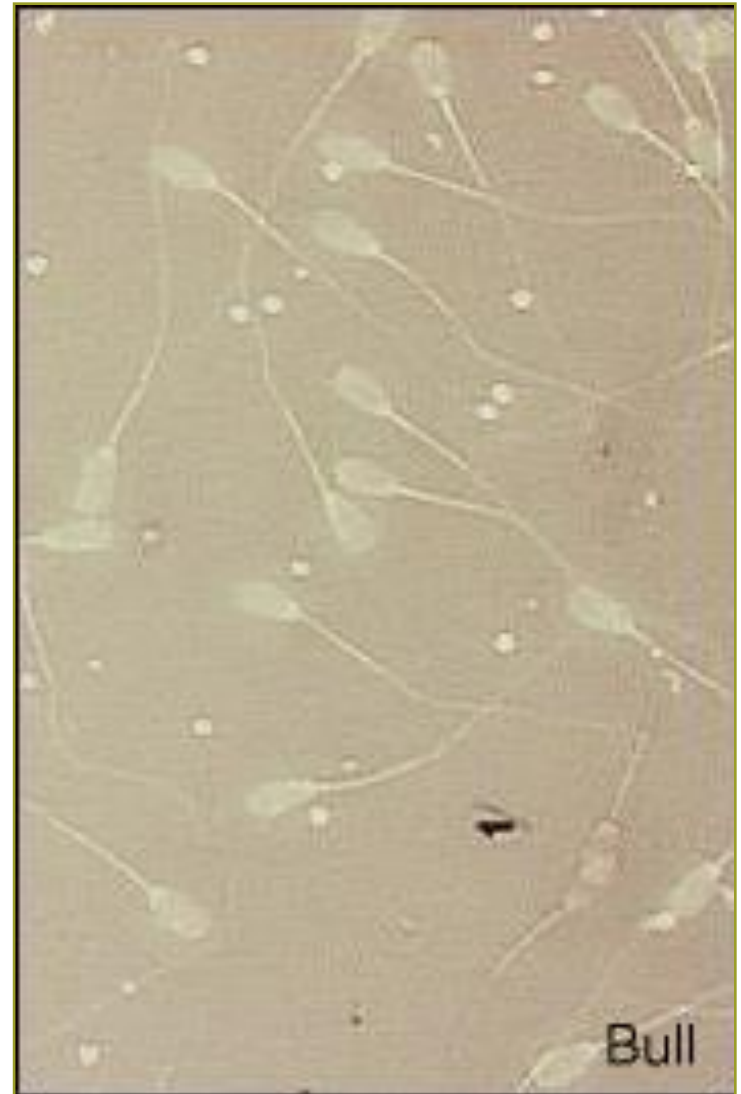
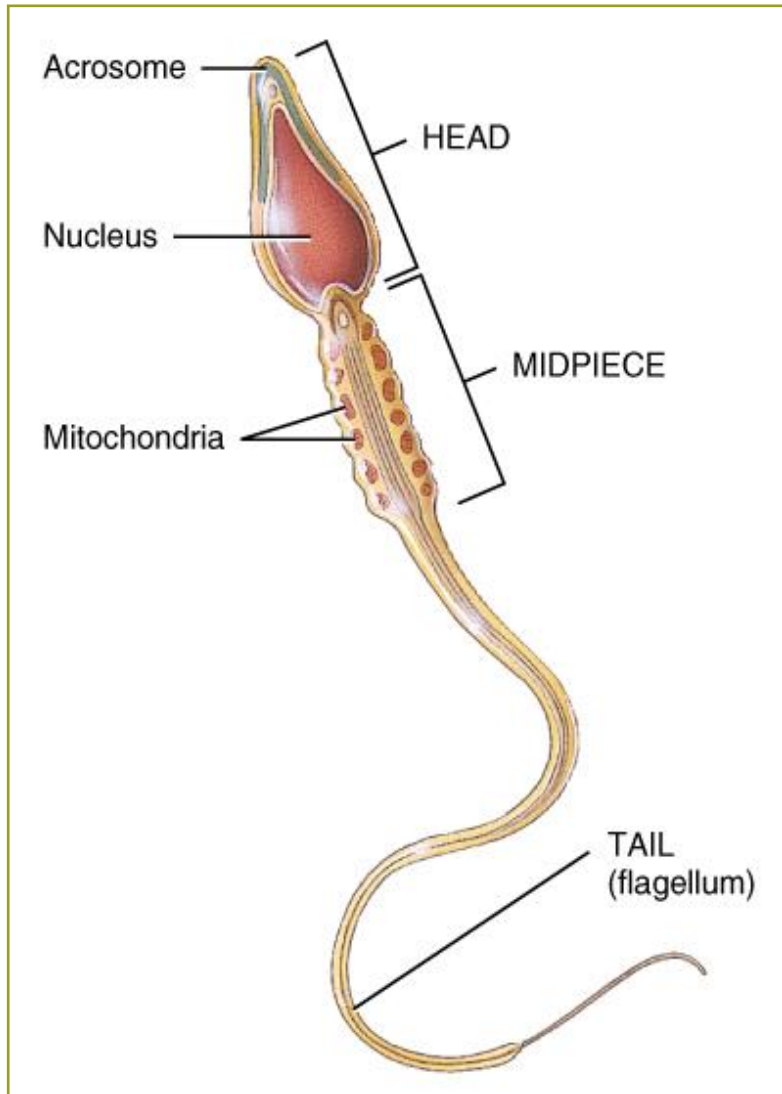
Spermatozoa Structure

Head

Midpiece

Tail

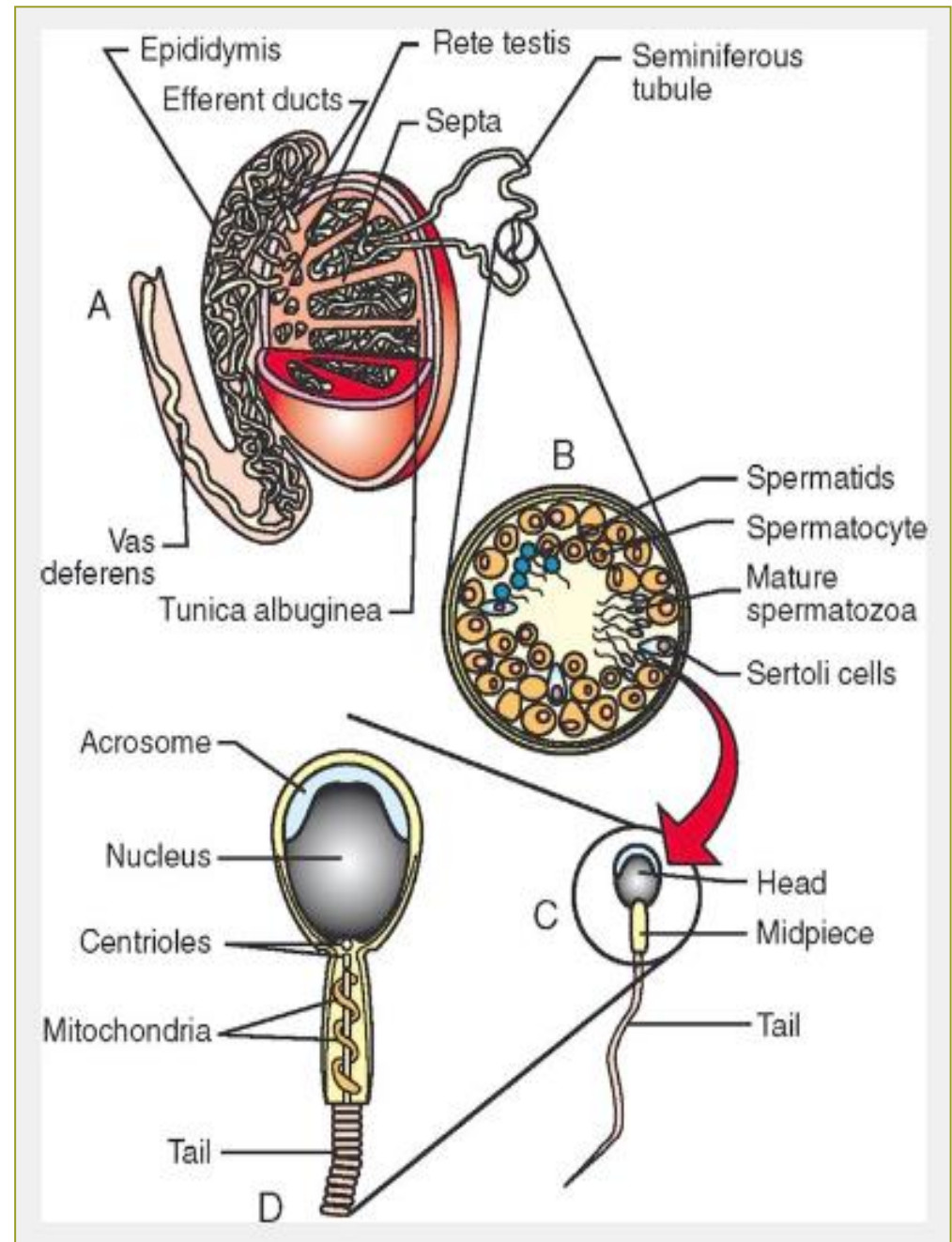
Sperm Structure



Head

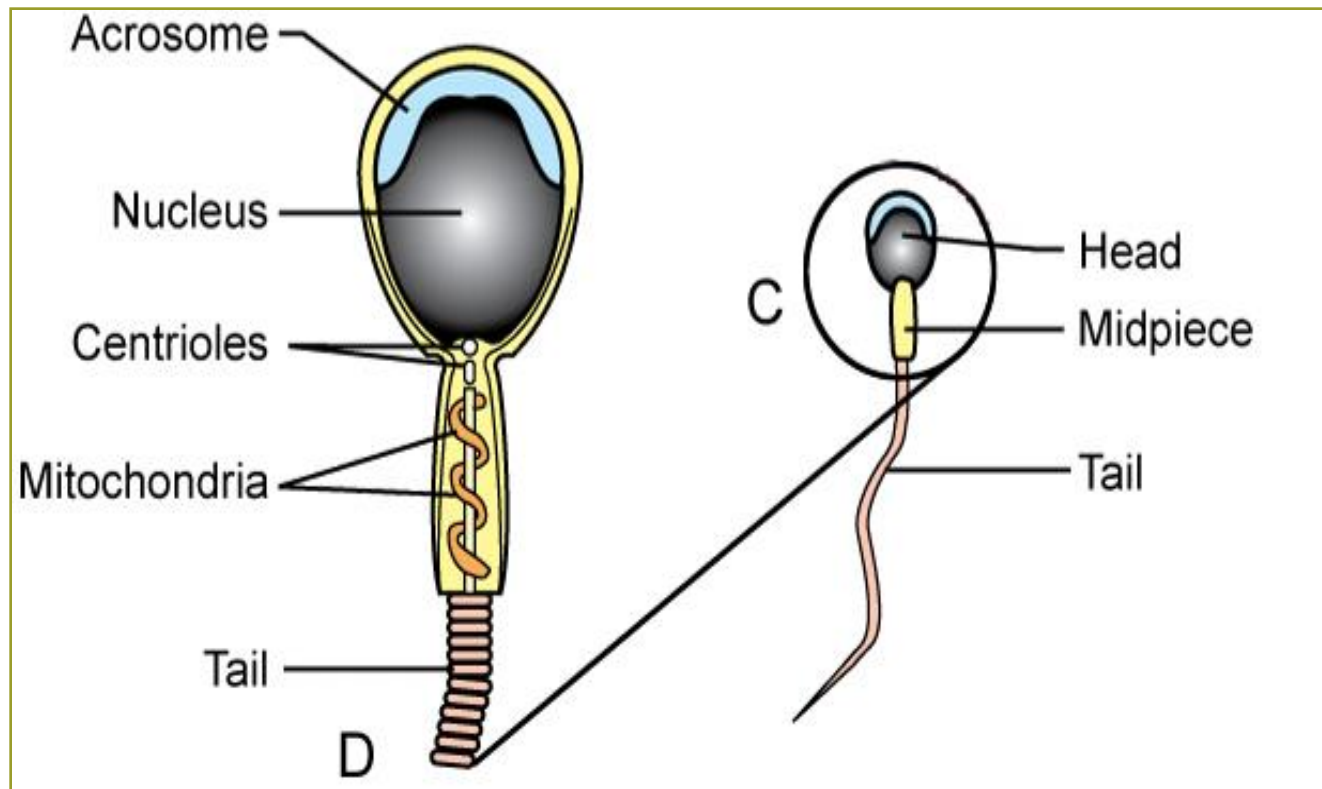
Figure 17-6, Page 392

- Contains nucleus
- Covered by acrosome
 - Contains digestive enzymes that help spermatozoon reach and penetrate ovum



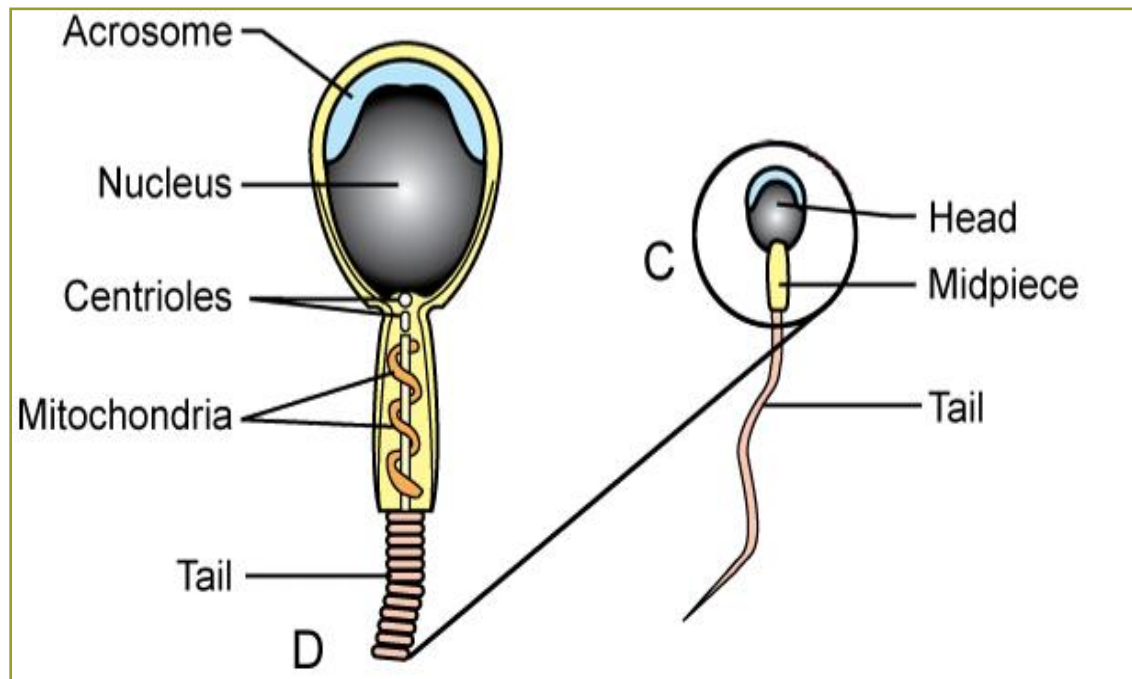
Midpiece

- Large concentration of mitochondria arranged in a spiral pattern



Tail

- Contains muscle-like contractile fibrils
 - Produces a whip-like movement of tail and propel sperm cell forward



Duct System

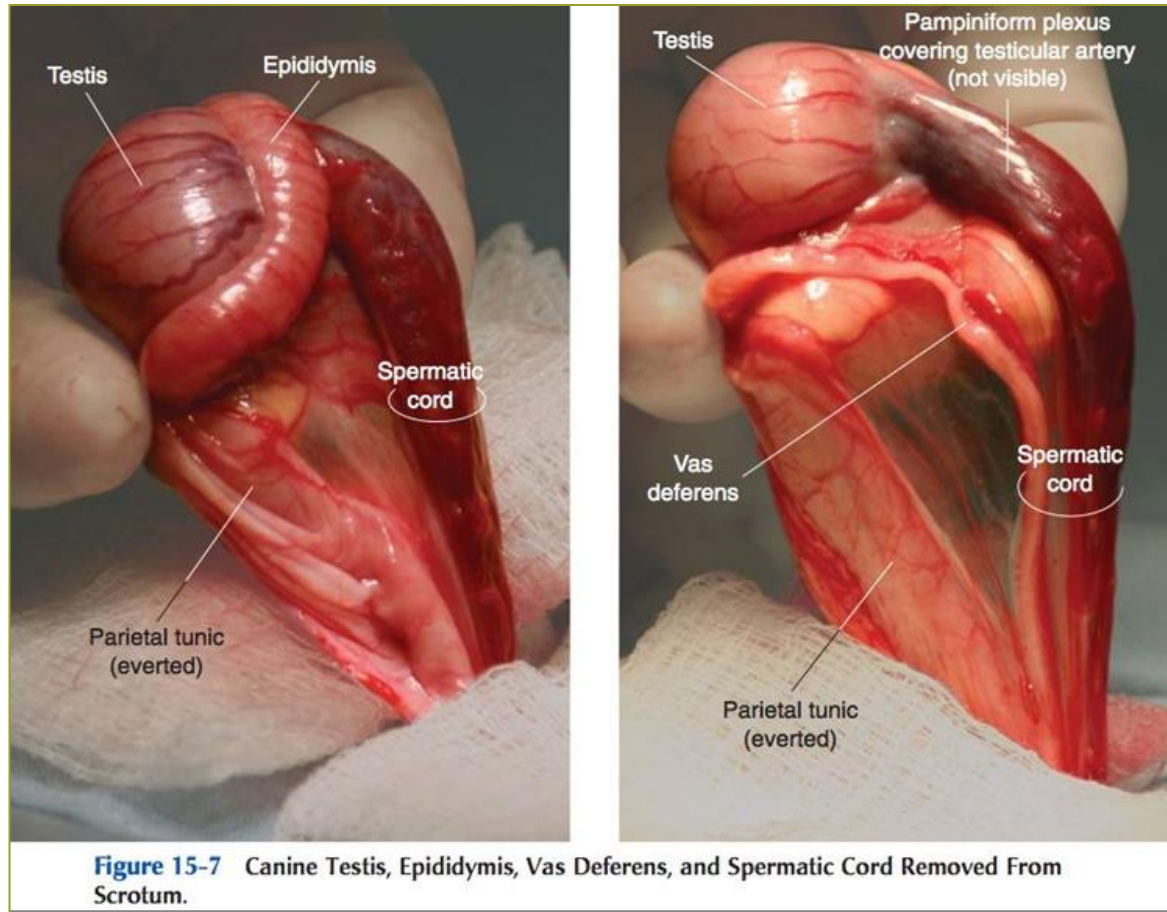
- After detaching from Sertoli cells, spermatozoa enter the rete testis
- Then flow through the efferent ducts to the epididymis
 - Single, long, convoluted tube that connects the efferent ducts of the testis with the vas deferens
 - Storage and maturation of spermatozoa
- Then flow into the vas deferens of the spermatic cord

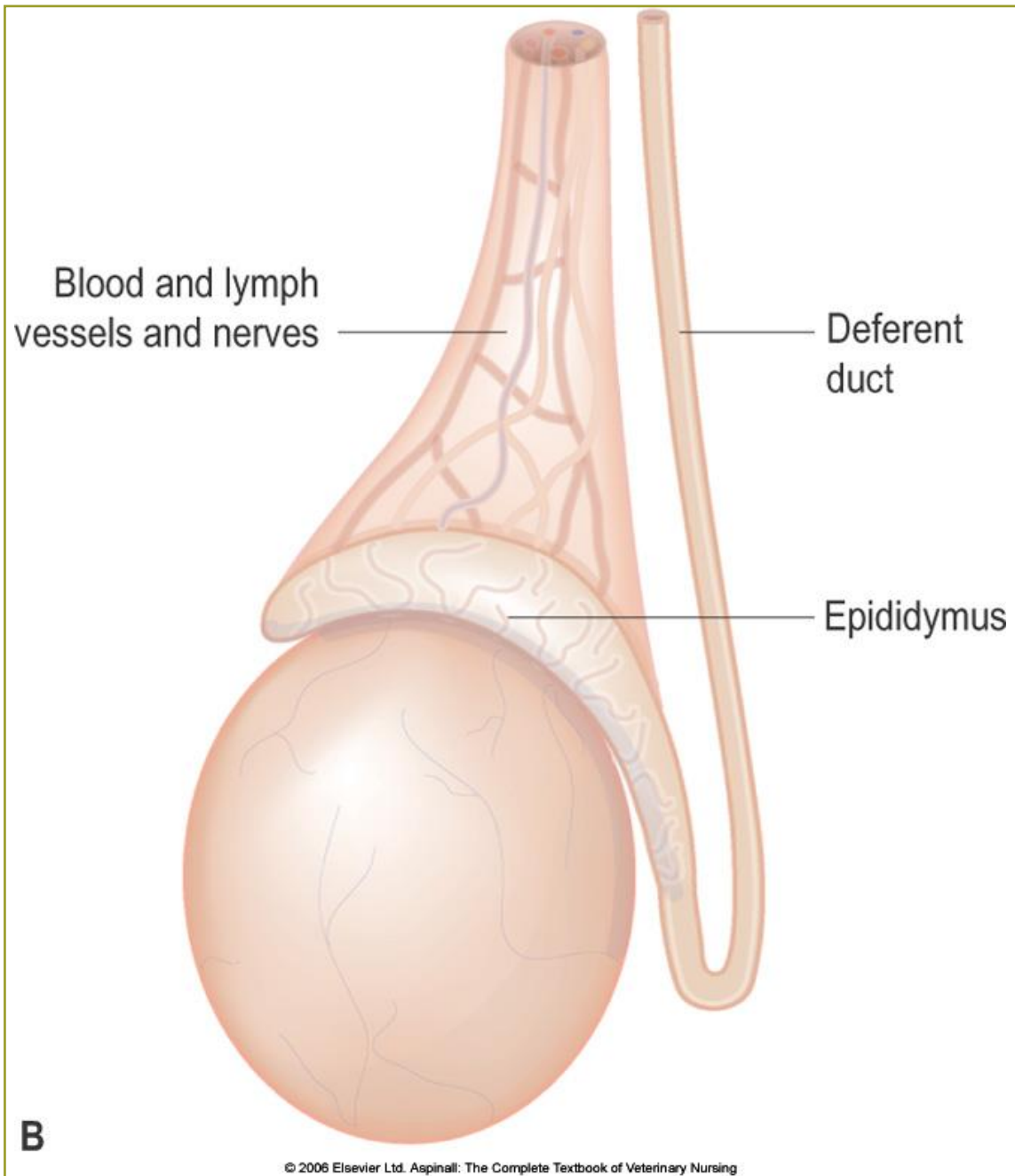
Vas Deferens

- Ductus deferens; part of the spermatic cord
- Passes through inguinal ring then separates from spermatic cord and connects with urethra
- Ampulla – enlargement of the vas deferens just before it joins the urethra found in some species
 - Contain glands that contribute material to semen

Canine Reproductive System

Bassett Lab Manual – Page 419

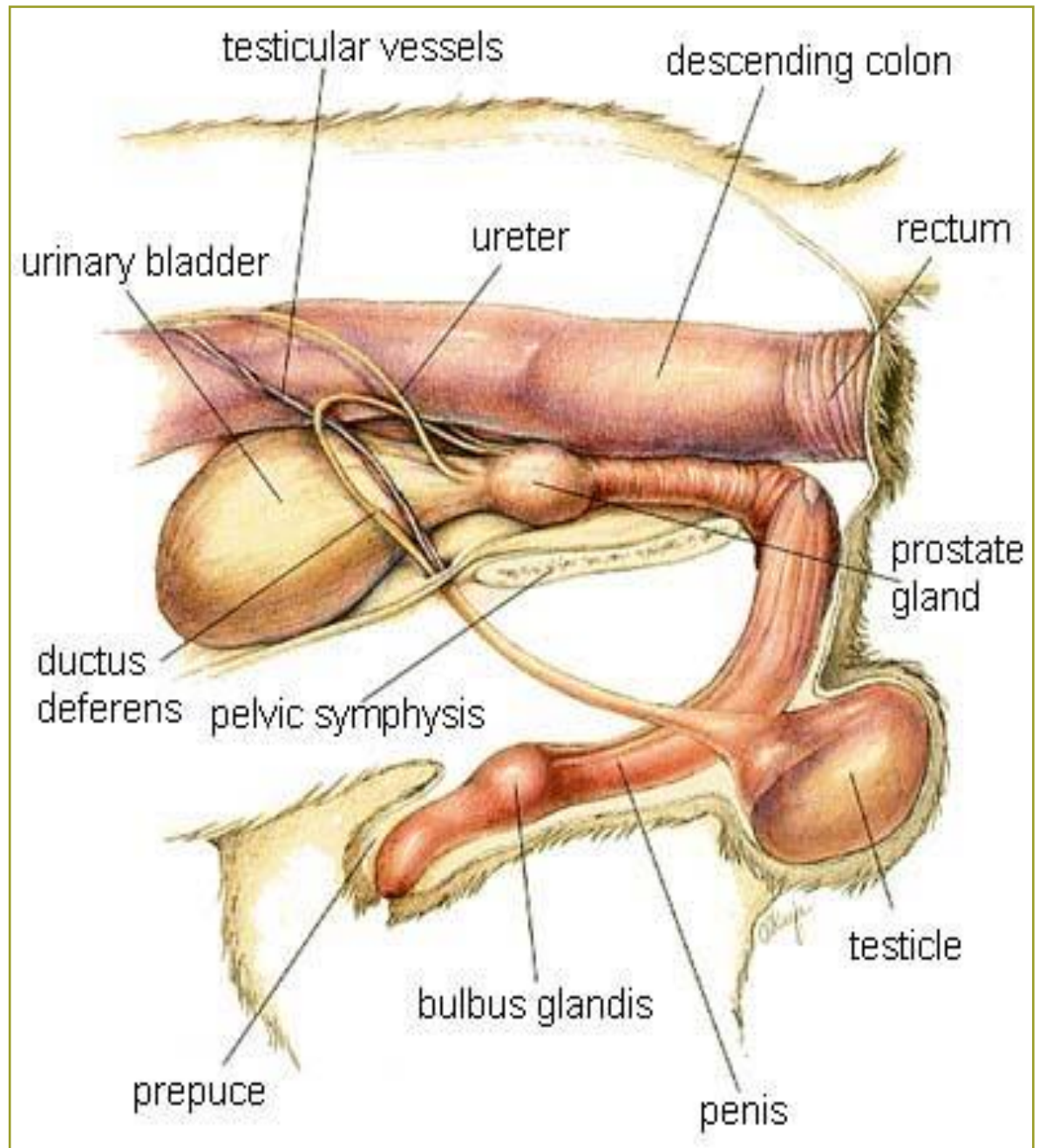




Urethra

- Pelvic portion - entry point of vas deferens and accessory reproductive glands
- Penile portion - runs down the length of the penis
- Spermatozoa from vas deferens and secretions from accessory reproductive glands enter urethra and are pumped out as semen
- Carries urine from the urinary bladder outside the body
 - Urine flow temporarily blocked when ejaculation occurs

Review Male Anatomy – Trace a Sperm Cell



Test Yourself – GREAT Questions!

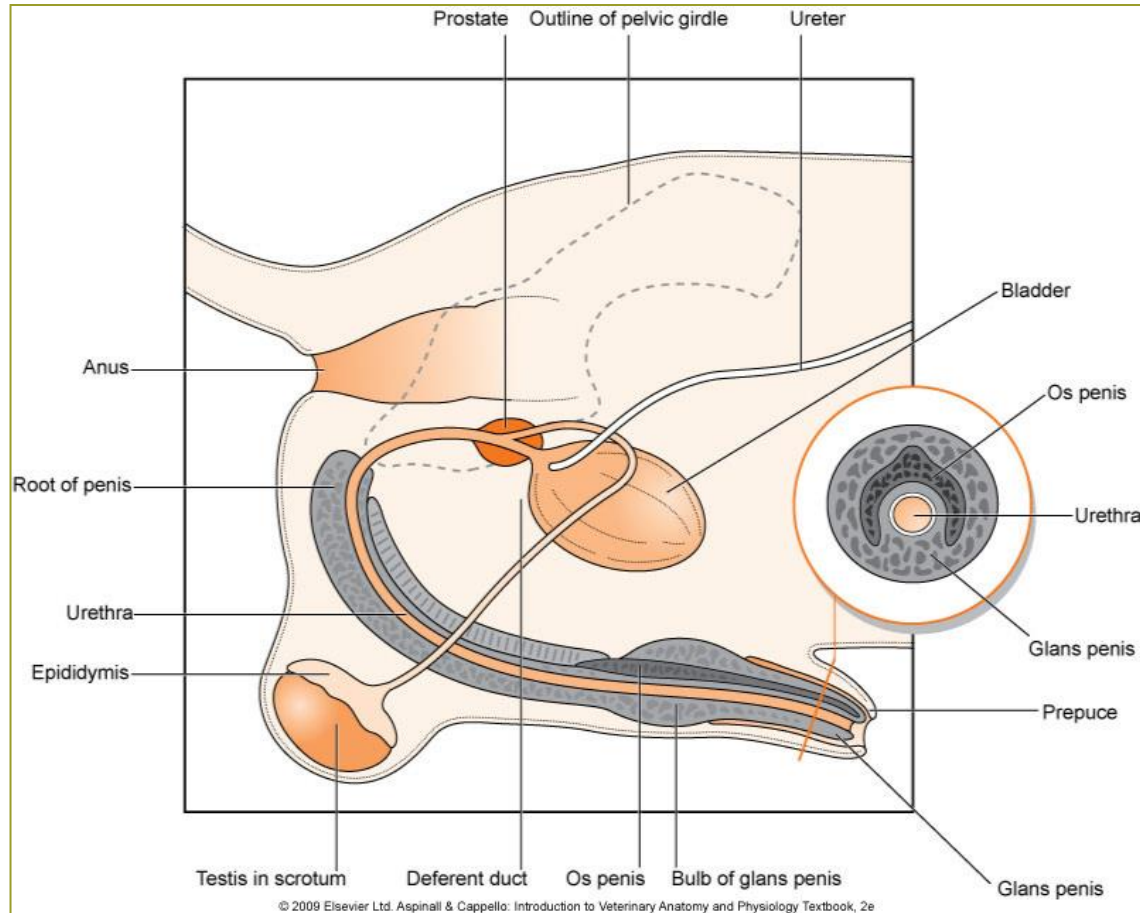
Bassert textbook – Page 395

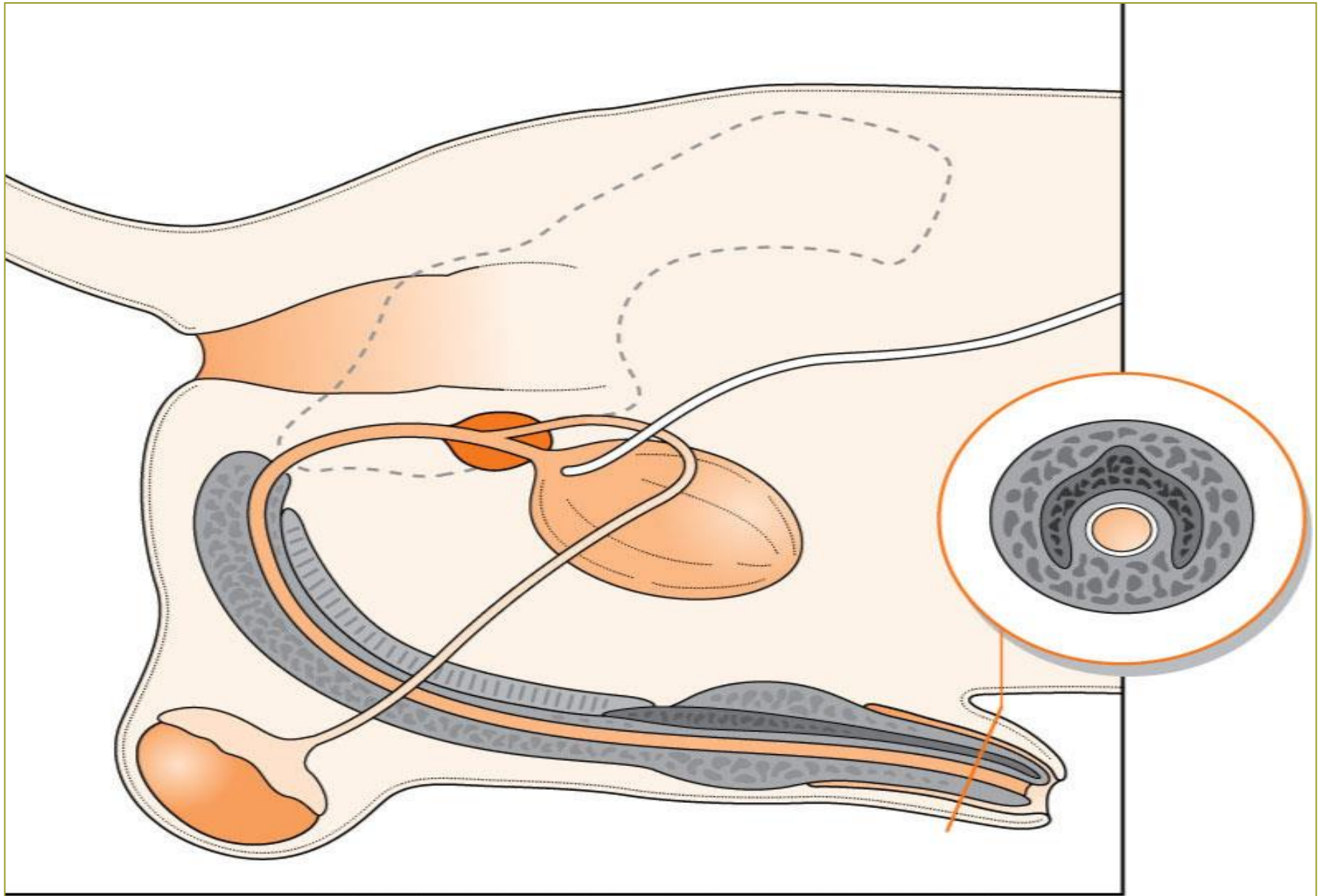


TEST YOURSELF

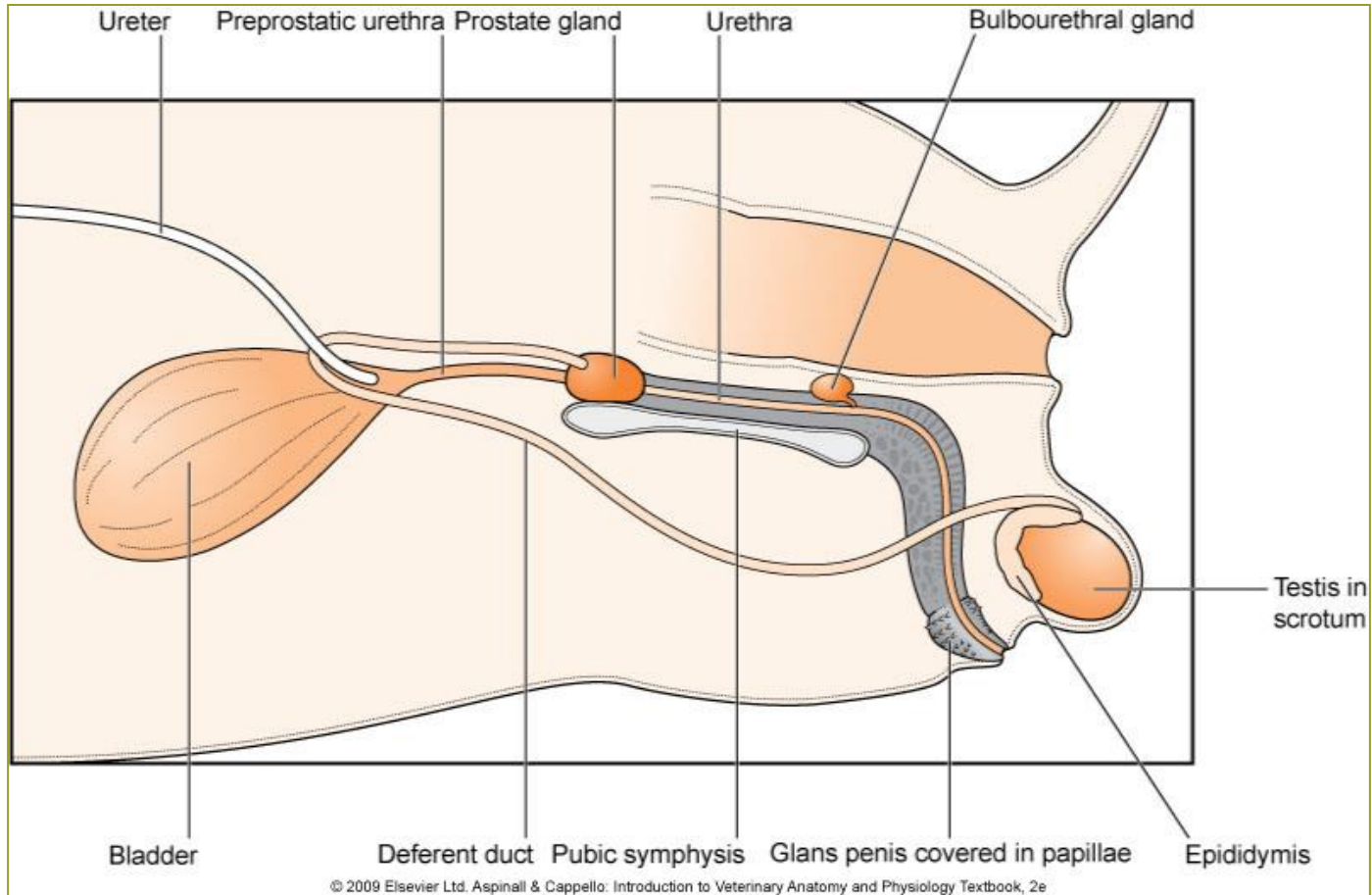
1. What are the two main functions of the testes? Where in the organ does each take place?
2. What are the three main parts of a spermatozoon? What is the main purpose or function of each?
3. Why is a bilaterally cryptorchid animal usually sterile?
4. Would a bilaterally cryptorchid animal exhibit normal male behavior? Why or why not?
5. What is important about the scrotum's ability to adjust the position of the testes relative to the body?
6. What are the main components of the spermatic cord?
7. From what are the visceral and parietal vaginal tunics that cover the testes derived?
8. Where are spermatozoa stored before ejaculation?

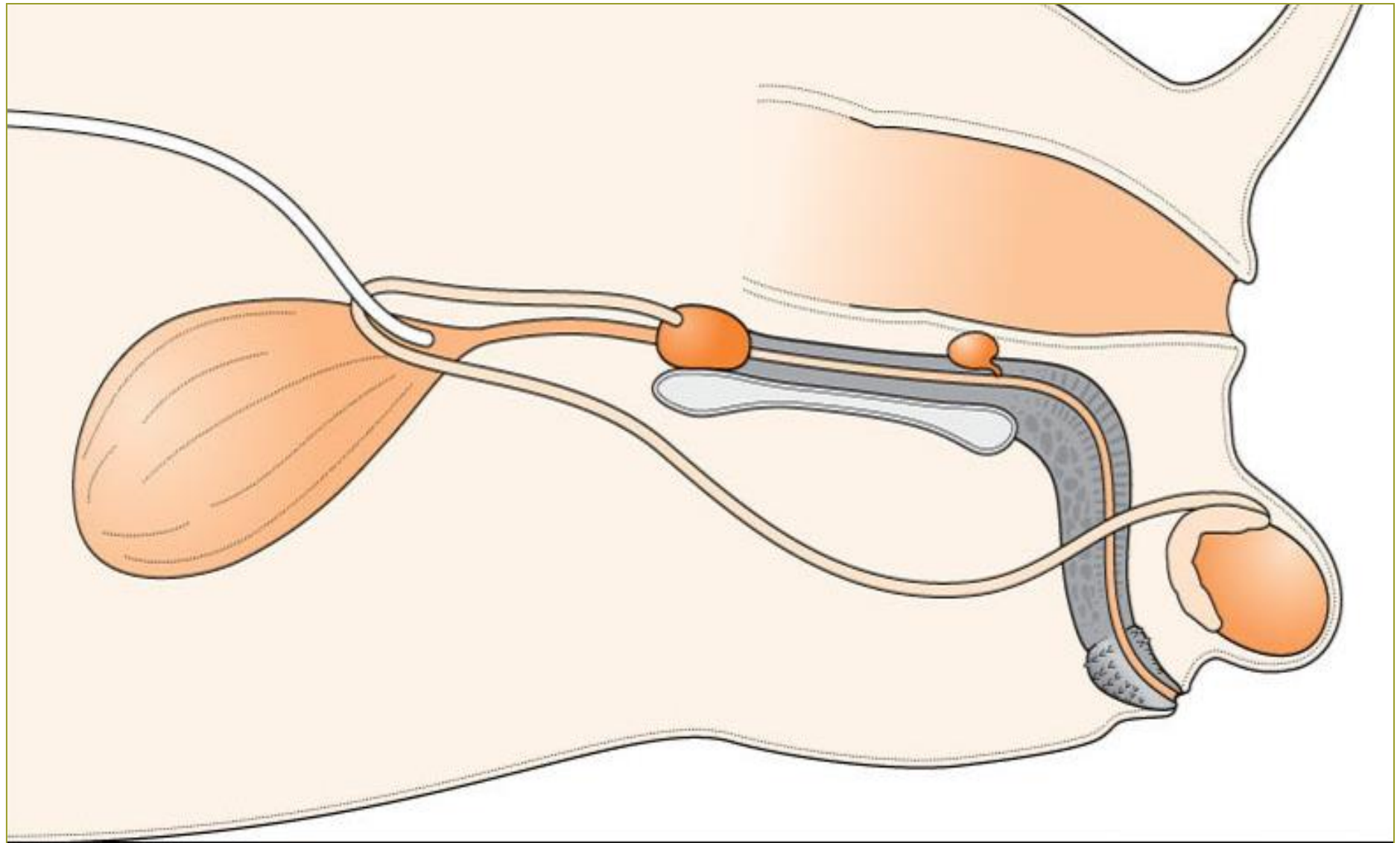
Male Dog – Anatomy Review





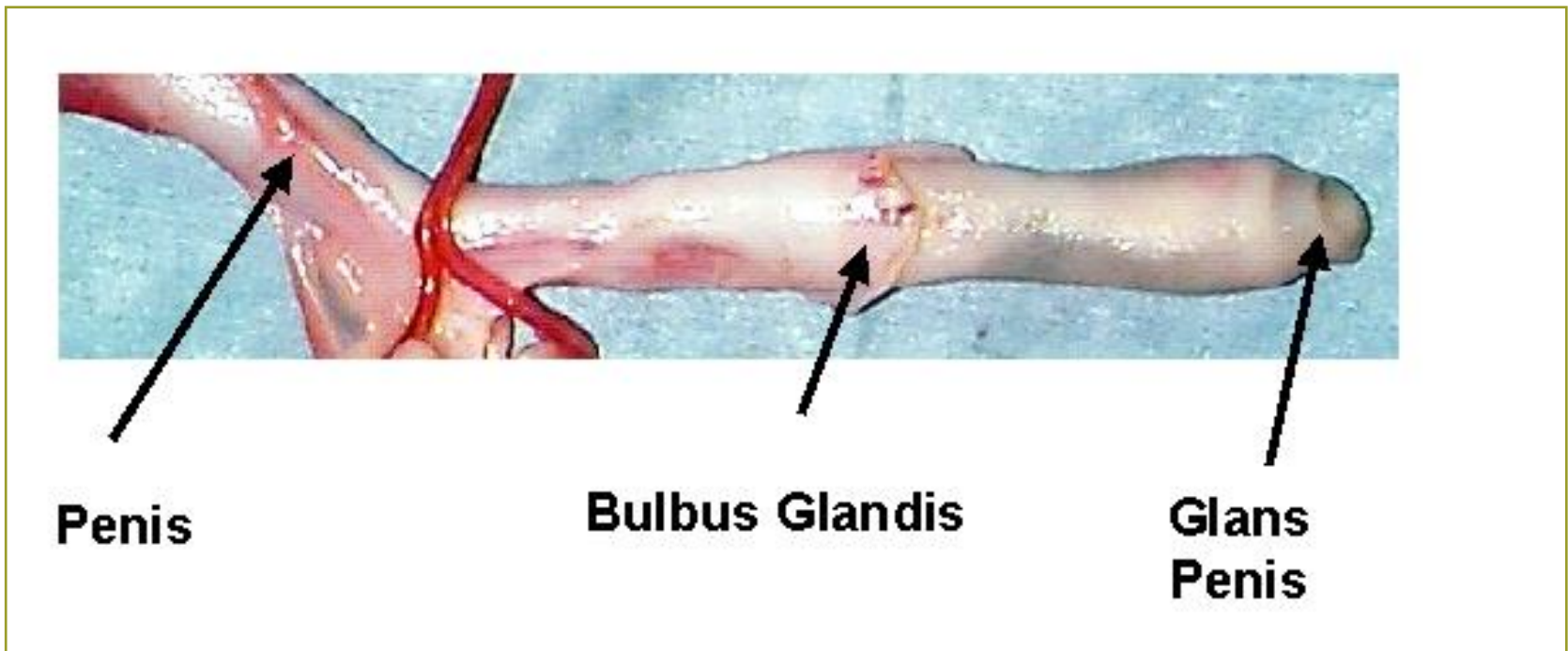
Tom Cat – Anatomy Review





Topic 12

List the structures and functions of the penis and the accessory structures of the male reproductive system

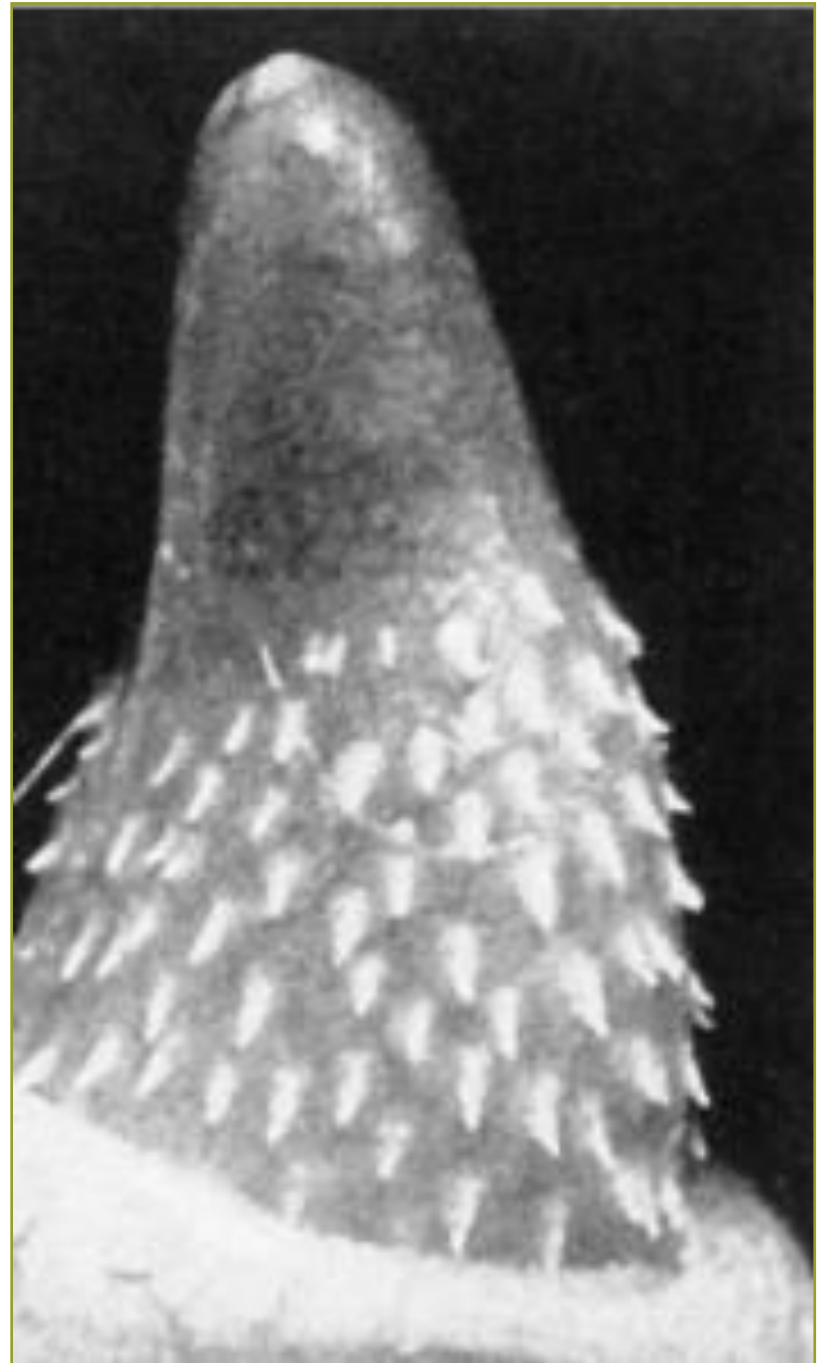


Penis

- Composed of muscle, erectile tissue, and connective tissue
- Large blood supply and many sensory nerve endings
- Three main parts of the penis – the root, the body, and the glans.

Penis

- Male breeding organ
- Urethra through middle
- 3 parts
 - Root
 - Body – largest part, erectile tissue
 - Glans – tip of penis
 - Horse – well-defined
 - Cat – spines



Penis – Comparative Anatomy



Canine Penis

Bassett Lab Manual – Page 421

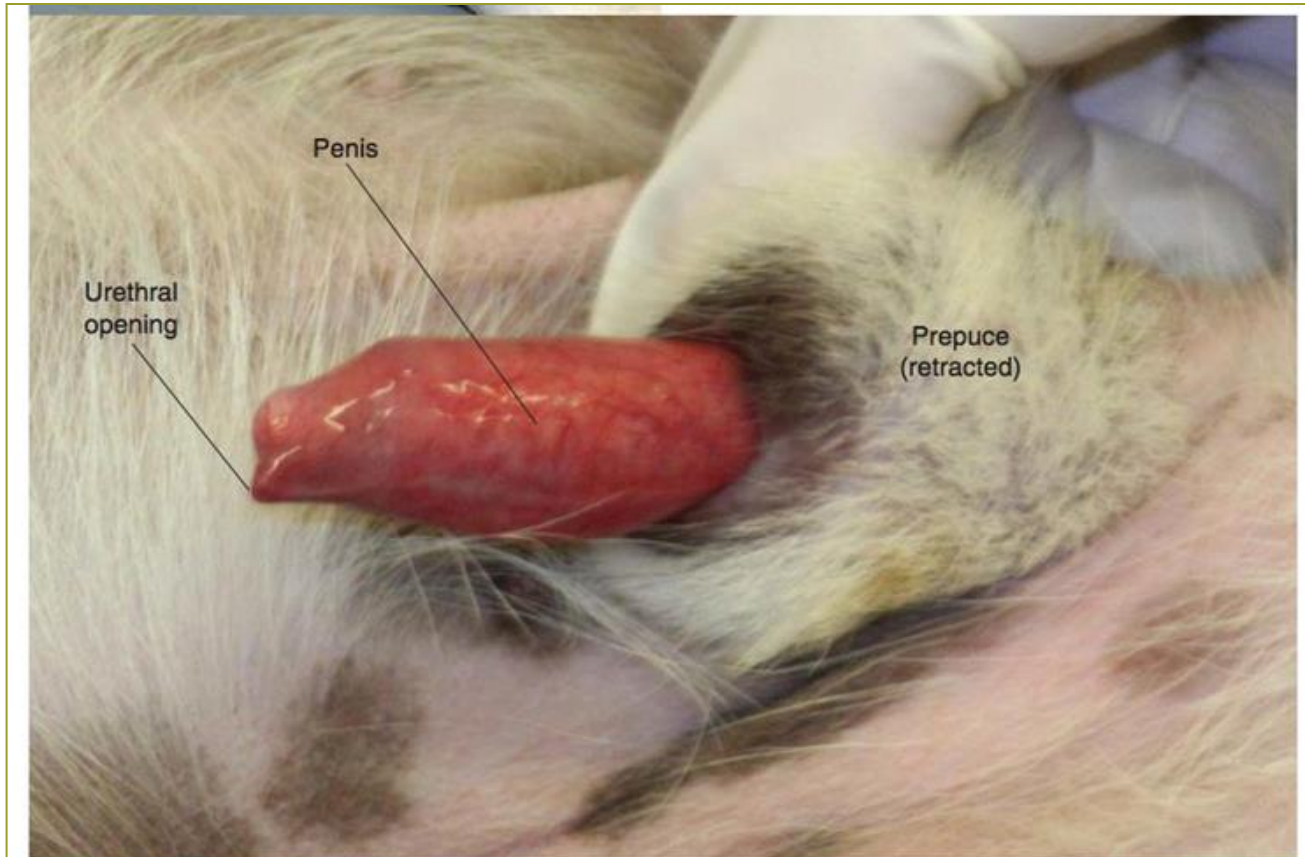
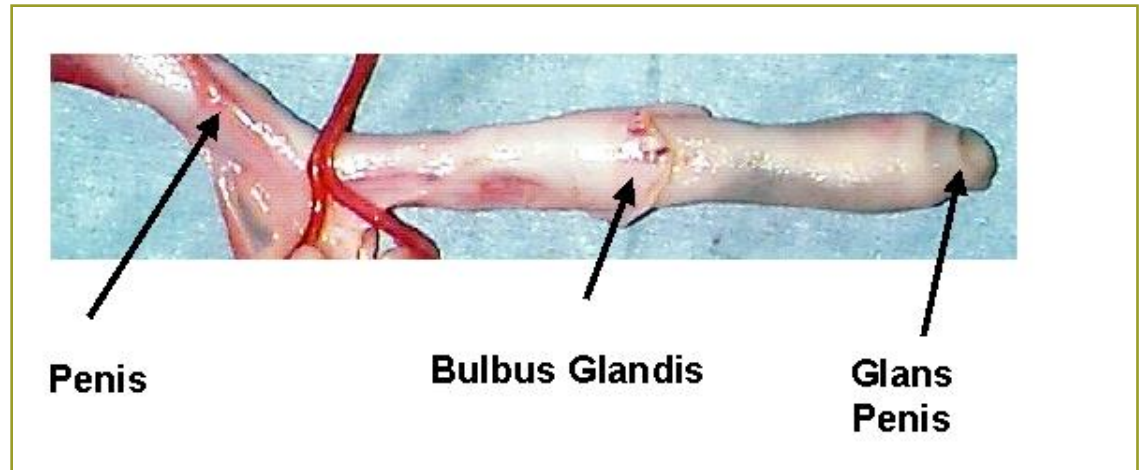


Figure 15-9 Canine Penis.

Canine Penis

- Os penis bone
 - Ossified in dog
 - Cartilage in cat
- Bulbus glandis
 - Erectile tissue
 - Full size after ejaculation
 - “The Tie”



Canine Penis



Penis

Bulbus Glandis

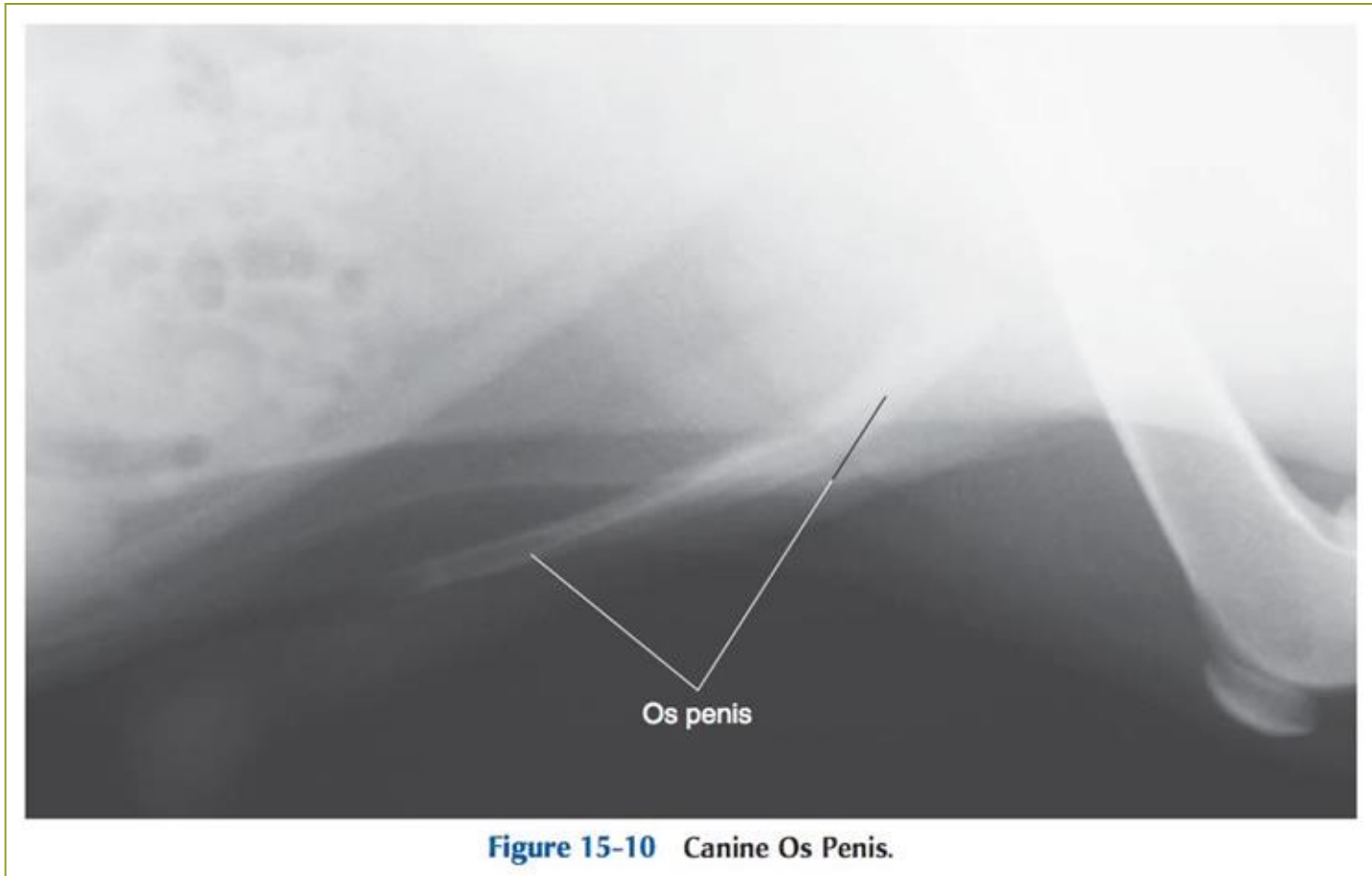
**Glans
Penis**

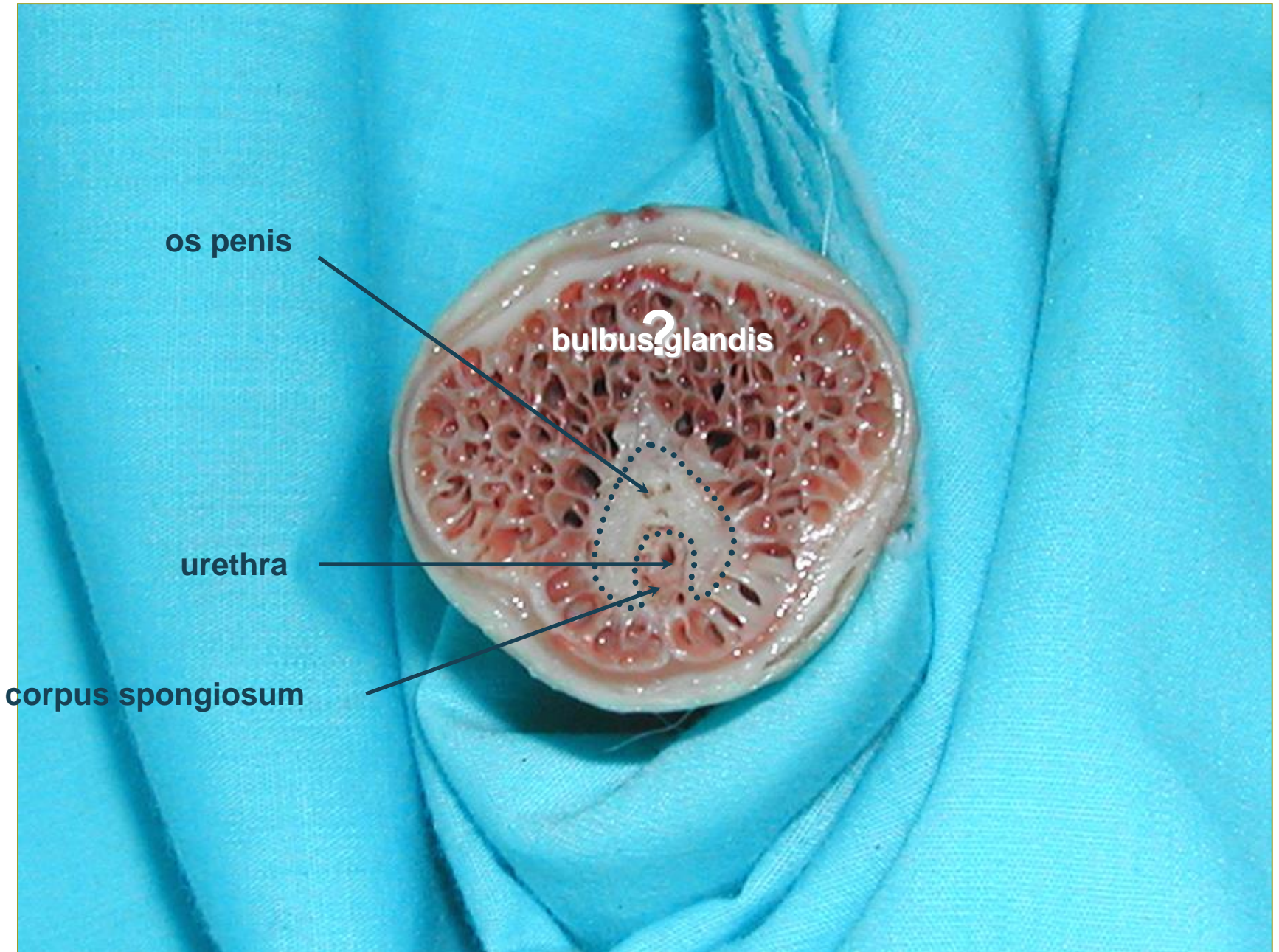
Canine Penis

- Os penis – bone in the penis; urethra runs through groove on ventral surface
- Bulb of the glans - enlargement toward rear of the glans
 - Engorges with blood; reaches full size after ejaculation
 - Remains clamped in place by contractions of muscles surrounding vagina and vulva
 - Erection of the bulb subsides in 15 – 20 minutes

Os Penis Bone

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os penis

bulbus?glandis

urethra

corpus spongiosum

Male Reproductive Physiology

- Erection – inflow of blood into erectile tissues of penis
- Ejaculation – reflex emptying of semen from epididymis, urethra, and accessory sex glands through penis
- Testosterone
 - Increased body size
 - Larger, thicker bones
 - Secondary sex characteristics

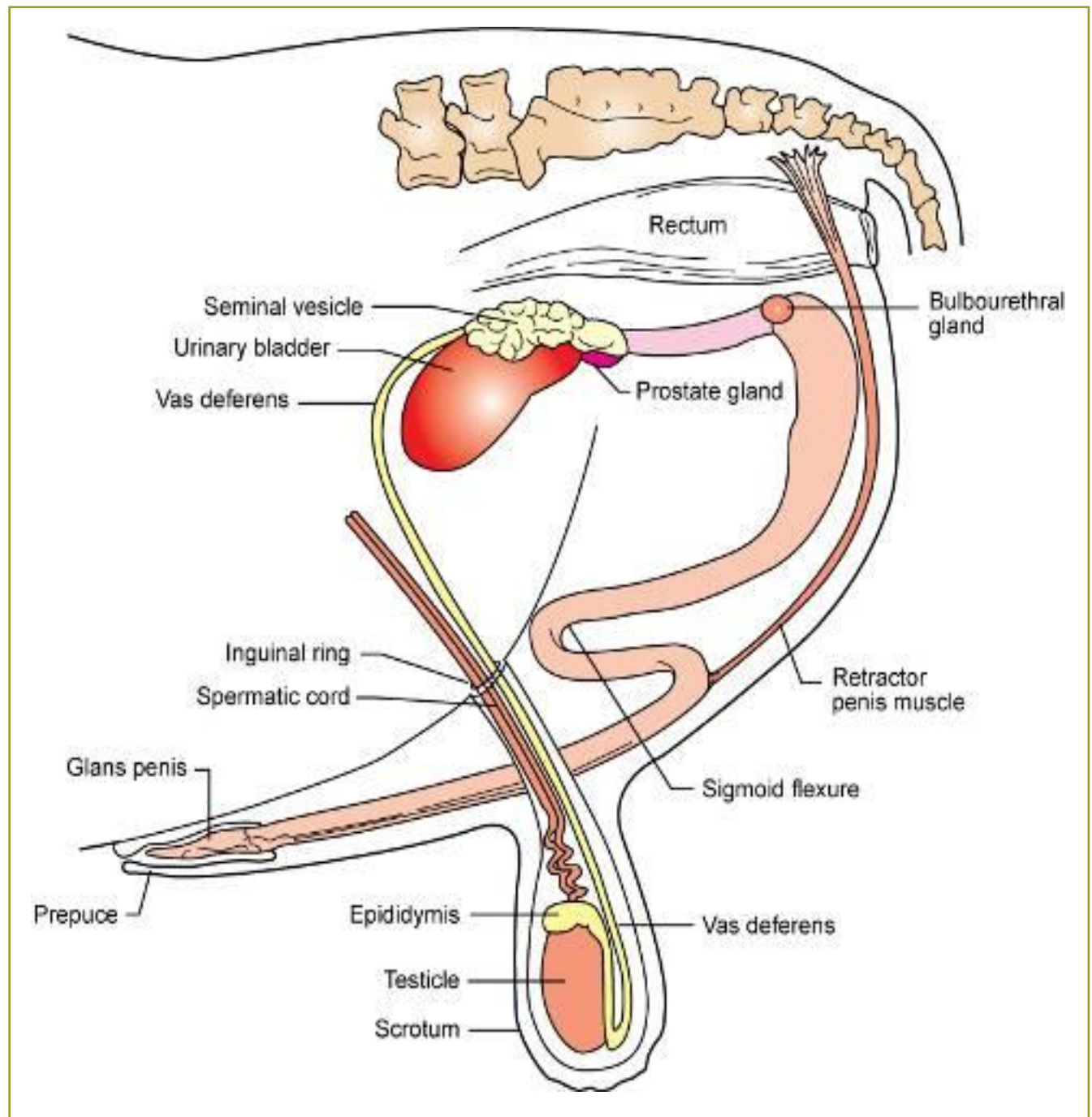
Erection; The Tie



Sigmoid Flexure – Farm Animals

- S shape of non-erect penis of the bull, ram, and boar
- Higher proportion of connective tissue to erectile tissue than other species
- Erection results from straightening of the sigmoid flexure from internal hydraulic pressure
- Causes the penis to protrude from the prepuce for breeding

Sigmoid Flexure (Bovine)

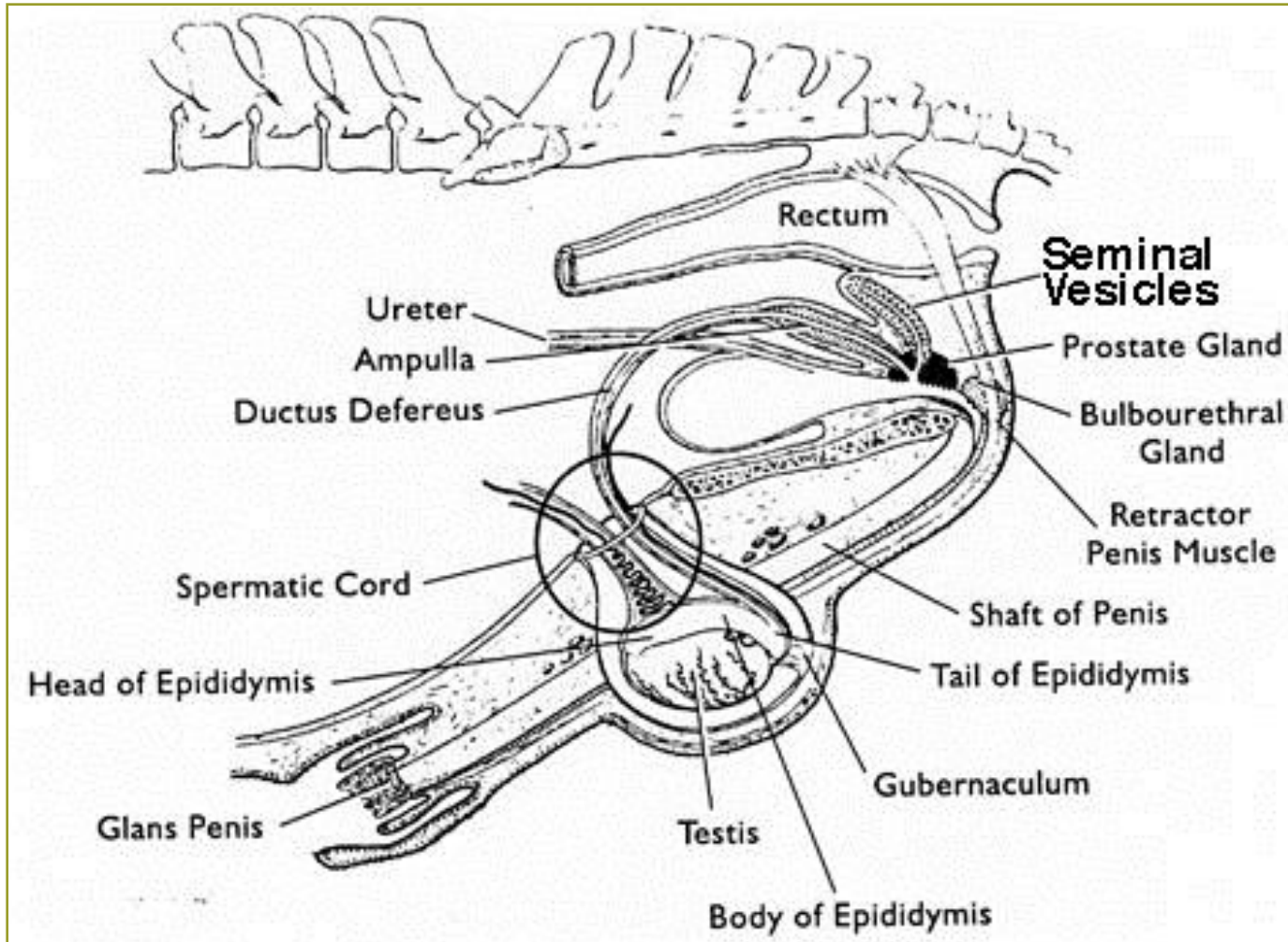


Prepuce

- Sheath of skin
- Protects penis
- Pouch on boar ([smegma](#))
- [Diverticulum](#) on horse (the “bean”)



Horse Prepuce



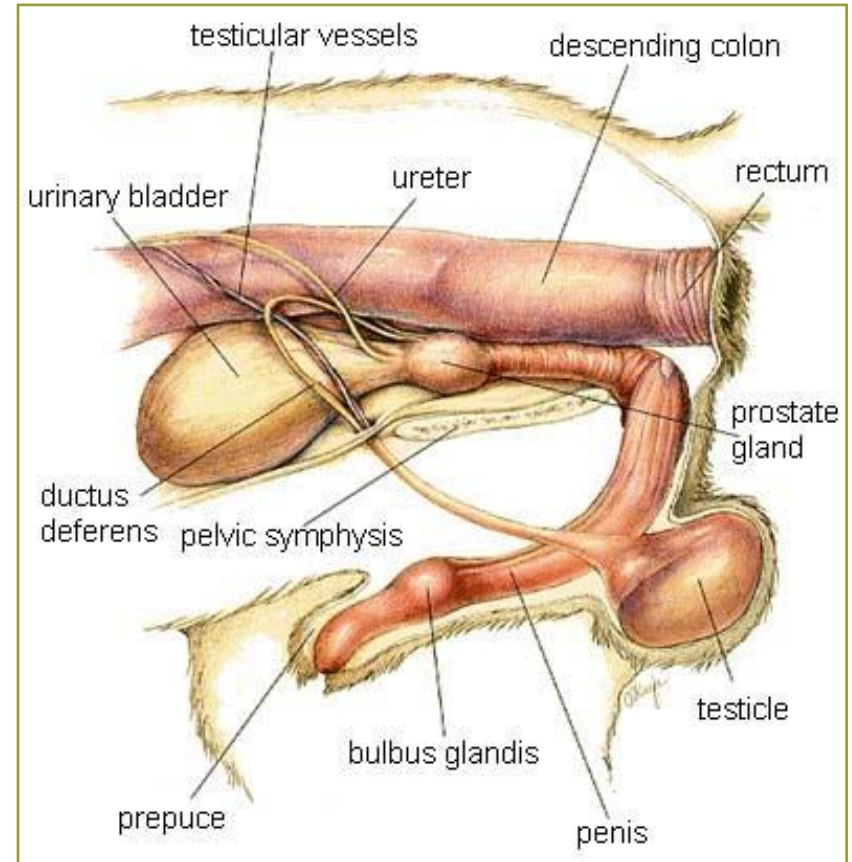
Accessory Reproductive Glands

- Ducts of all accessory reproductive glands enter pelvic portion of the urethra
- Different species have different combinations of accessory reproductive glands
- Produce alkaline fluid that helps counteract the acidity of the female reproductive tract

Accessory Sex Glands

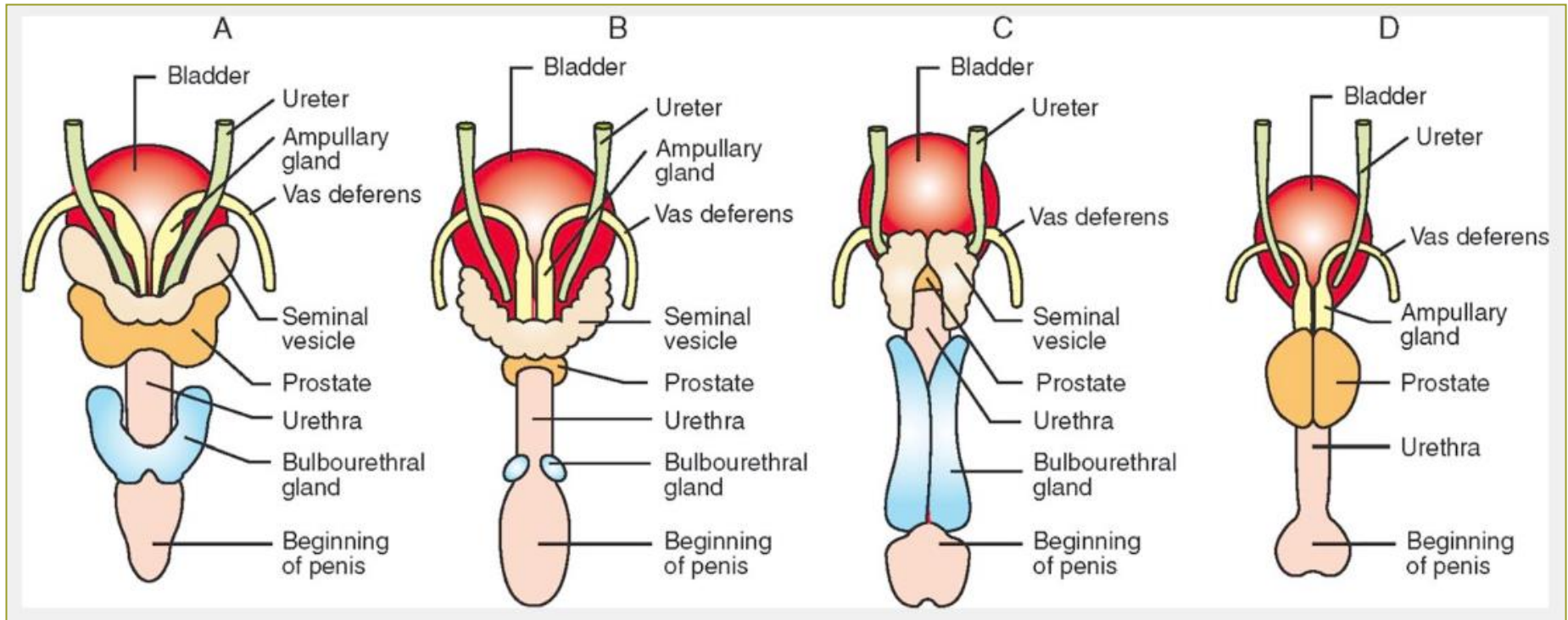
Figure 17-11, Table 17-2 – Page 396

- Accessory Sex Glands
 - Prostate gland
 - Seminal vesicles
 - Bulbourethral glands
 - Function – produce fluid of semen
- Semen – sperm + alkaline fluid
 - Electrolytes, fructose



Accessory Sex Glands

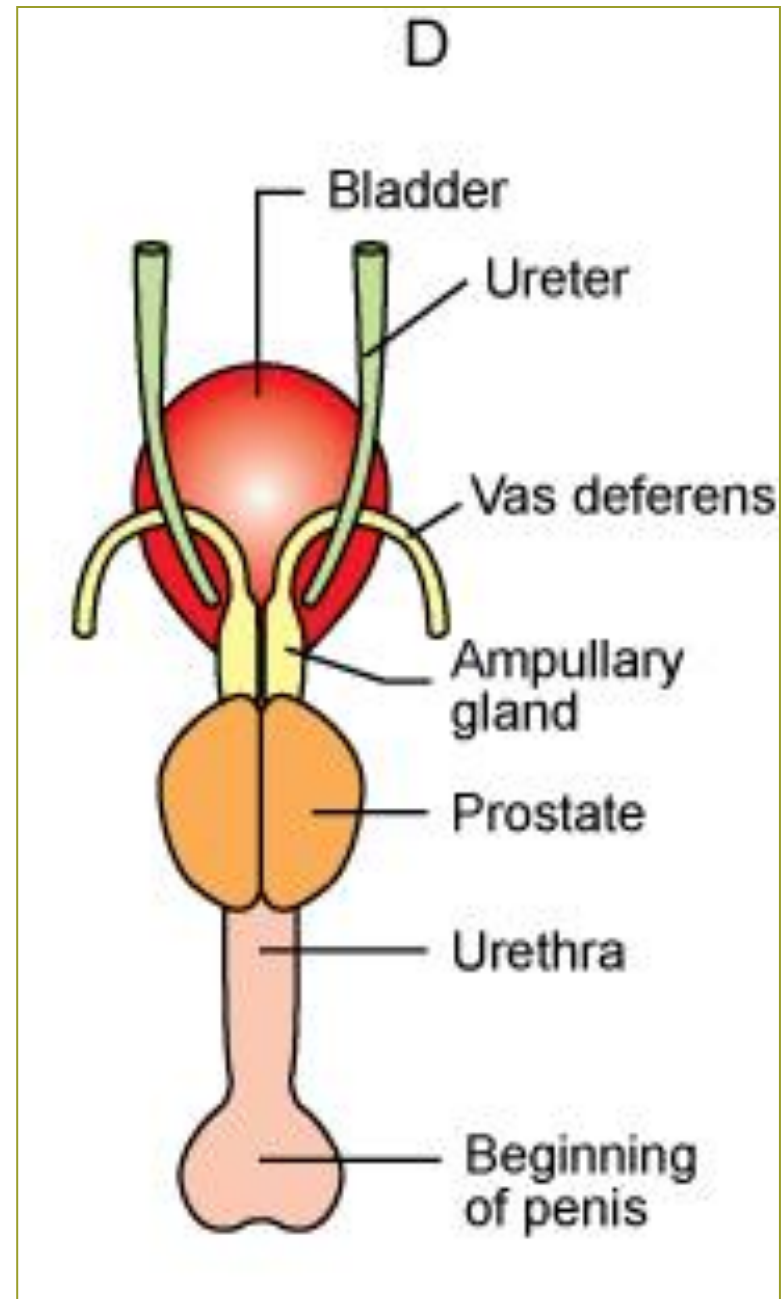
Figure 17-11, page 396



Prostate Gland

Figure 17-11D, page 396

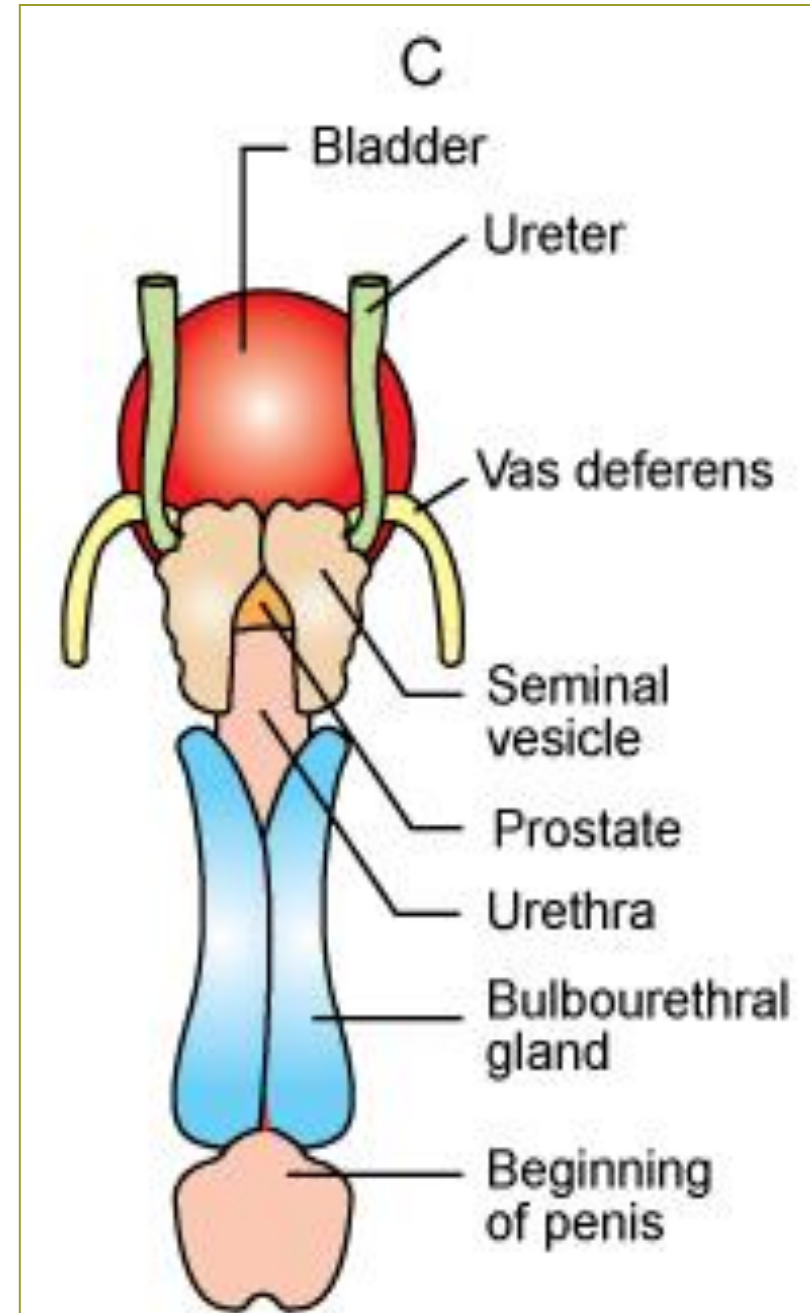
- Surrounds the urethra
- Multiple ducts carry secretions into urethra



Bulbourethral Glands

Figure 17-11C, page 396

- Cowper's glands
- Ducts enter urethra near caudal border of pelvis
- Secrete mucinous fluid just before ejaculation that clears and lubricates the urethra



Accessory Sex Glands

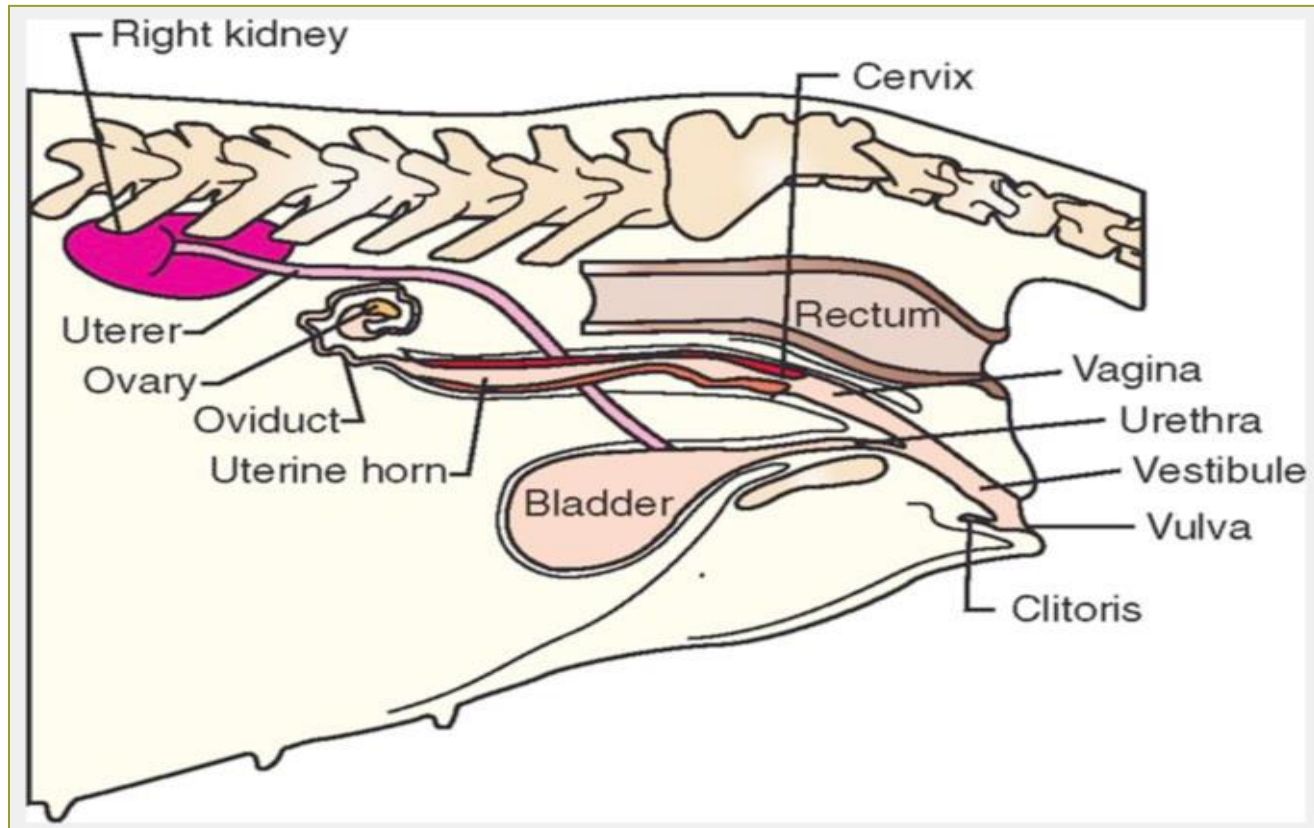
Table 17-2, Page 396

Animal	Seminal Vesicles	Prostate Gland	Bulbourethral Glands
Boar	+	+	+
Bull	+	+	+
Cat	-	+	+
Dog	-	+	-
Human	+	+	+
Ram	+	+	+
Stallion	+	+	+

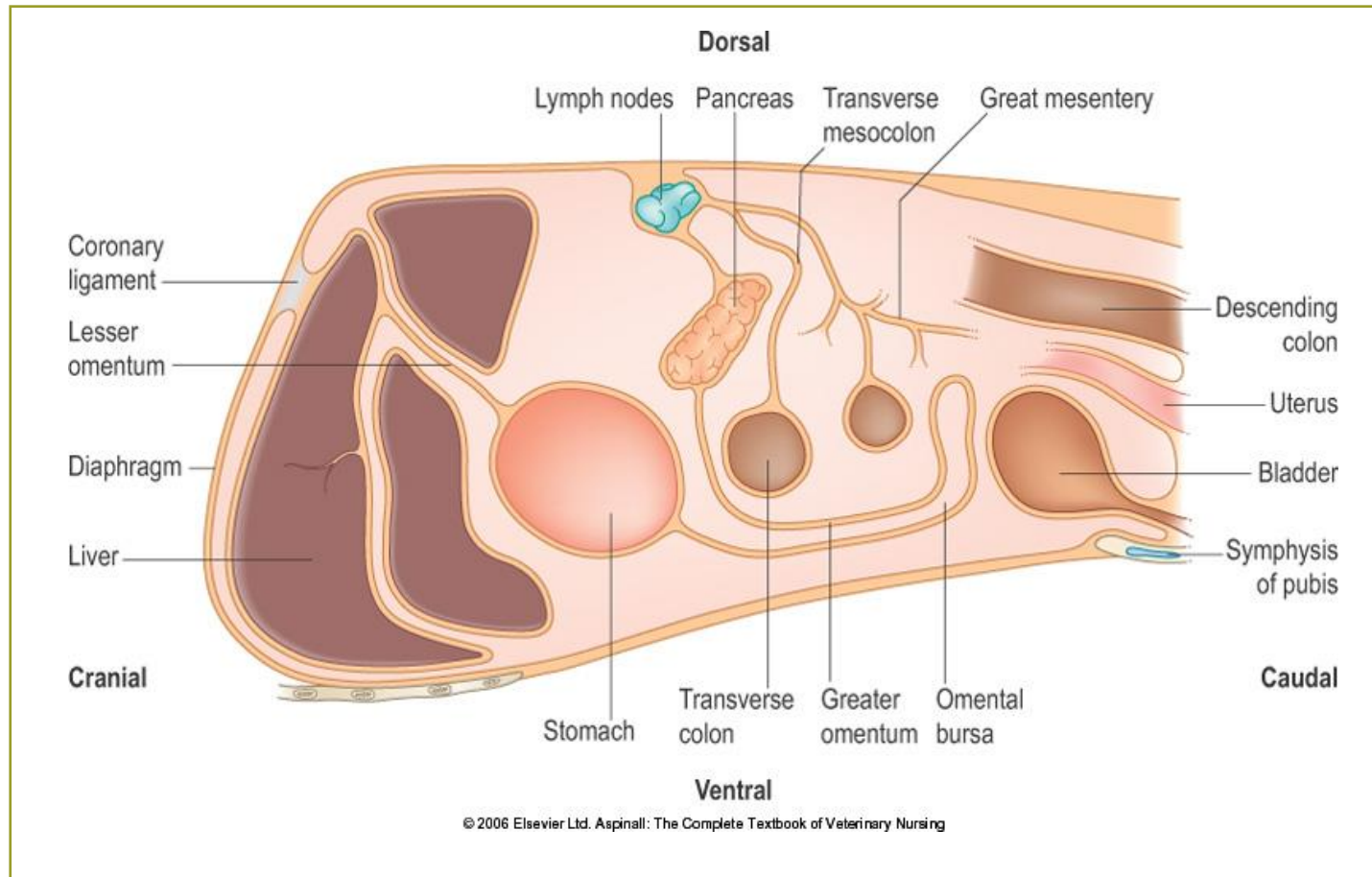
+ indicates the presence of a gland; - indicates the gland is absent.

Topic 13

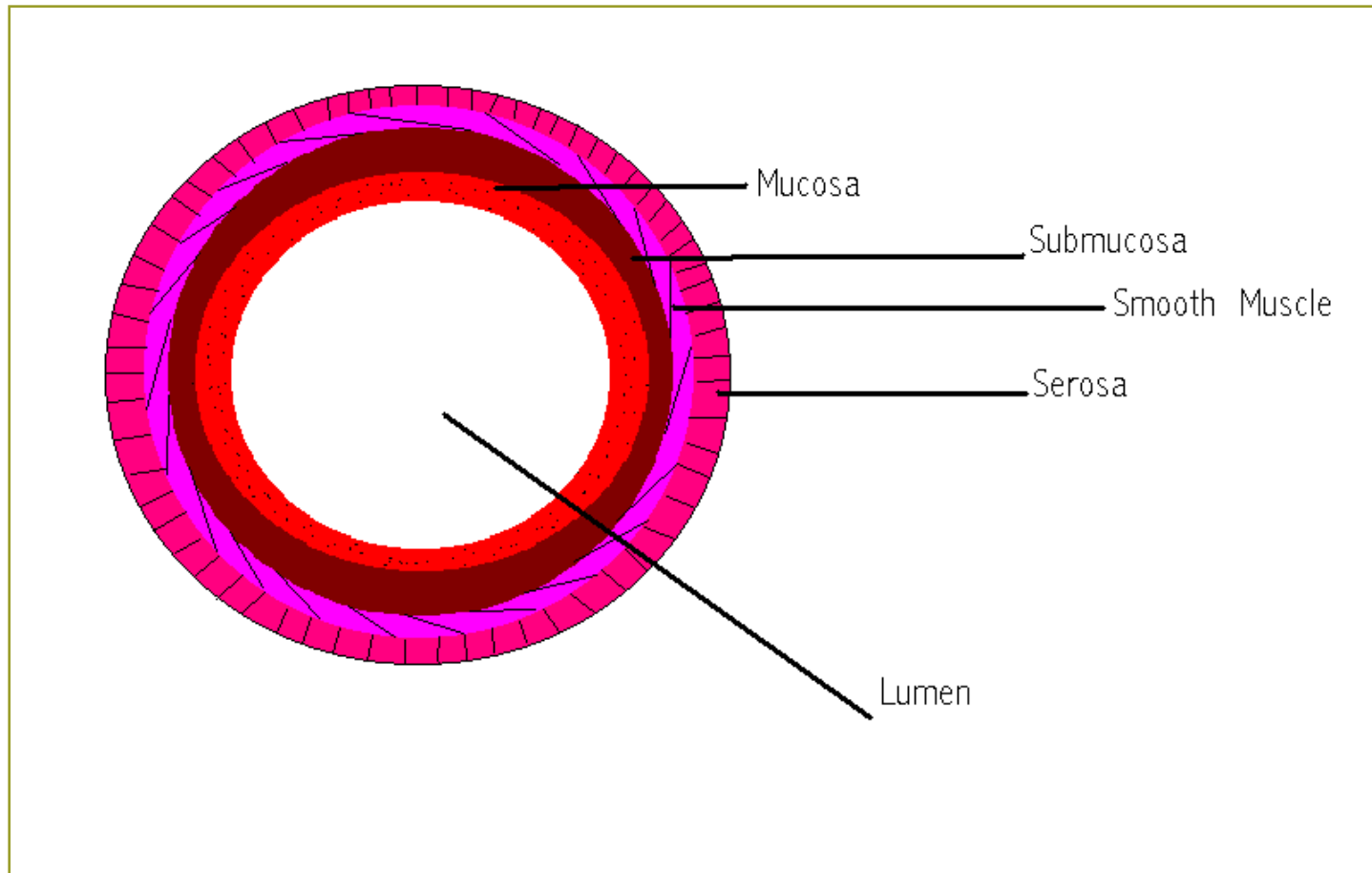
List the structures and functions of the female reproductive system

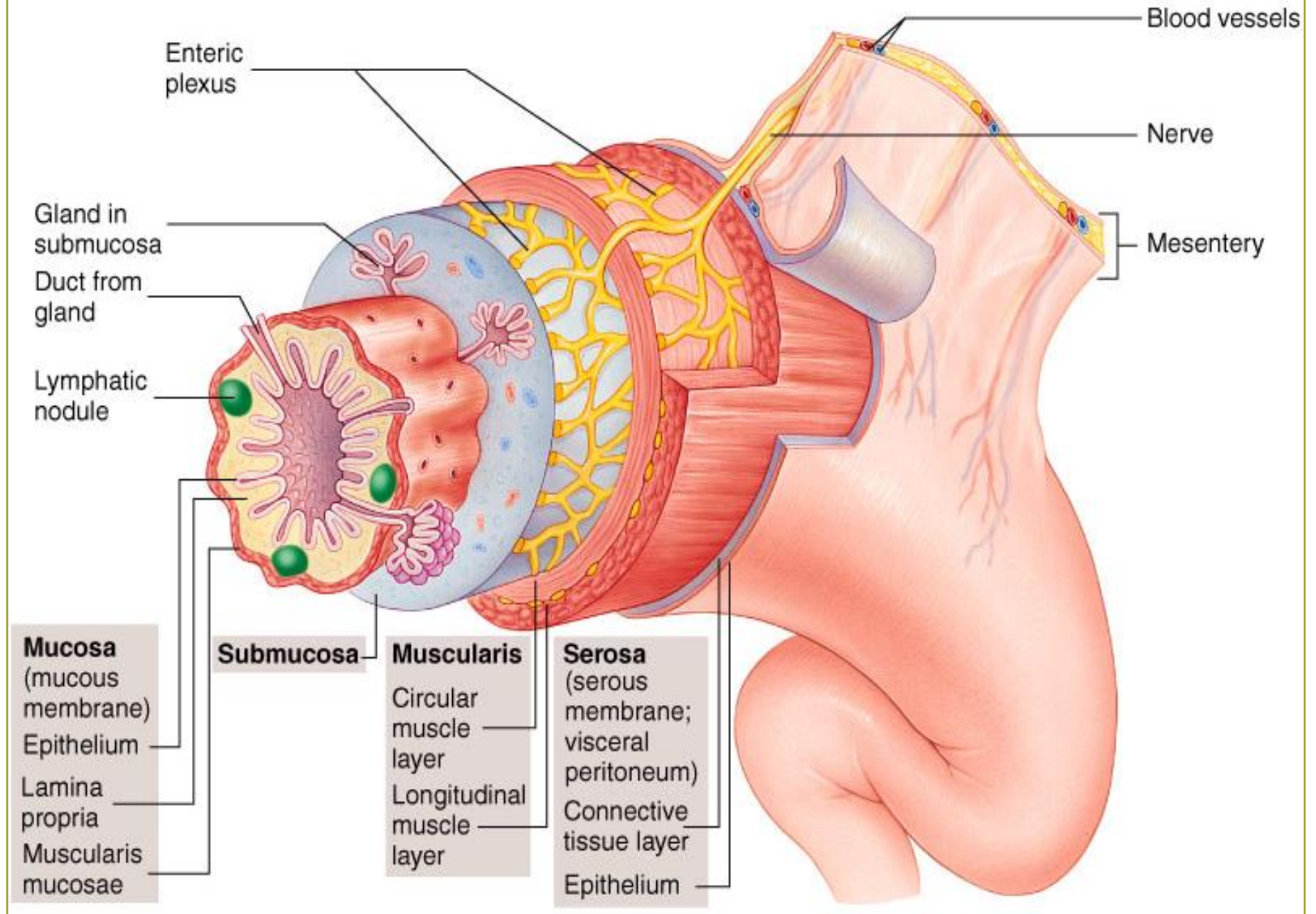


Female – 3 Tracts



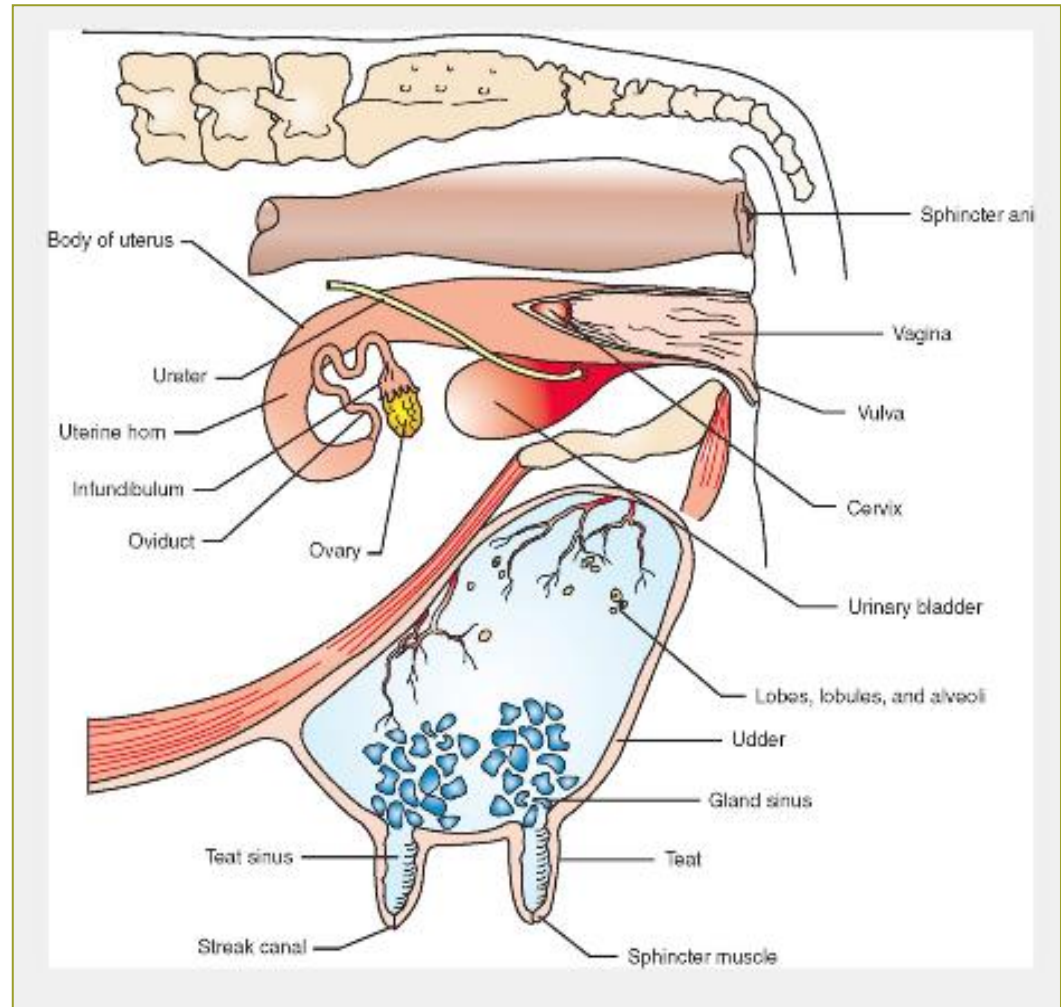
4 Layers of the Tracts





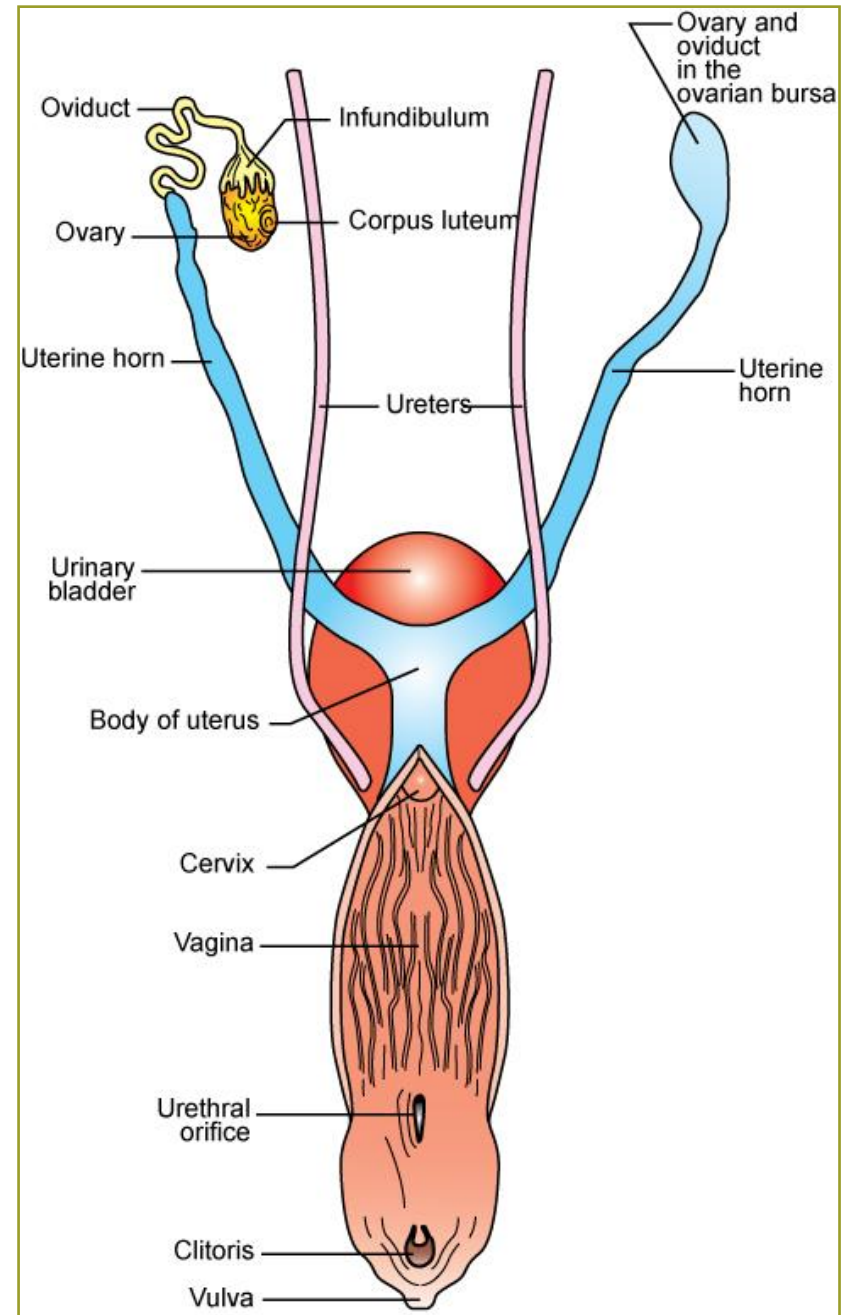
Female Reproductive System Functions

- Produces female sex hormones
- Develops ova
- Fertilization
- Pregnancy
- Parturition
- Nursing of newborn



Trace an Egg Cell (Canine)

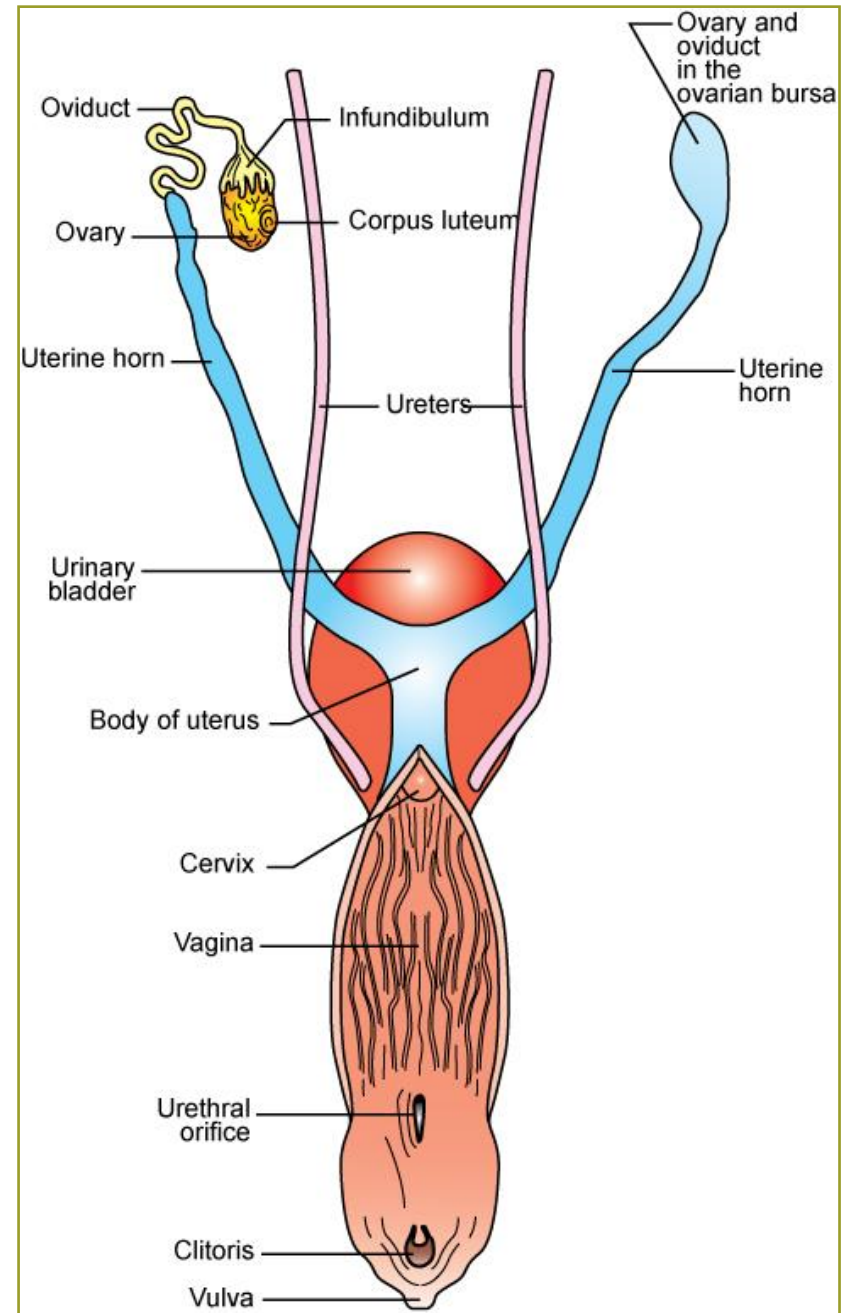
Figure 17-13, Page 399

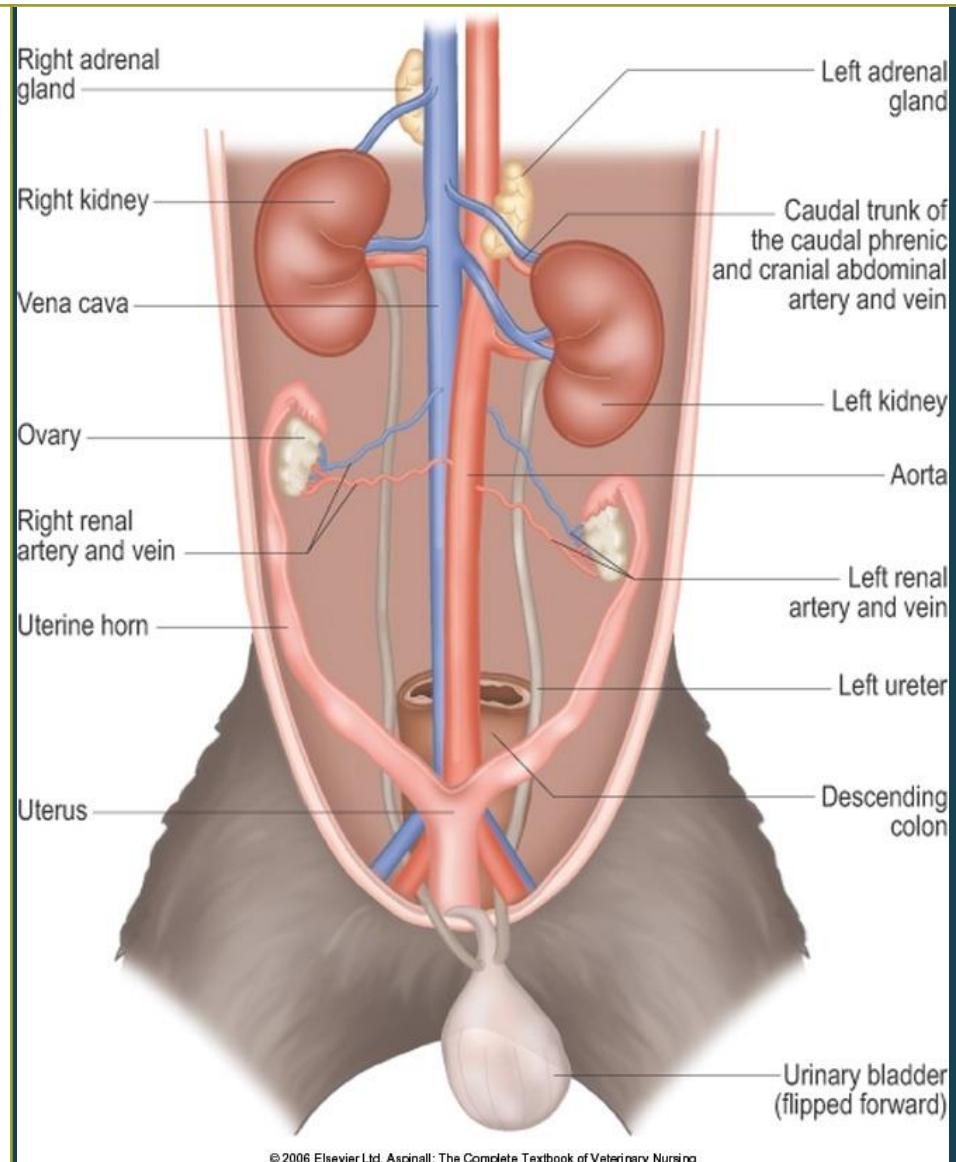
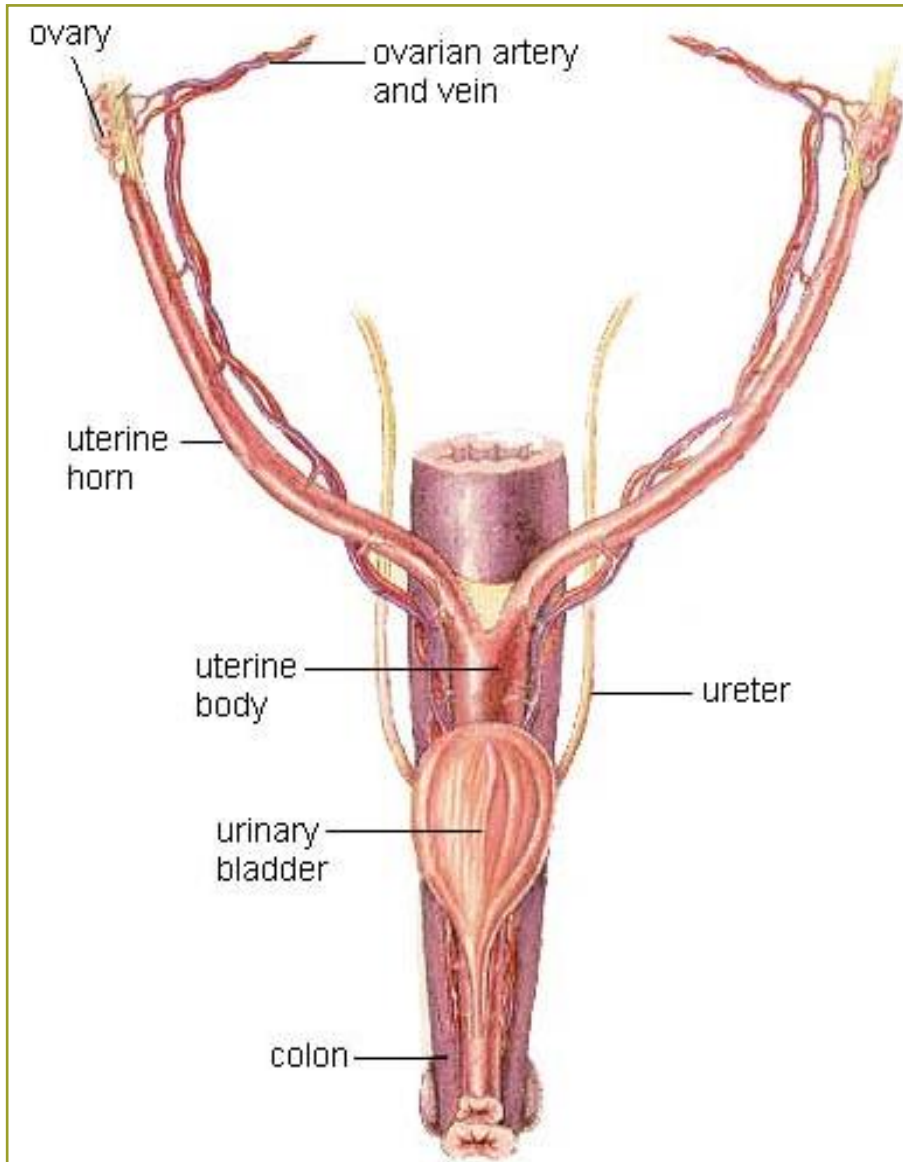


Female Reproductive System

Figures 17-12 to 17-16,
Pages 399-400

- Ligaments
- Ovaries
- Oviducts
- Uterus
- Cervix
- Vagina
- Vulva





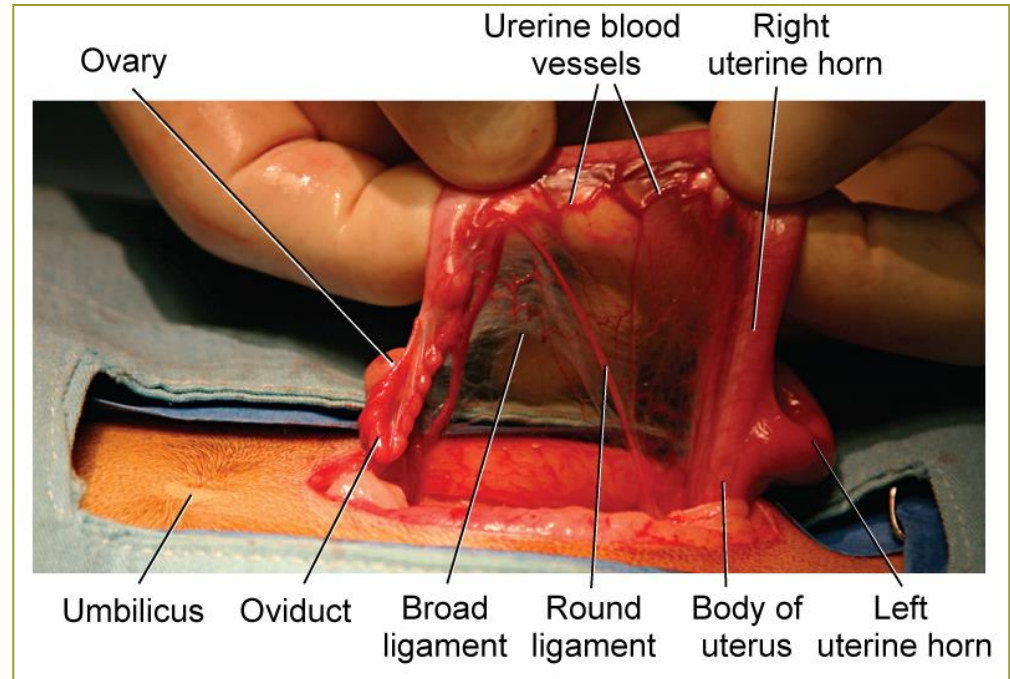
Broad and Round Ligaments

Figure 17-15, Page 400

- Broad ligament:

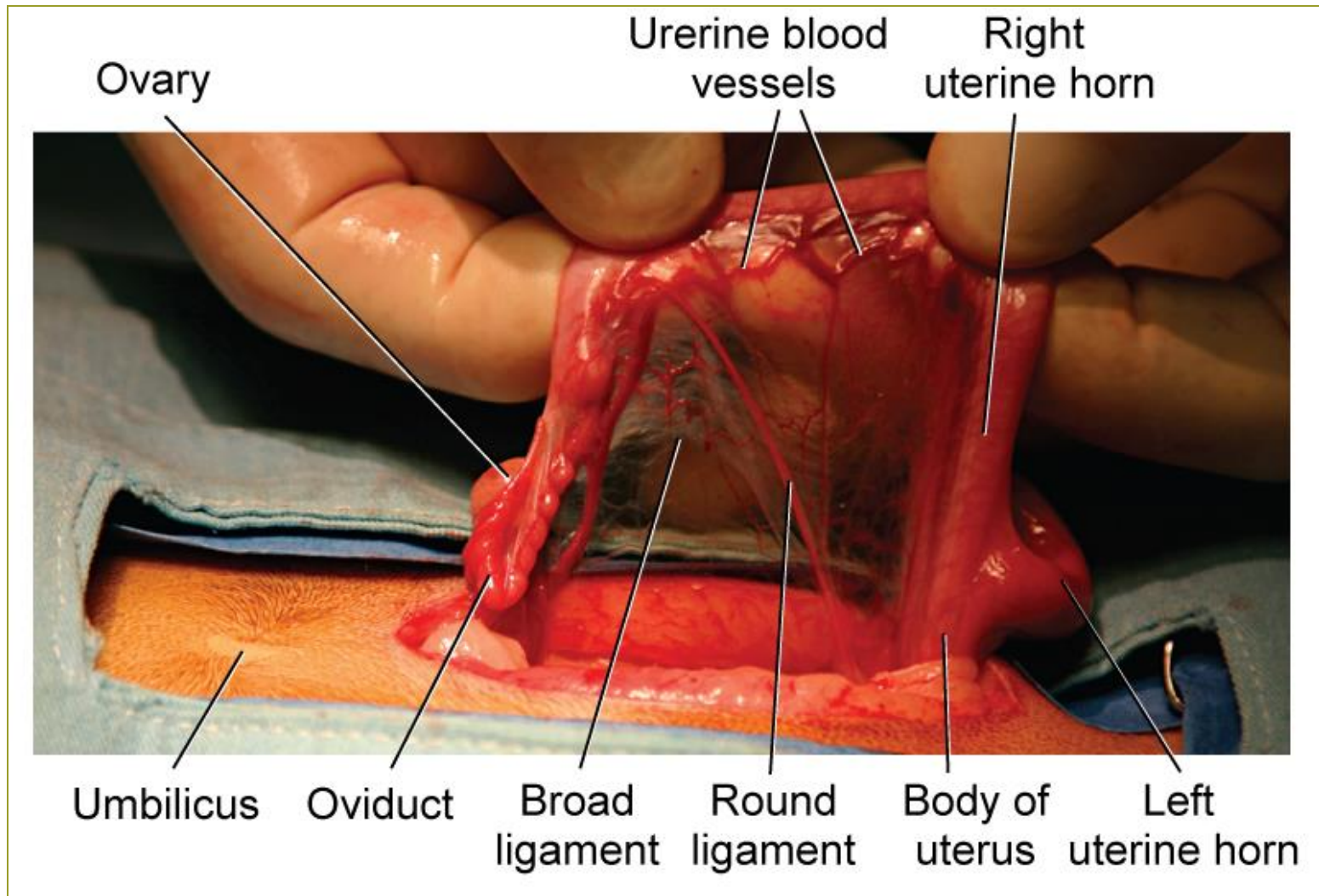
- Suspend ovaries, oviducts, and uterus
- Contain blood vessels and nerves

- Round ligament of the uterus



Broad and Round Ligaments

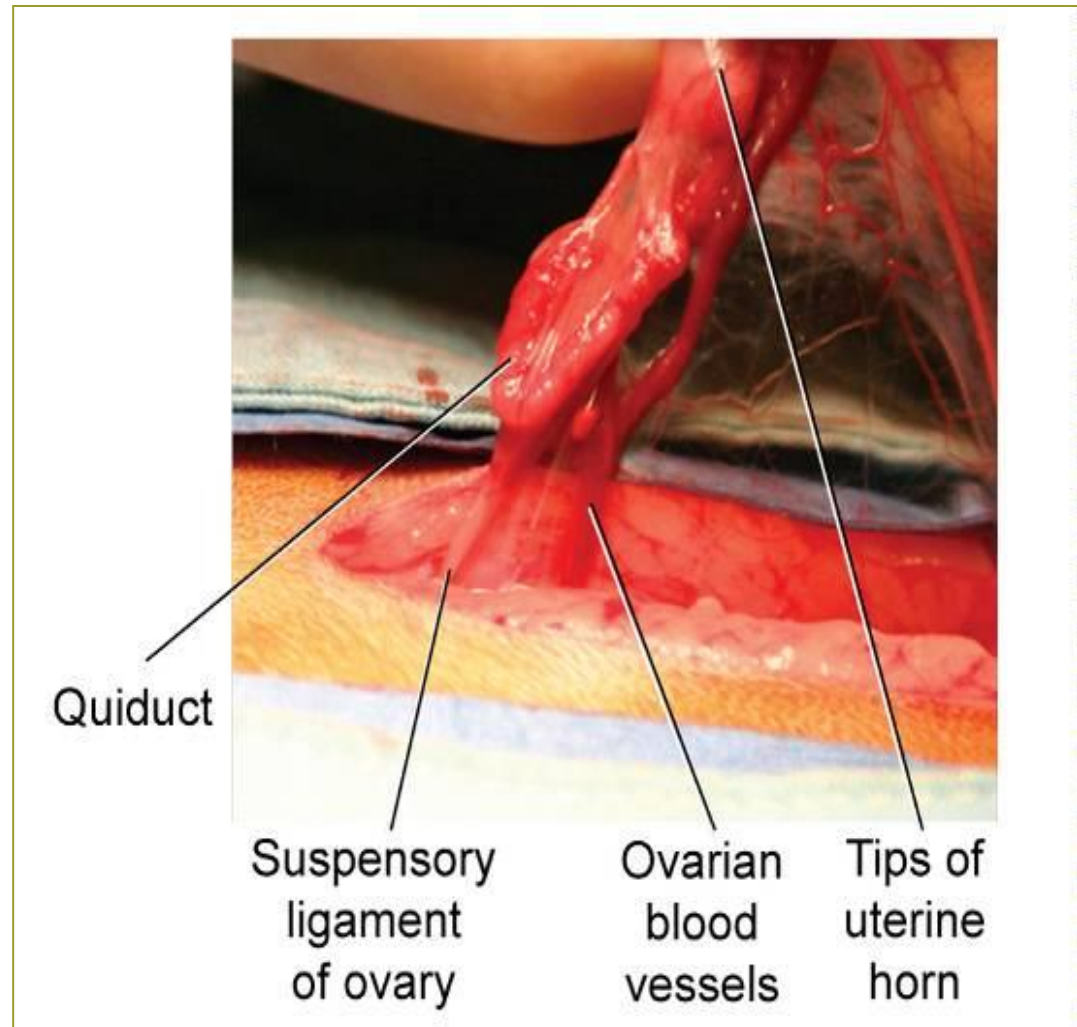
Figure 17-15, Page 400



Suspensory Ligament of Ovary

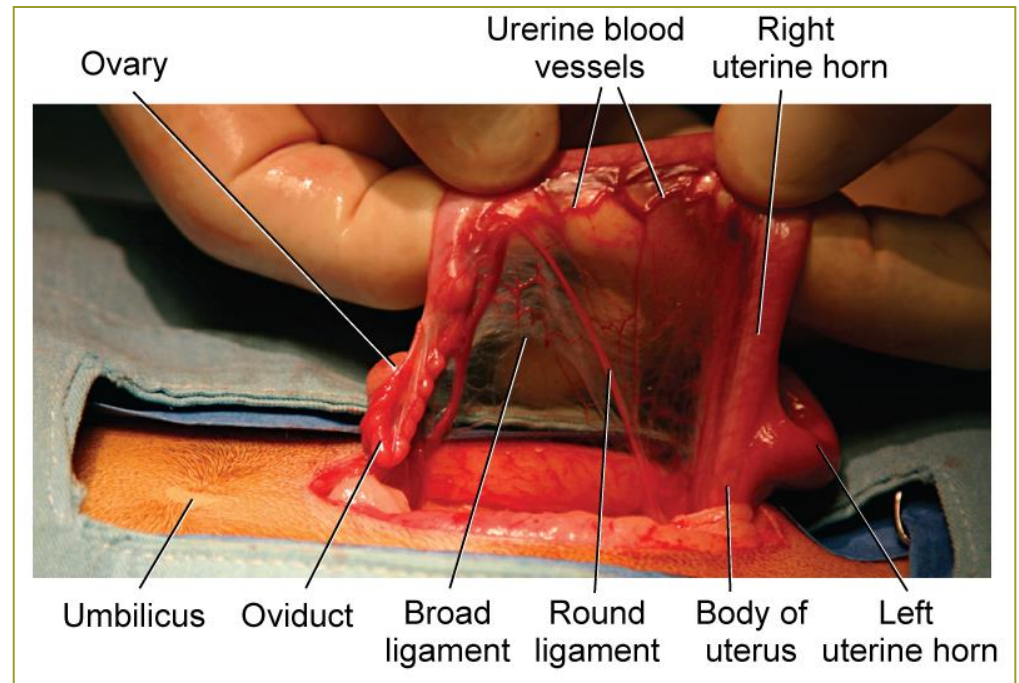
Figure 17-16, Page 400

- Ovarian end of broad ligament attached to body wall in area of last rib
- Must be broken during OHE



Ovaries

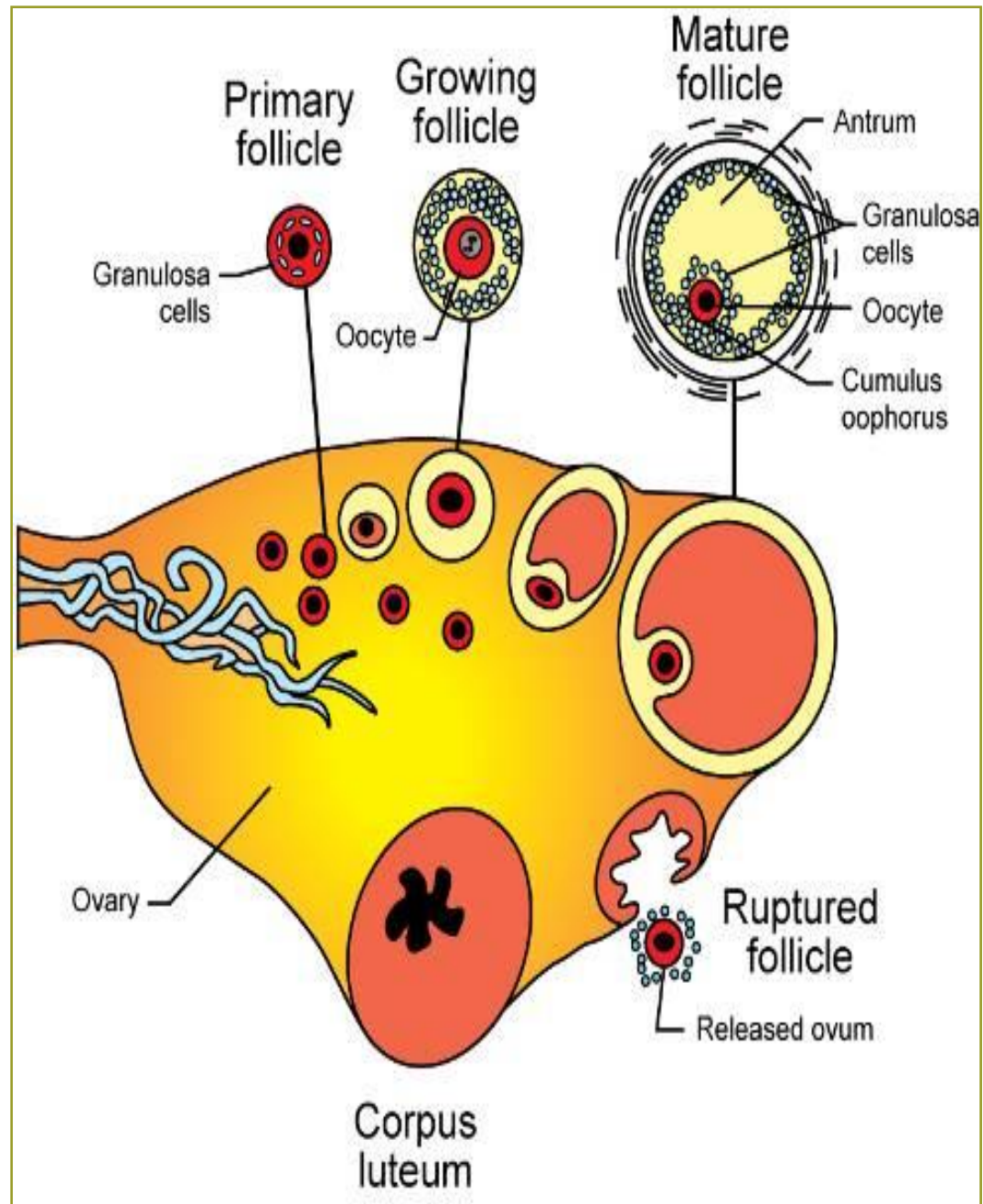
- In dorsal abdomen just posterior to kidneys
- Species variation in appearance
- Site of oogenesis
- Production of estrogens and progestins

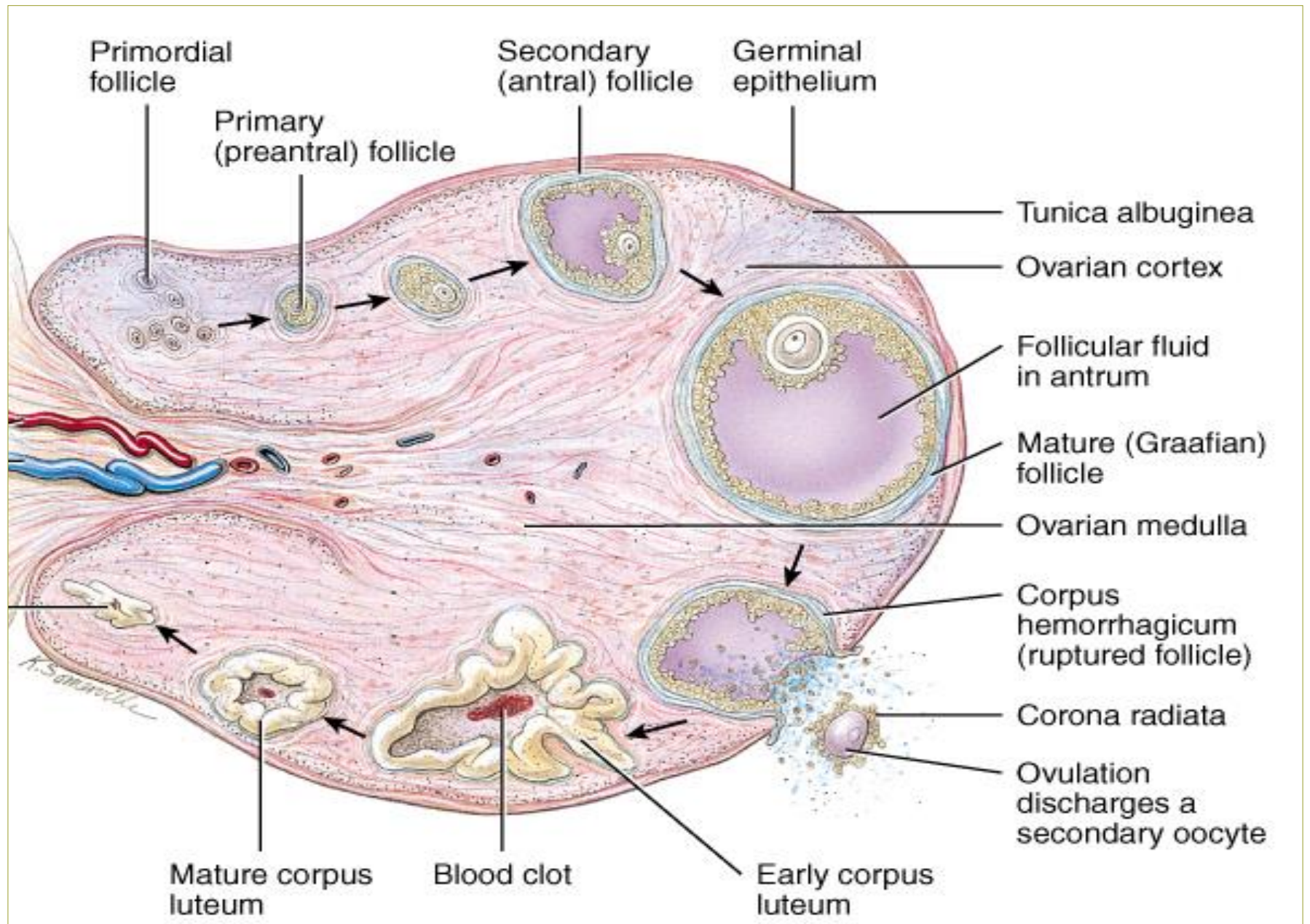


Ovaries

Figure 17-17, Page 401

- 2 functions
 - Ova (eggs)
 - Female hormones
 - Estrogen
 - Progesterone
 - Follicles & corpus luteum
- Ovarian artery
- Palpated rectally in cows, mares
 - Determines when to breed



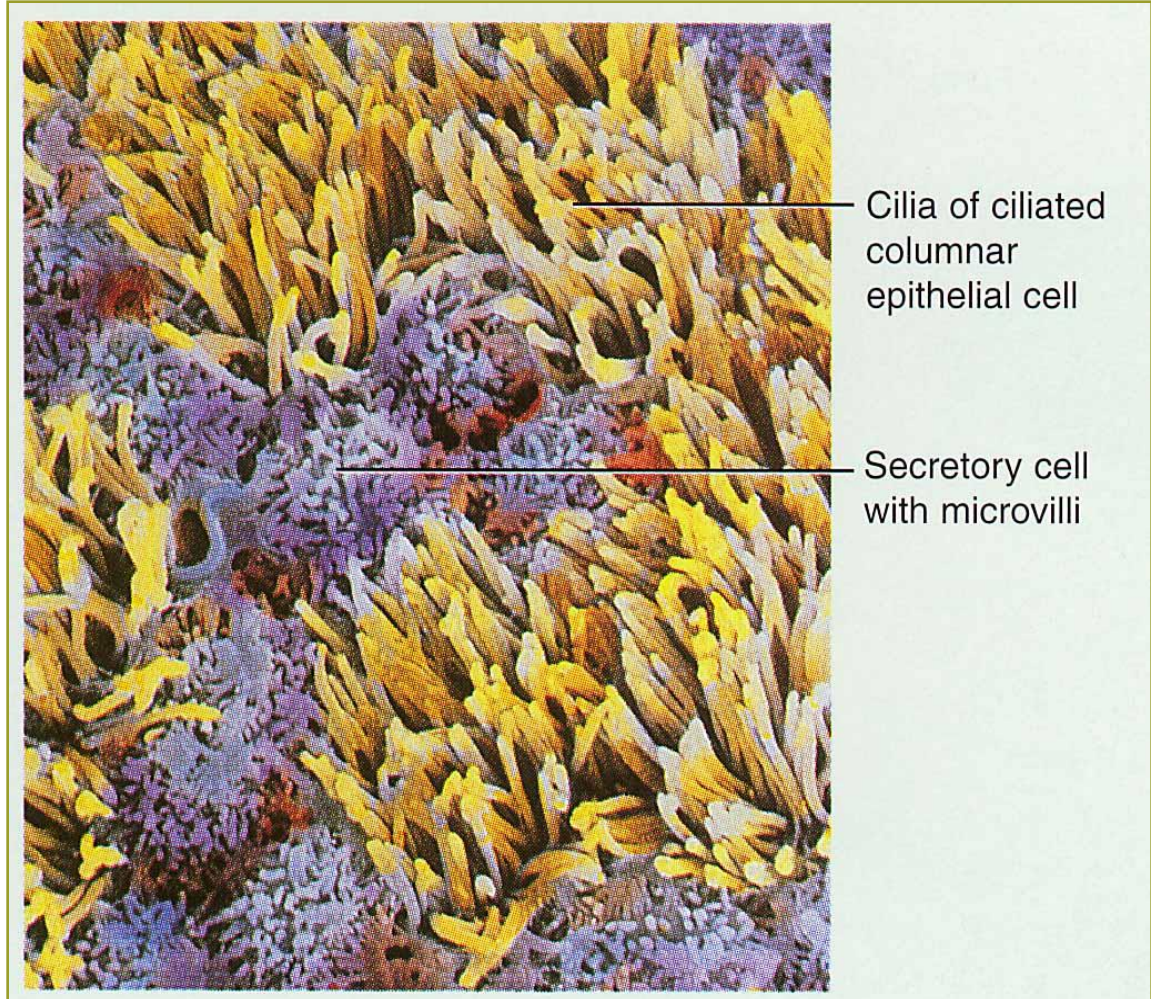


Oviducts

- Also known as fallopian tubes and uterine tubes
- Extend from the tips of the uterine horns
- Infundibulum: enlarged opening at the ovarian end of each oviduct
- Fimbriae: muscular projections form margin of infundibulum; help properly position infundibulum

Oviducts

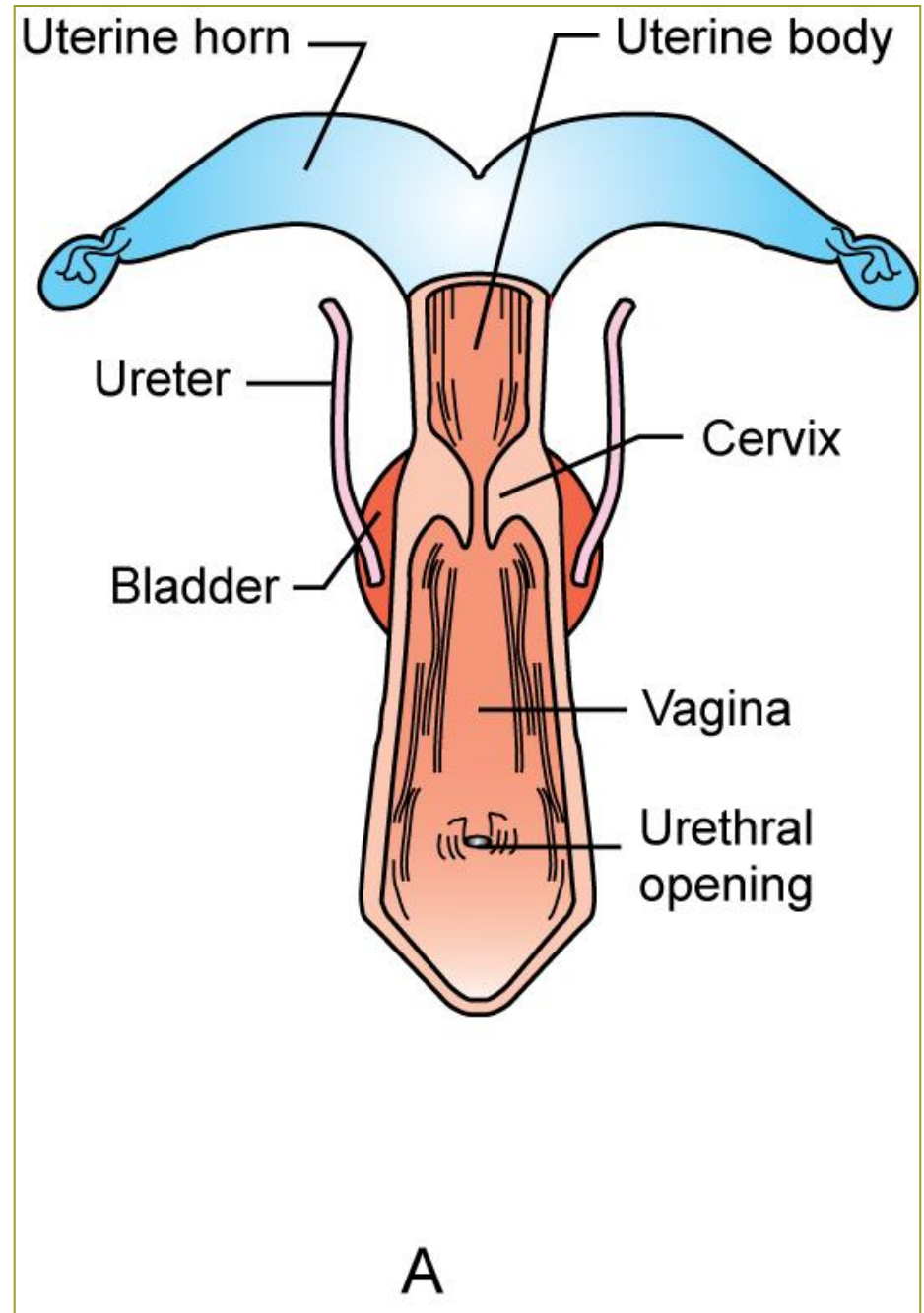
- Site of fertilization
- Linings covered with many cilia
- Move ova down toward uterus



Uterus

Figure 17-14A, Page 400

- Hollow muscular organ
- Usually Y shaped
 - Uterine body forms the base of the Y
 - Uterine horns form the arms



Uterus (Womb)

- Where zygote implants and grows
- “Litter species” have more horn than body
 - Dogs, cats, pigs
- 3 layers
 - Endometrium – site of zygote implantation
 - Myometrium – thickest layer
 - Perimetrium

How Many Newborn, You Ask? 😊

- Uniparous species
 - One mature ovum produced per cycle
 - Horse, cow, and human
- Multiparous species
 - Multiple ova produced per cycle
 - Cat, dog, and sow

3 Layers of Uterine Wall

- Endometrium: lining composed of simple columnar epithelium and simple tubular glands
 - Secrete mucus and other substances
- Myometrium: thick layers of smooth muscle
- Perimetrium: outermost layer covered by the visceral layer of peritoneum

Cervix

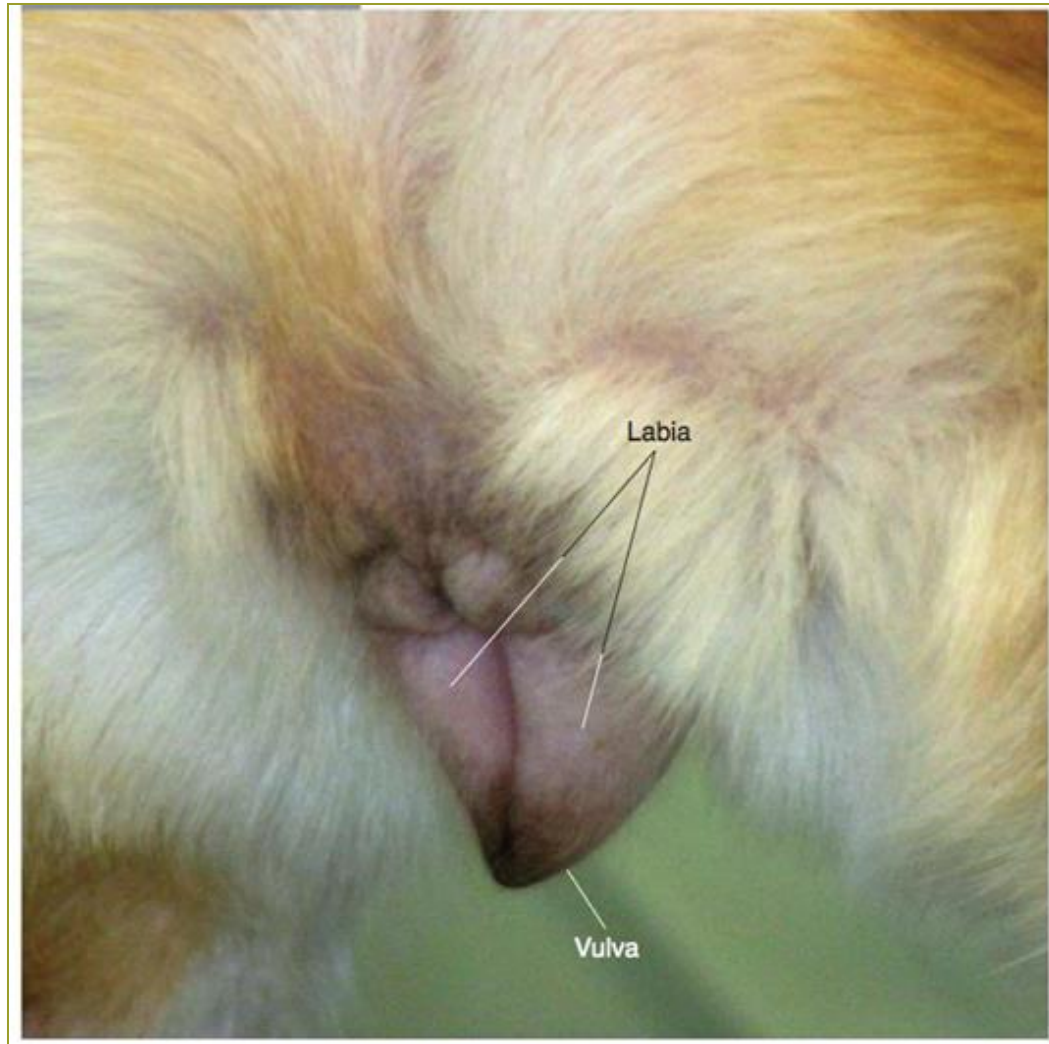
- Muscular valve that seals off uterus
- Naturally open on only 2 occasions
 - Estrus (true heat)
 - Sperm in
 - Parturition (birthing)
 - Newborns out
- Smooth muscle sphincter between uterus & vagina

Vagina & Vulva

- Vagina
 - Tube that receives the penis at breeding
 - Urethral orifice on ventral floor
- Vulva (& Vestibule)
 - Only part of female reproductive system visible outside the body (**external genitalia**)
 - Clitoris
 - Labia

Swollen Vulva of Bitch in Heat

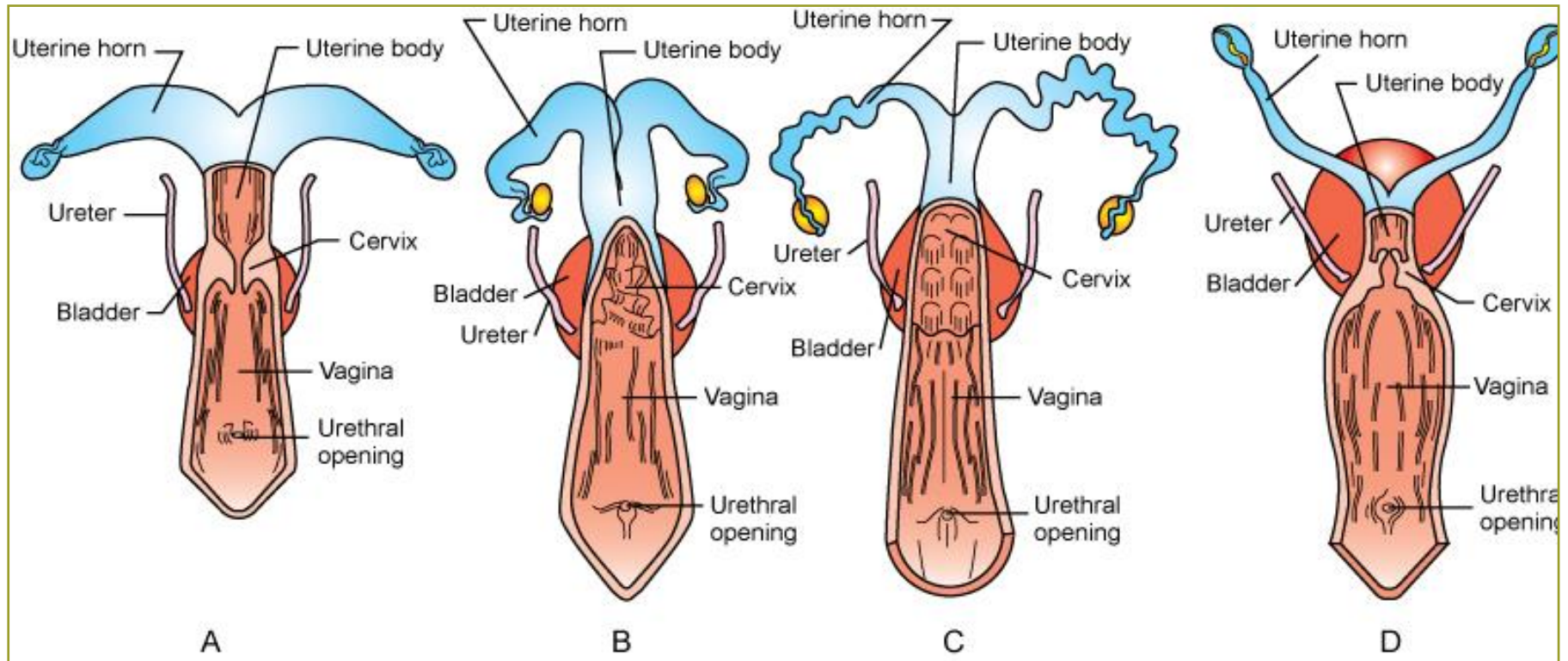
Bassett Lab Manual – Page 429



Comparative Female Reproductive Anatomy

Figure 17-14, Page 400

- Mare (A), Cow (B), Sow (C), Bitch (D)



Breeding, Parturition

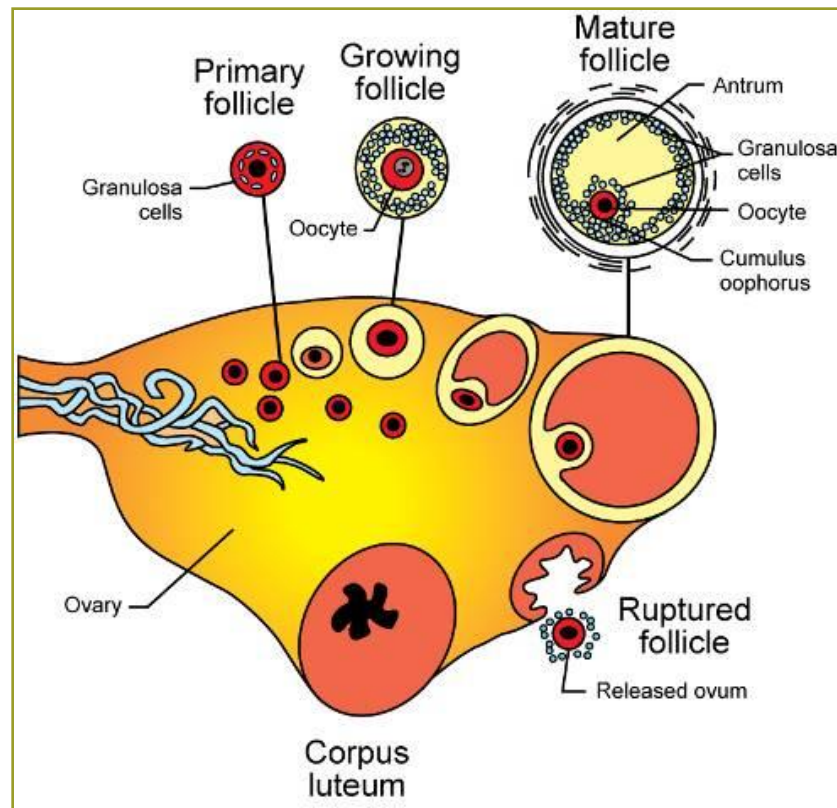


Names for Female Animals

Species	Name
Dog	Bitch
Cat	Queen
Horse	Mare
Cattle (after 1 st calf)	Cow
Cattle (before 1 st calf)	Heifer
Pig	Sow
Sheep	Ewe

Topic 14

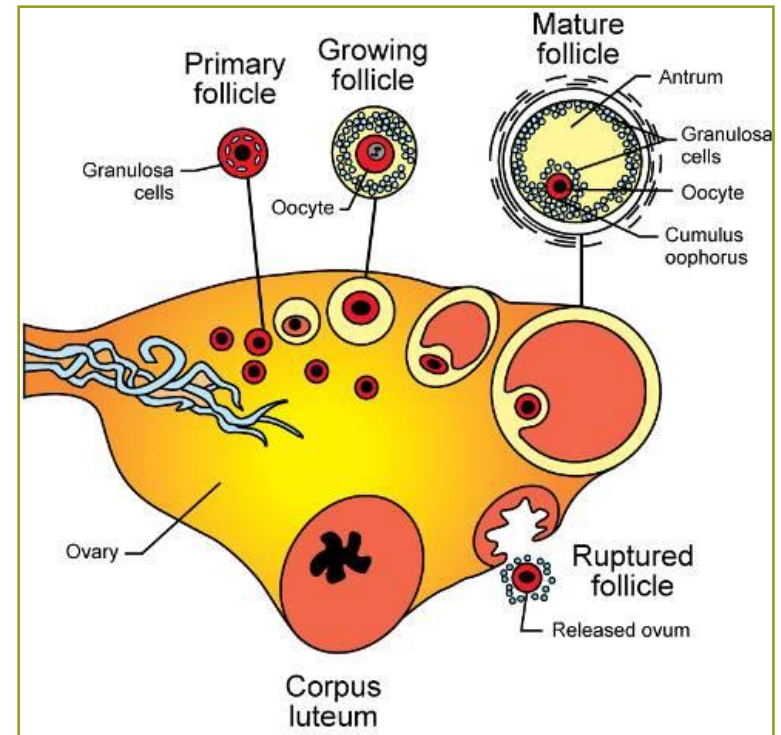
Describe the events that occur during the ovarian cycle of female animals

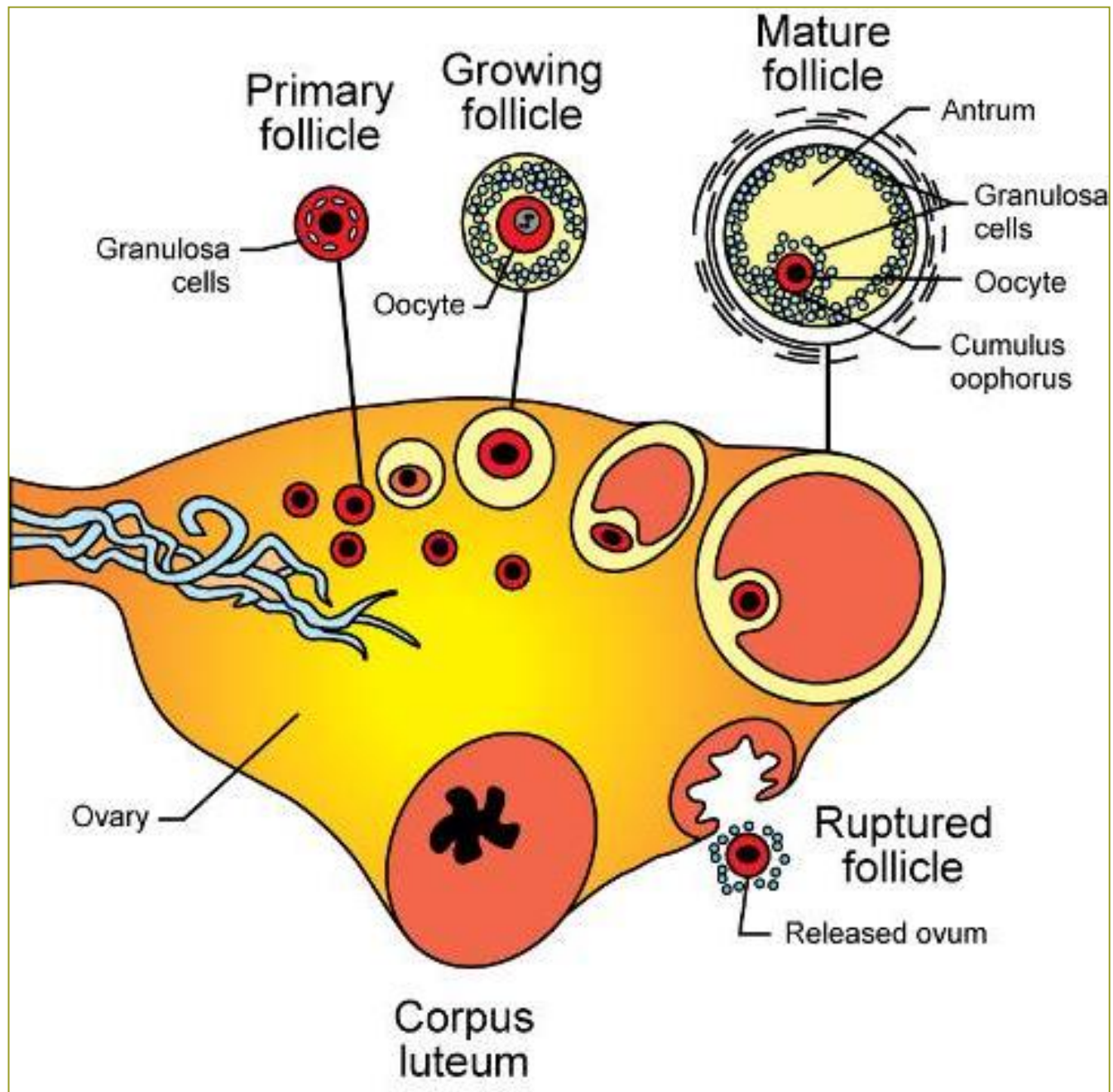


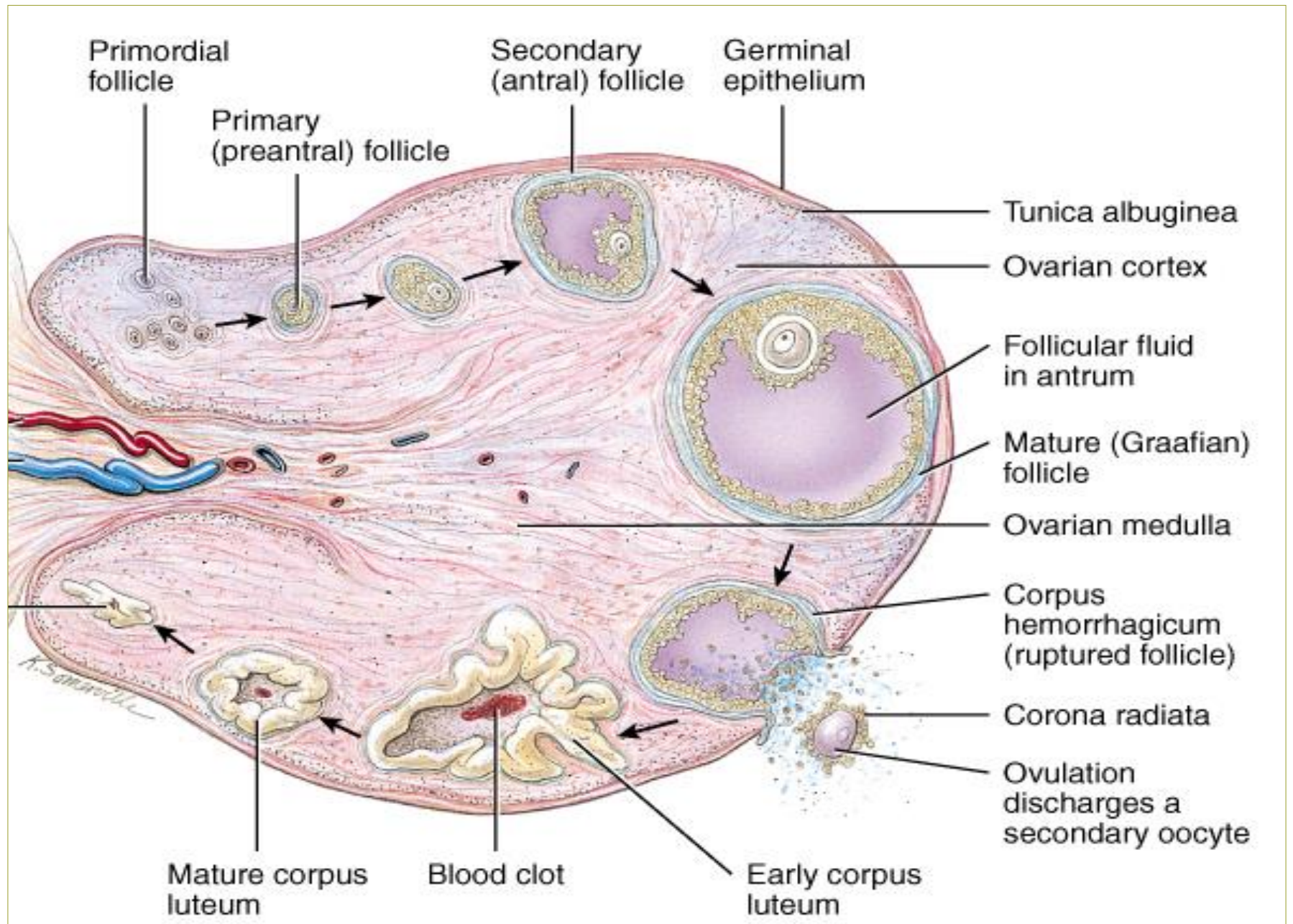
Ovarian Physiology

Figure 17-17, Page 401

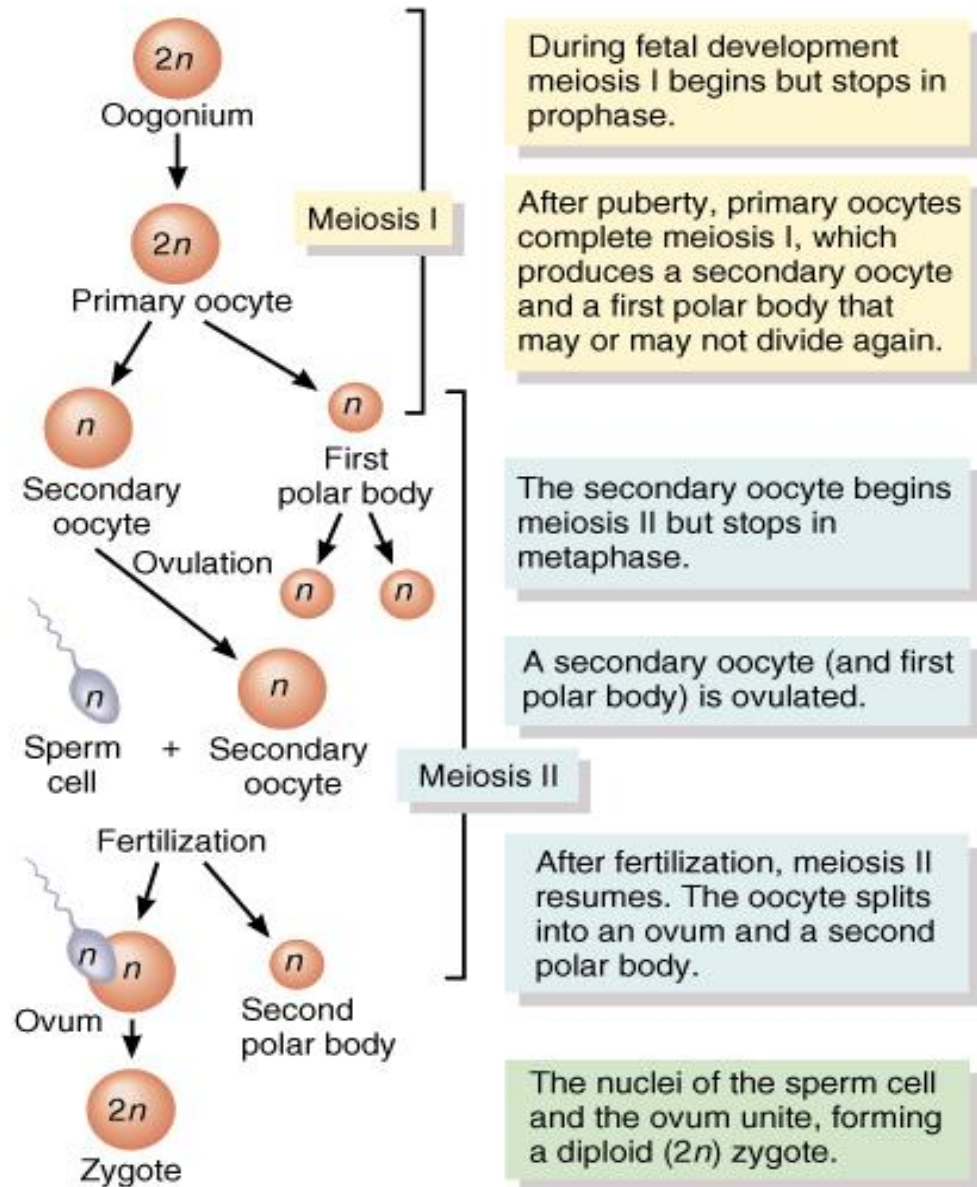
- Follicle
 - 1 egg (ovum)
 - Estrogen production
 - Prepares animal for breeding & pregnancy
- Graafian follicle (mature)
- Ovulation – follicle rupture
 - Egg “caught” by oviduct
 - Ruptured follicle become corpus luteum
- Corpus luteum produces progesterone
 - Maintains pregnancy







Oogenesis In Ovaries



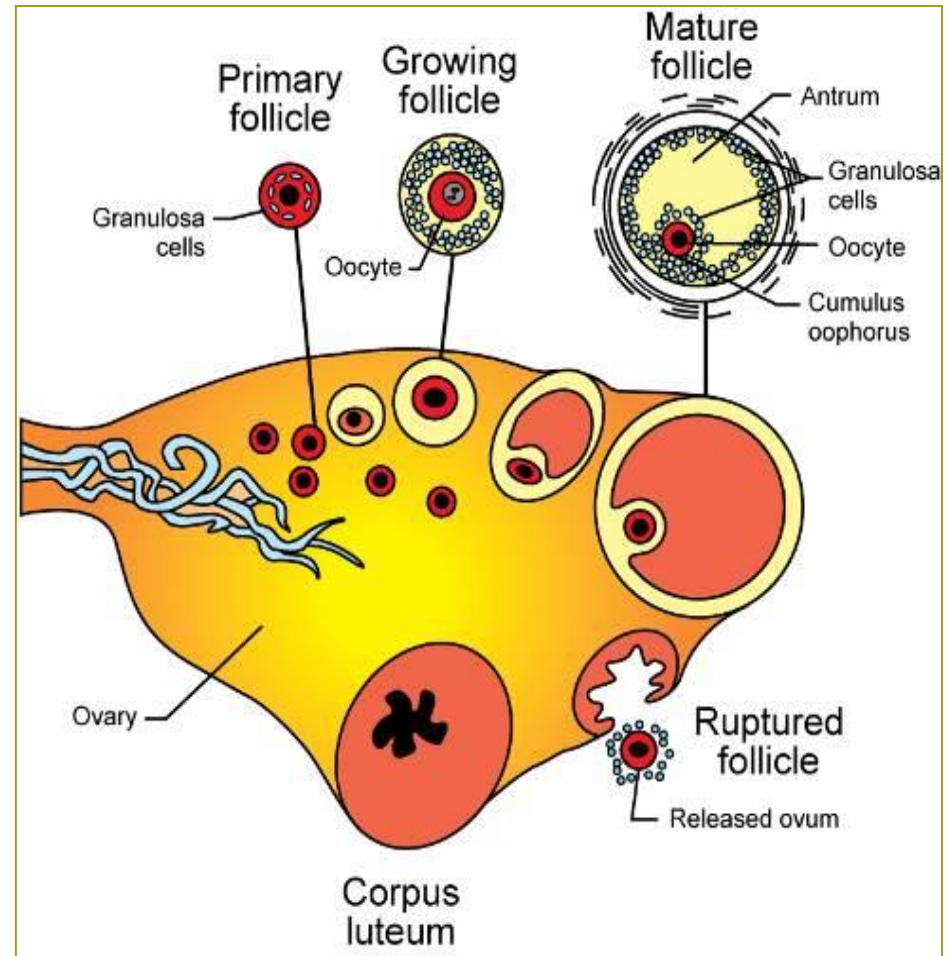
Corpus Luteum

- If pregnancy occurs, remains for entire pregnancy
- If pregnancy does not occur, degenerates after a short period
- False pregnancy (pseudocyesis)
 - Common in dogs



Ovarian Cycle

- Development of ovum, ovulation, formation of corpus luteum, and degeneration of unripened follicles and corpus luteum
- Influenced by follicle stimulating hormone (FSH) and luteinizing hormone (LH)



Ovulation

- Rupture of mature follicle and release of secondary oocyte into oviduct
 - Becomes ovum if fertilization occurs
- Surface of mature follicle weakens, ruptures
- Fluid released from antrum along with oocyte (still surrounded by corona radiata)
- Empty follicle fills with blood (corpus hemorrhagicum)

Ovulation

- Occurs spontaneously in most species as a result of rising levels of LH
- Induced ovulators: ovulation occurs after breeding
 - Cat
 - Rabbit
 - Ferret

Corpus Luteum

- Formed by divisions of granulosa cells that line the blood-filled follicle
- Influenced by continued stimulation of LH
- Produces progestins (primarily progesterone)
 - Necessary for maintenance of pregnancy
- Endocrine signal to ovary causes corpus luteum to be maintained if ovum implants in uterus

Topic 15

List the stages of the estrous cycle and describe the events that occur during each stage

A Dog's Menstrual (Heat) Cycle



Introduction

While dogs may seem to have a menstrual cycle that is very similar to a woman's menstrual cycle, dogs do not experience an actual menstrual cycle. Primates are the only mammals that have a true menstrual cycle. Instead, dogs have what is called an estrus cycle.

Female Reproductive Physiology

- **Puberty** – age at which reproductive organs become functional
- Males
 - Quite often mature later than female
 - Always ready for breeding
- Females
 - Usually mature first
 - Are only fertile and receptive for a brief time



Estrous Cycle

- Time from the beginning of one heat period to the beginning of the next
- Controlled by 2 anterior pituitary hormones
 - Follicle stimulating hormone (FSH)
 - Oogenesis
 - Luteinizing hormone (LH)
 - Ovulation, corpus luteum production

Estrous Cycle Stages

Proestrus

Estrus

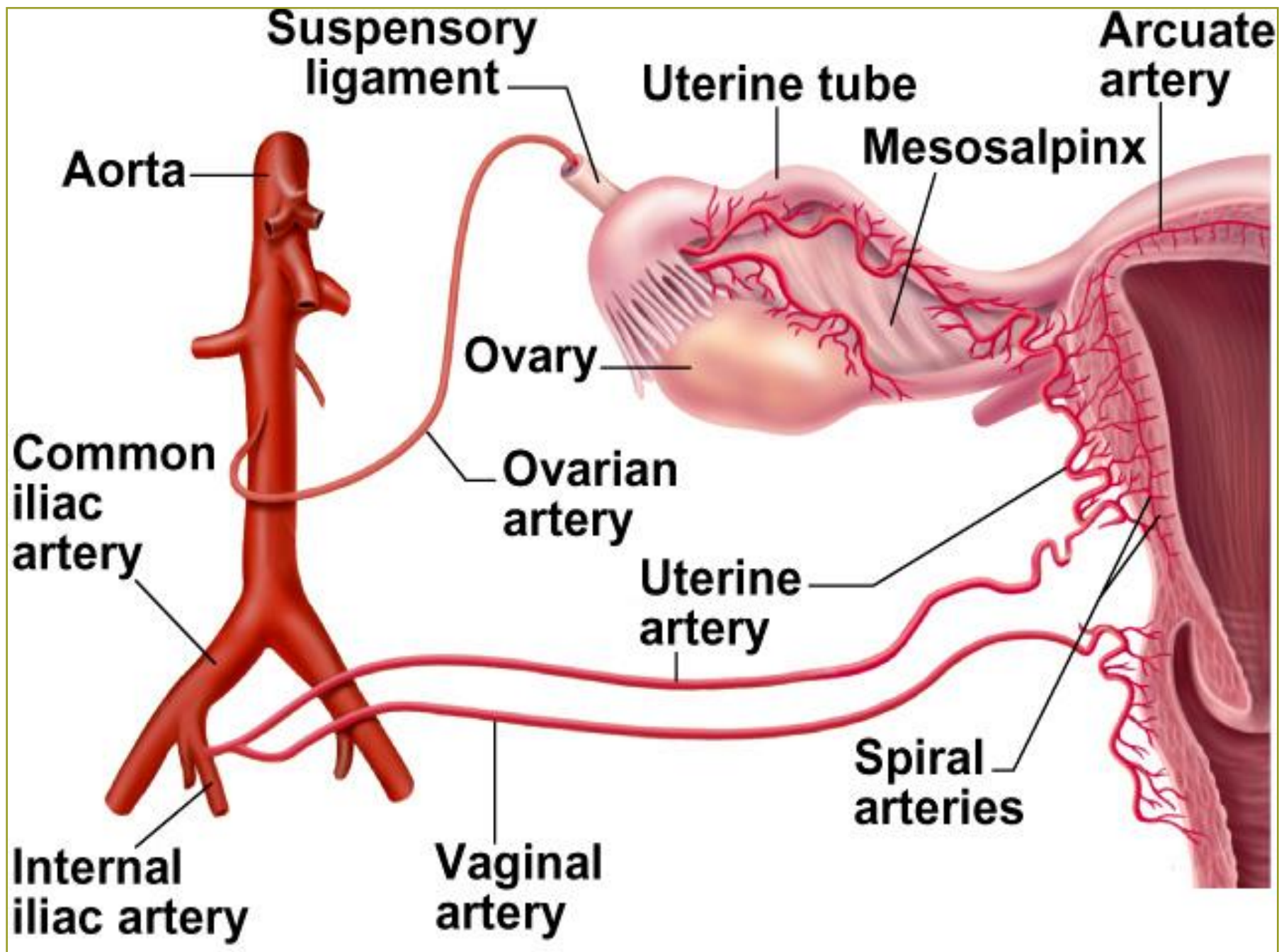
Metestrus

Diestrus

Anestrus (in some species)

Proestrus

- The “building up” phase (7 days)
- Blood spotting starts (Day 1)
- Follicles begin developing
- Estrogen output increases
- Blood supply to ovaries increases



Estrus

- “True heat” (7 days)
- Estrogen level production peaks
- Female sexually receptive
- Bloody discharge lighter (straw colored?)
- Ovulation! (one or multiple ova)
 - Ovulation occurs near end of estrus in some species
- Induced ovulator species (e.g., cat, rabbit) remain in a prolonged state of estrus if not bred

Metestrus

- 7 days
- Time when corpus luteum develops
- Lining of uterus thickens for implantation
- Progesterone produced by corpus luteum temporarily inhibits follicular development in the ovary
- Cornified epithelial lining that developed in the vagina during proestrus and estrus is lost

Diestrus

- Corpus luteum at maximum size and exerting maximum effect
- If fertilized ovum implants, corpus luteum is retained well into the pregnancy
- If no pregnancy occurs, corpus luteum degenerates at the end of diestrus
 - Animal then either goes back into proestrus or ovary shuts down and animal goes into anestrus
- Seen in seasonally polyestrus animals (cat, horse, cattle, swine)

Anestrus

- Period of temporary ovarian inactivity
- Seen in seasonally polyestrous, diestrous, and monoestrous animals
- Ovary temporarily shuts down
- Ovarian inactivity (5+ months in dogs)
- Period between breeding cycles

Types of Estrous Cycles

- Polyestrous: animals that cycle continuously throughout the year if they are not pregnant (cattle and swine)
- Seasonally polyestrous: animals with seasonal variations in estrous cycles (horse, sheep, cat)
- Diestrous: animals with two cycles per year, usually spring and fall (dog)
- Monoestrous: animals with one cycle per year (fox and mink)

Why Are There Sooooo Many Cats?

- **Seasonally polyestrus** (10 months)
- Anestrus (2 months)
- **Induced ovulators**
 - Need 2 stimuli
- **Post-partum estrus**
 - Can have 3 litters per year!
- Female cats left alone for 30 minutes outside..... pregnant!
- Rabbits the same

The Numbers!

Table 18-1, Page 409

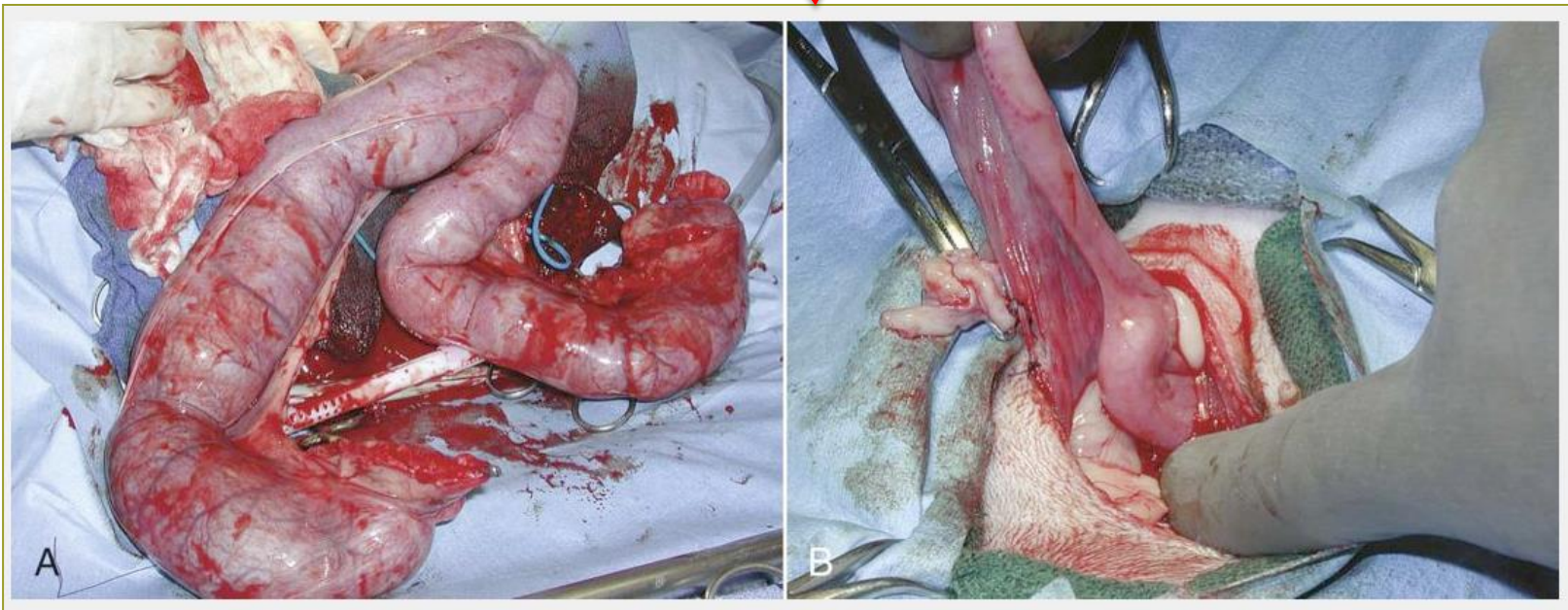
Female	Length of Cycle	Length of Estrus	Gestation
Bitch	21 days	7 days	2 months
Queen	18-21 days	Induced Ovulator	2 months
Mare	~21 days	5 days	11 months
Cow	21 days	18 hours!	9 months

Topic 16

McCurnin 8th edition – Page 1236

List and describe clinical applications and diseases of the reproductive system

FIGURE 32-29 Pyometra. The uterus must be carefully handled in cases of pyometra because it is often large, friable, and heavy. Compare (A) the pyometra uterus with (B) the normal uterus.

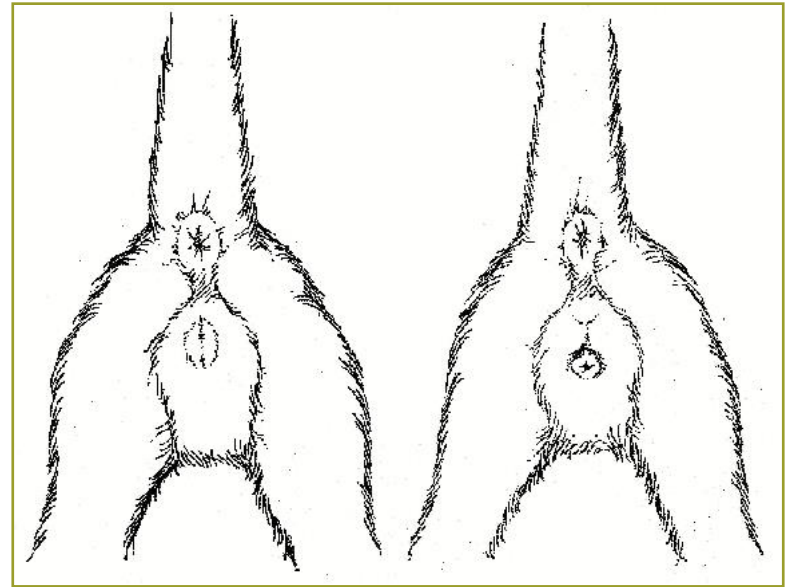


Male Clinical Applications

- Cryptorchidism **(Page 395)**
 - Cat vs. dog
 - Increased tumor risk?
- Sertoli cell tumor **(Page 395)**
- Vasectomy **(Page 397)**
- Canine Prostate Problems **(Page 397)**



What About Sexing Cats?



Orchidectomy

- Castration, “neutering”, OE
- Definition – surgical removal of testicles
- Medical vs. behavioral reasons
- What age?
- **Client education!**



McCurnin 8th edition – Page 1242

FIGURE 32-34 Feline castration. **A**, A skin incision is made directly over the scrotum as pictured. **B**, Manual pressure is applied to the testicle to exteriorize it through the incision. **C**, Traction is then applied to the testicle to pull it out of the scrotal sac for ligation. **D**, In this image, the spermatic cord has been knotted on itself and then will be released to go back into the scrotal sac. The scrotal sac will be left unsutured.



Why Neuter?



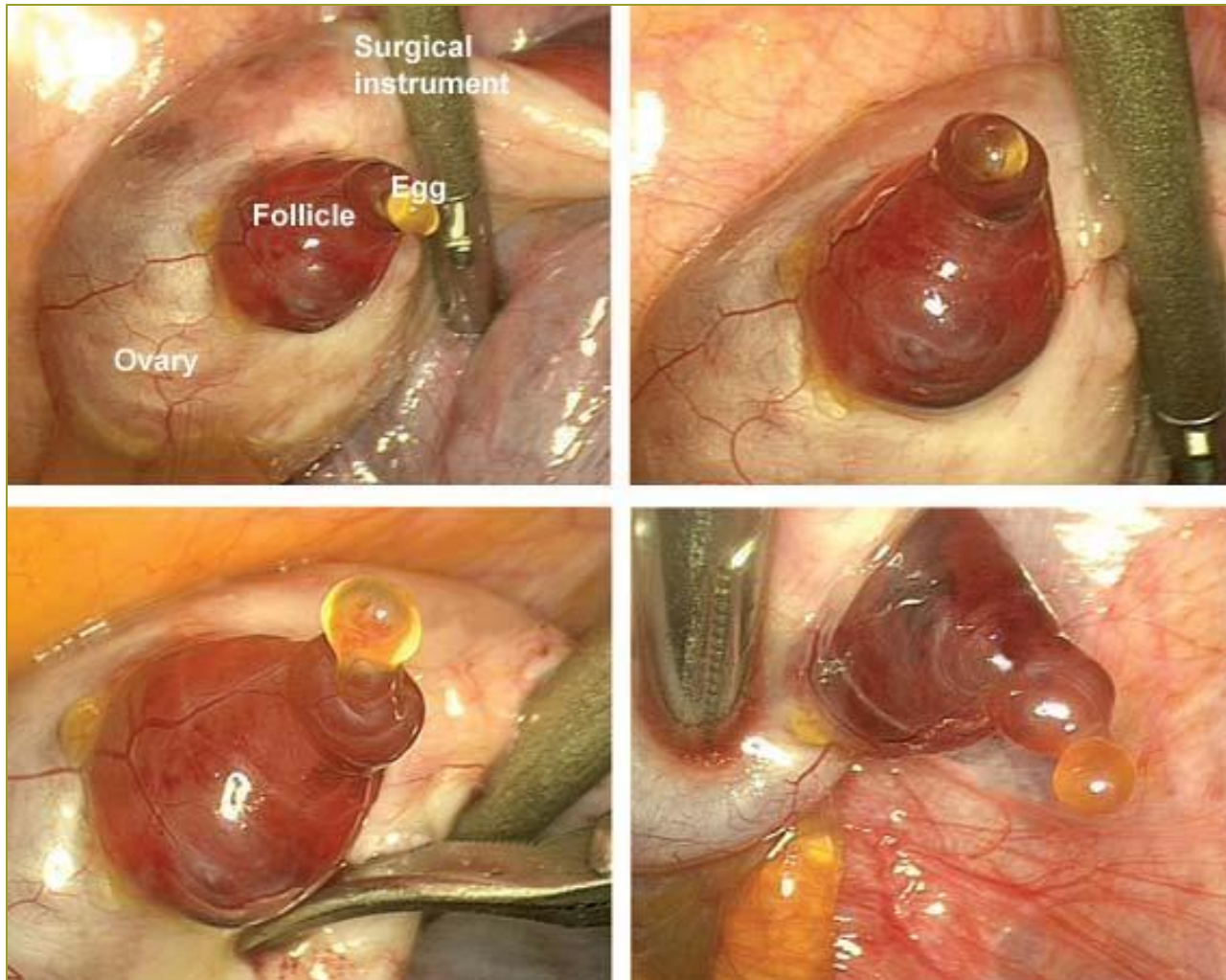
Neutering by Species

Species	Intact	Castrated
Dog	Dog	Neutered Dog
Cat	Tom	Neutered Tom
Horse	Stallion	Gelding
Cattle	Bull	Steer
Pig	Boar	Barrow
Sheep	Ram	Wether

Female Reproductive Pathology

- Pyometra
- Dystocia
- Mastitis
- Pseudocyesis (false pregnancy)
- Cystic ovaries
 - Cats
 - Cows

Feline Cystic Ovaries



Birth Control

- When in bitches are in heat, the leash in the BEST form of birth control! 😊
- Surgical birth control
 - Ovariohysterectomy (OHE)
 - Orchiectomy (OE)
 - Stress **MEDICAL** (not behavioral) benefits
- Birth control pills? (**Secret of Life!**)

Ovariohysterectomy

Clinical Application – Page 401
Bassett Lab Manual – Page 425

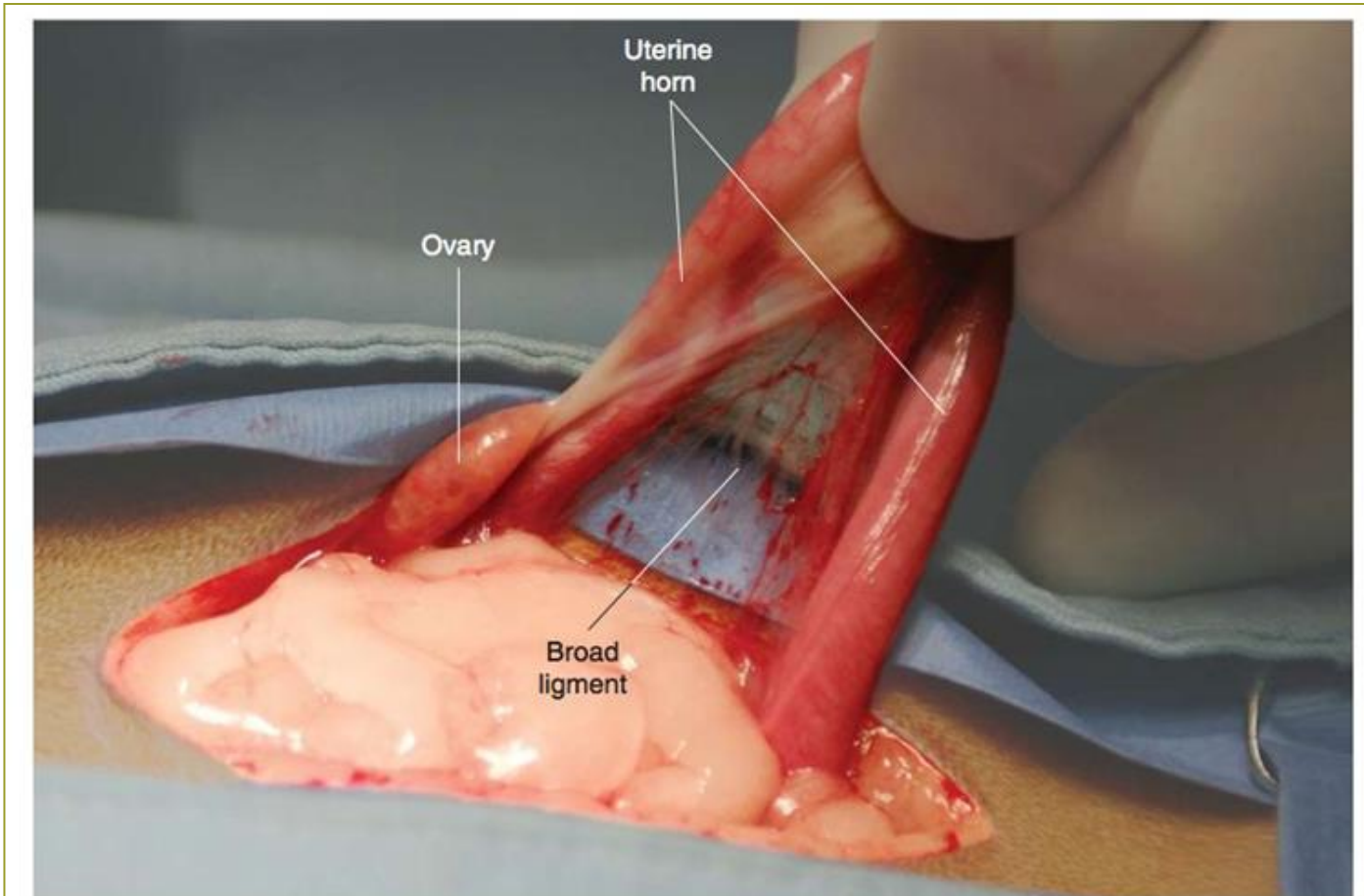
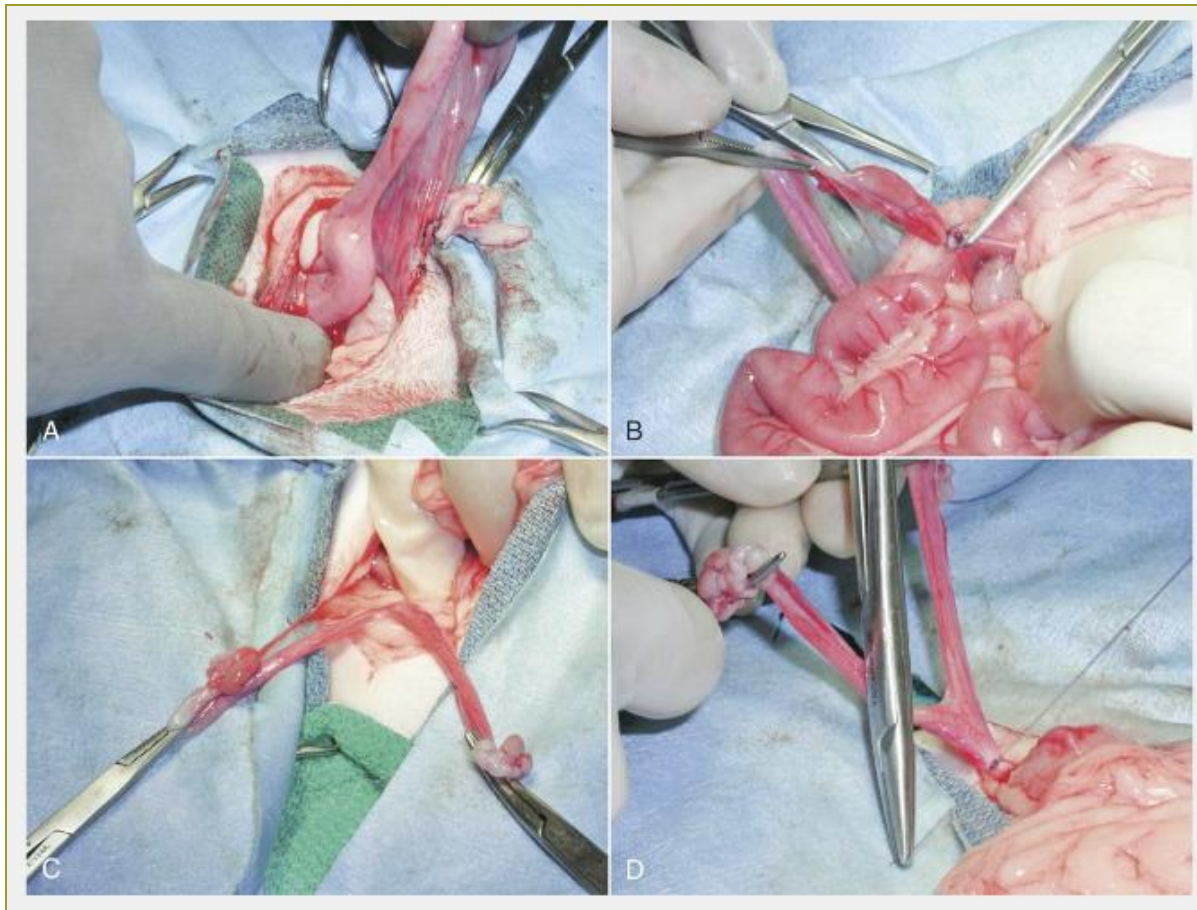


Figure 15-14 "Quiet" Ovary During the Anestrus Period. Feline.

McCurnin 8th edition – Page 1234

FIGURE 32-27 Ovariohysterectomy. **A**, The uterine body is exposed and the suspensory ligament broken down so the ovarian pedicles can be ligated. Both uterine horns are shown in this figure as digital manipulation is used to bring the uterus out of the abdomen. **B**, Once the ovarian pedicle is freed, two circumferential sutures are secured on the portion that will remain in the animal. The ovarian pedicle would be severed proximal to the ovary but distal to the placed ligatures. **C**, The uterine body is fully exposed with gentle traction once the ovarian pedicles are ligated and severed and after the broad ligament is broken down. **D**, The uterine vessels are ligated with tranfixation sutures that individually ligate the vessels on either side of the uterine body and/or as shown with circumferential ligatures that encircle the entire uterine body and the uterine vessels.

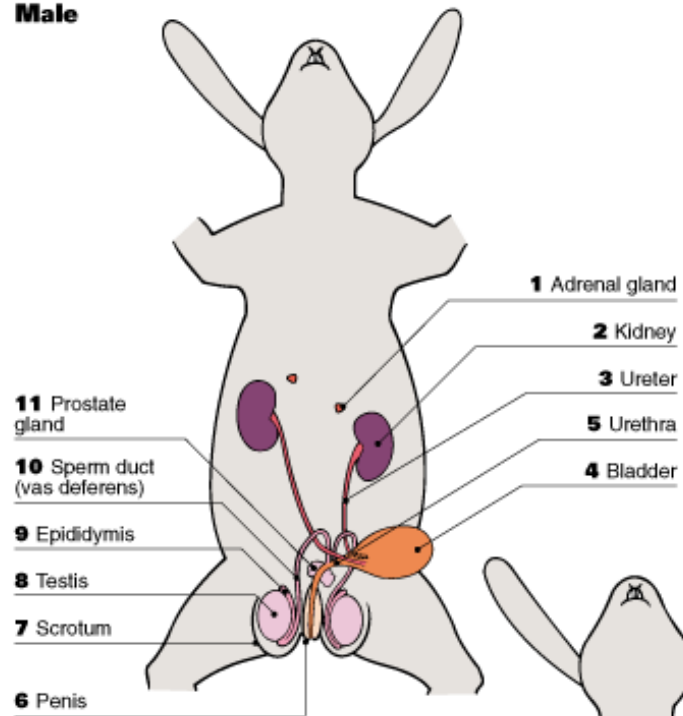


So You Want To Breed Your Dog?

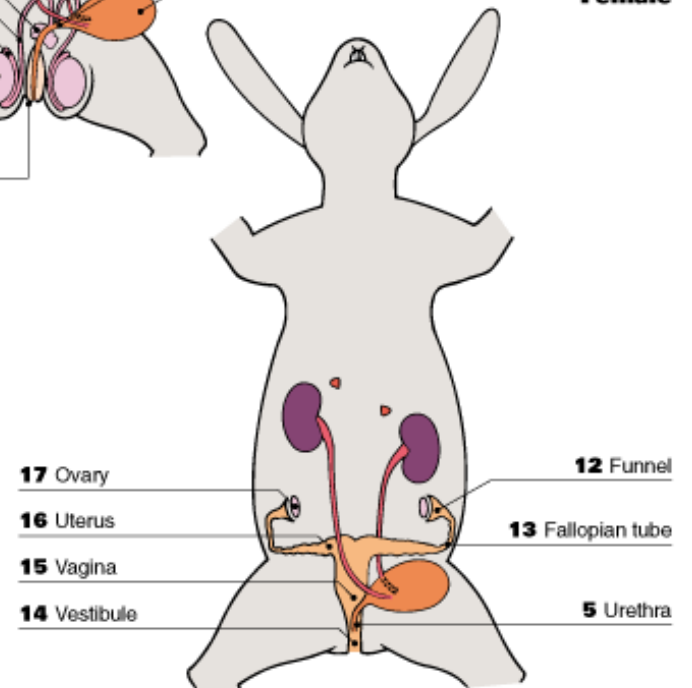
- Breed twice when ovulation is occurring
- Eggs only in oviduct 72 hours
- Sperm only live for 72 hours
- Best time to breed? Day 10 – Day 12
- Vaginal cytology
 - Best way to detect ovulation

Fun Page!

Male



Female

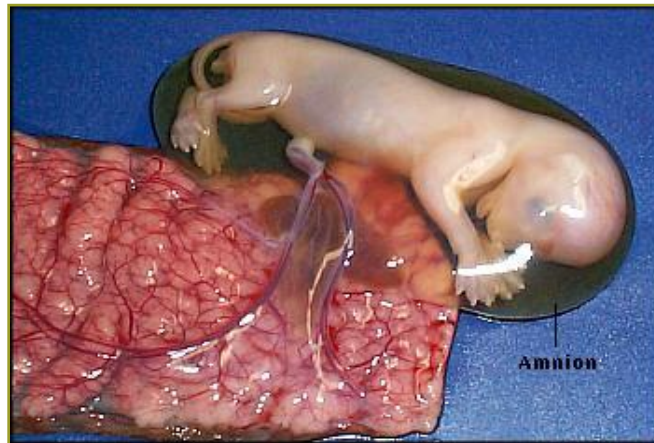


Test Yourself
KNOW THESE IN EVERY CHAPTER!

Pages 388, 390, 395, 399, 402, 403, 404

Clinical Applications

Pages 389, 395, 395, 397, 397, 401



Pregnancy, Development, and Lactation Chapter 18



Pages 404-413

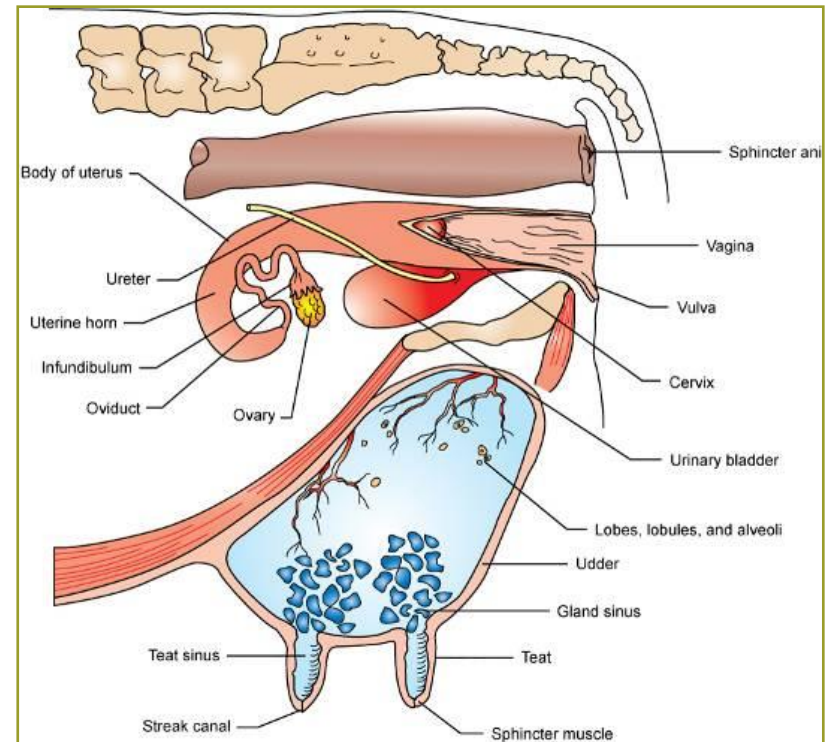
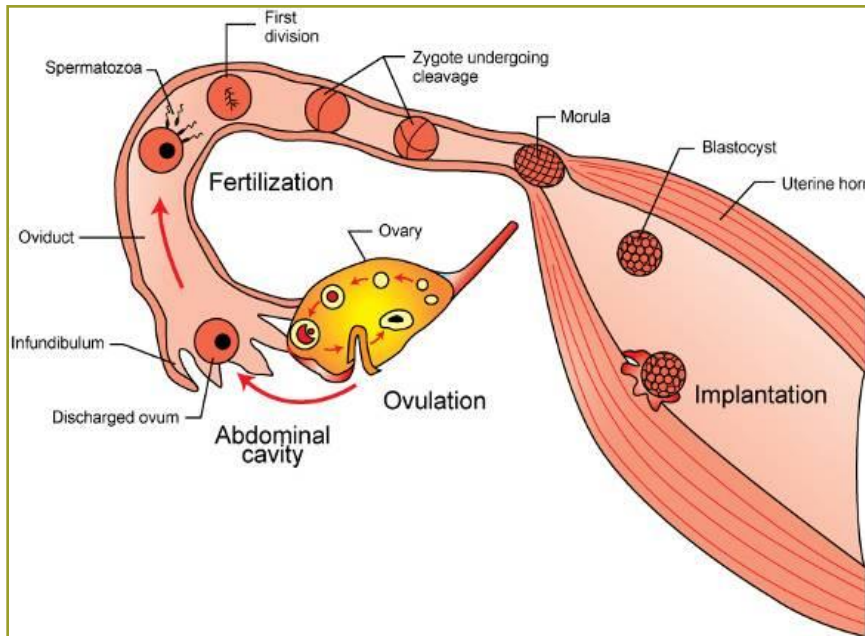
Textbook Learning Objectives

Chapter 18 – Page 405

- Describe the processes of capacitation of spermatozoa and fertilization of the ovum.
- Describe the events that occur between fertilization of the ovum and implantation of the zygote.
- Describe the structure and functions of the placenta and explain the relationship between the fetus and the amniotic and allantoic sacs of the placenta.
- Describe the structures and functions of the components that make up the umbilical cord.
- Differentiate between diffuse, cotyledonary, zonary, and discoid attachments.
- List the stages of and describe the events that occur in each stage.
- Describe the structure and development of mammary glands.
- Describe the general composition of colostrum and explain its importance to the health of the neonate.
- Describe the overall process of lactation.

Topic 14

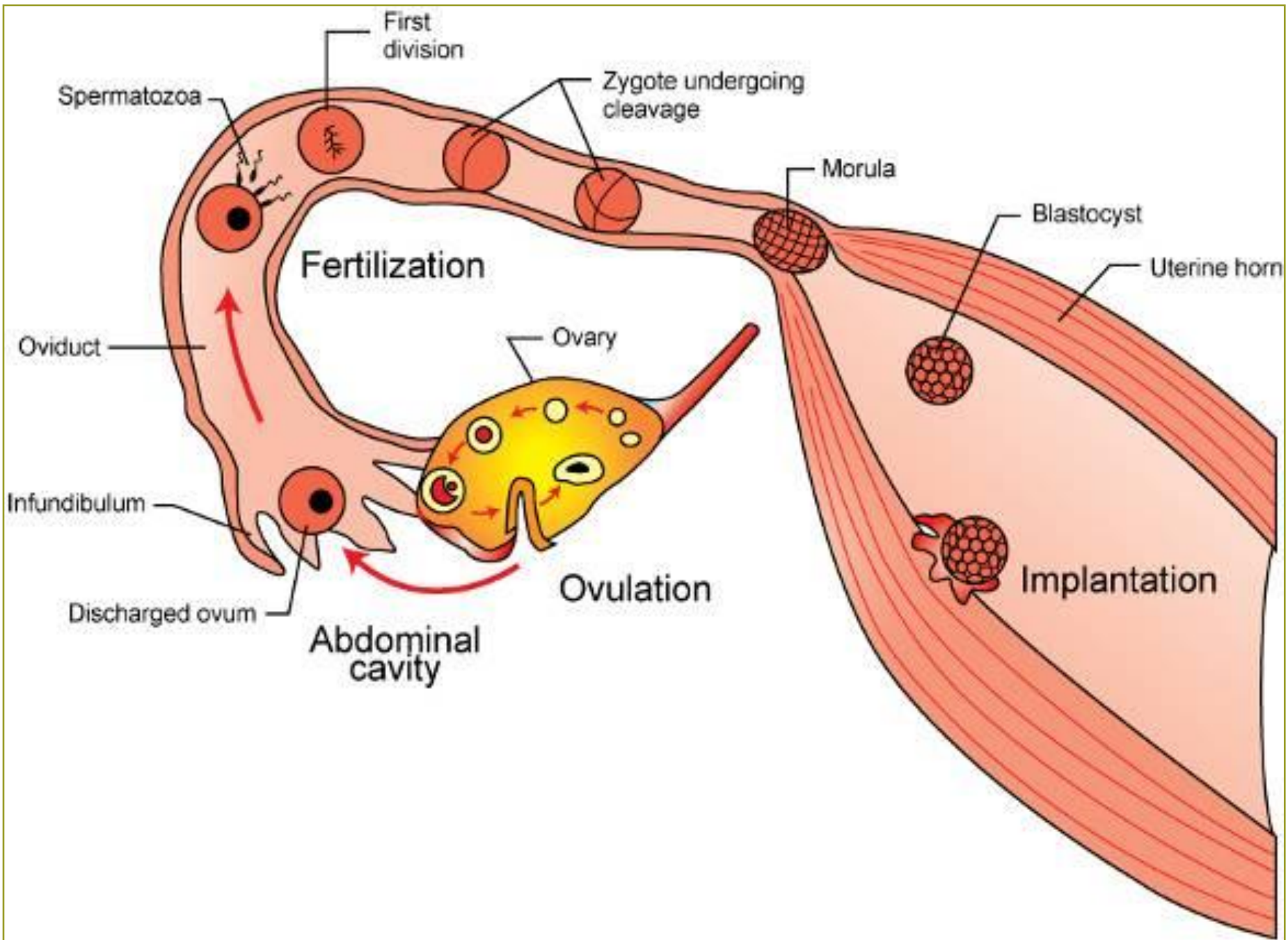
Describe the events that occur in the female during pregnancy, development, and lactation

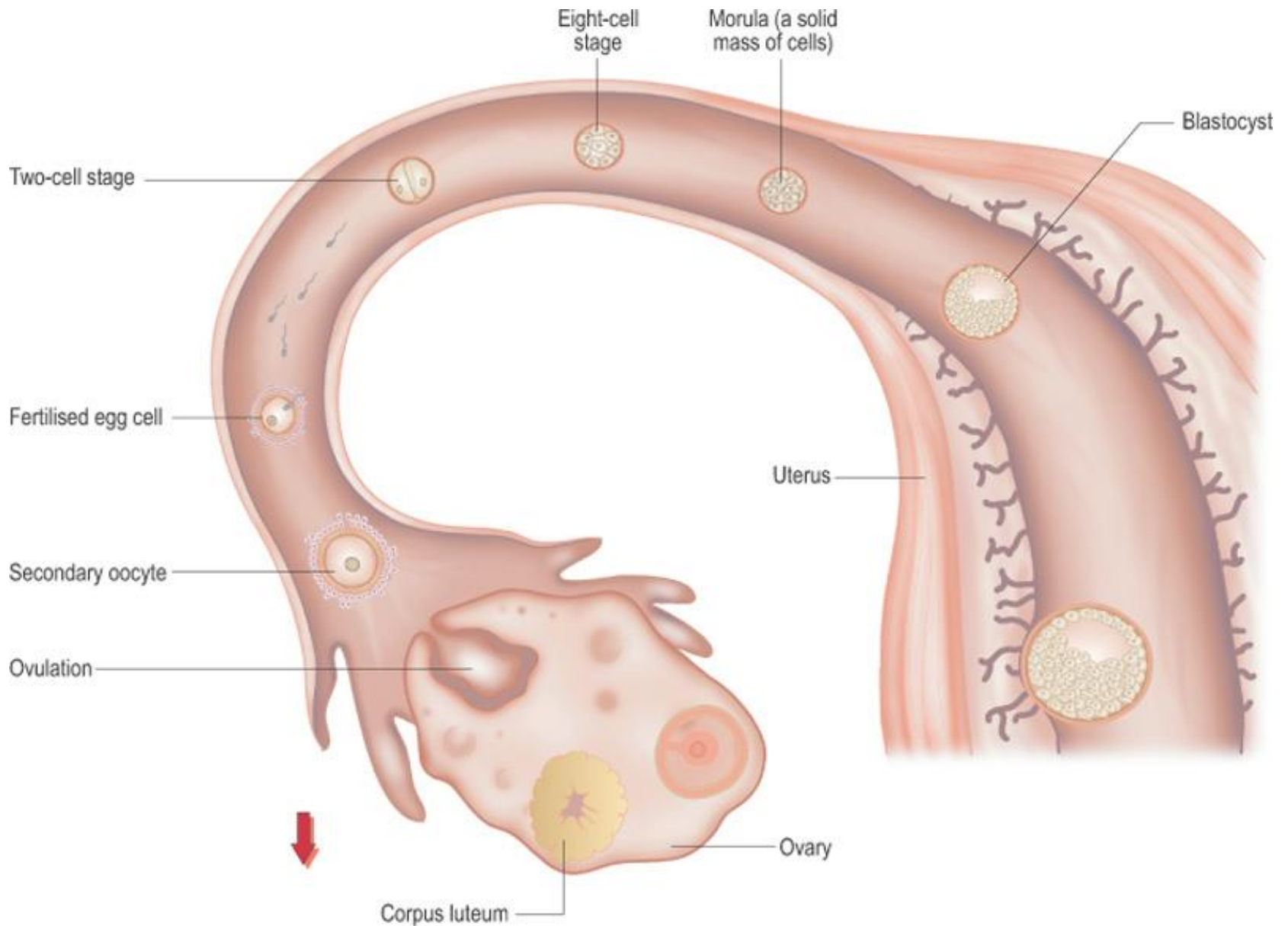


Fertilization & Implantation

Figure 18-1, Page 407

- Copulation – the act of breeding
- Fertilization – in oviduct
- Capacitation
 - Sperm must arrive first in order to mature
 - Acrosome becomes “armed”
- Cleavage – cell division of zygote
- Implantation – zygote attaches to endometrium





Fertilization

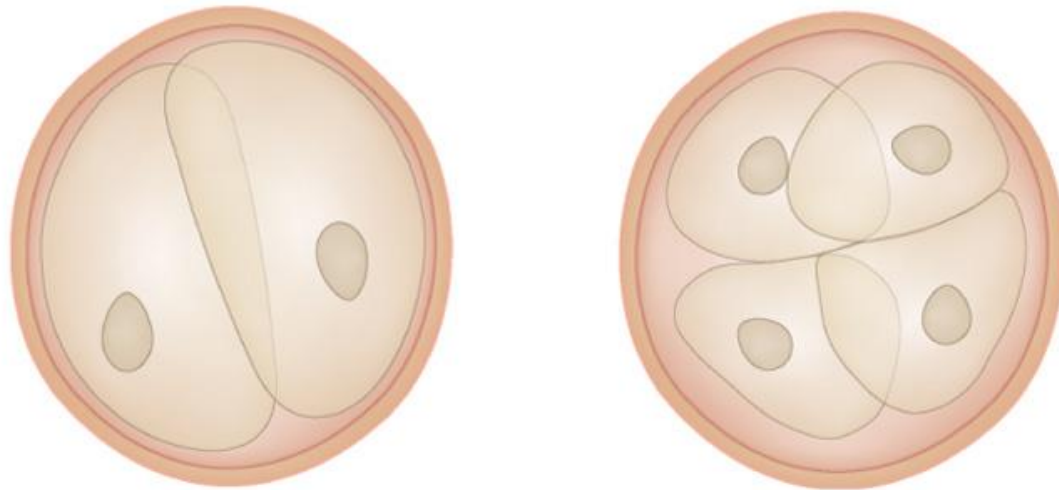
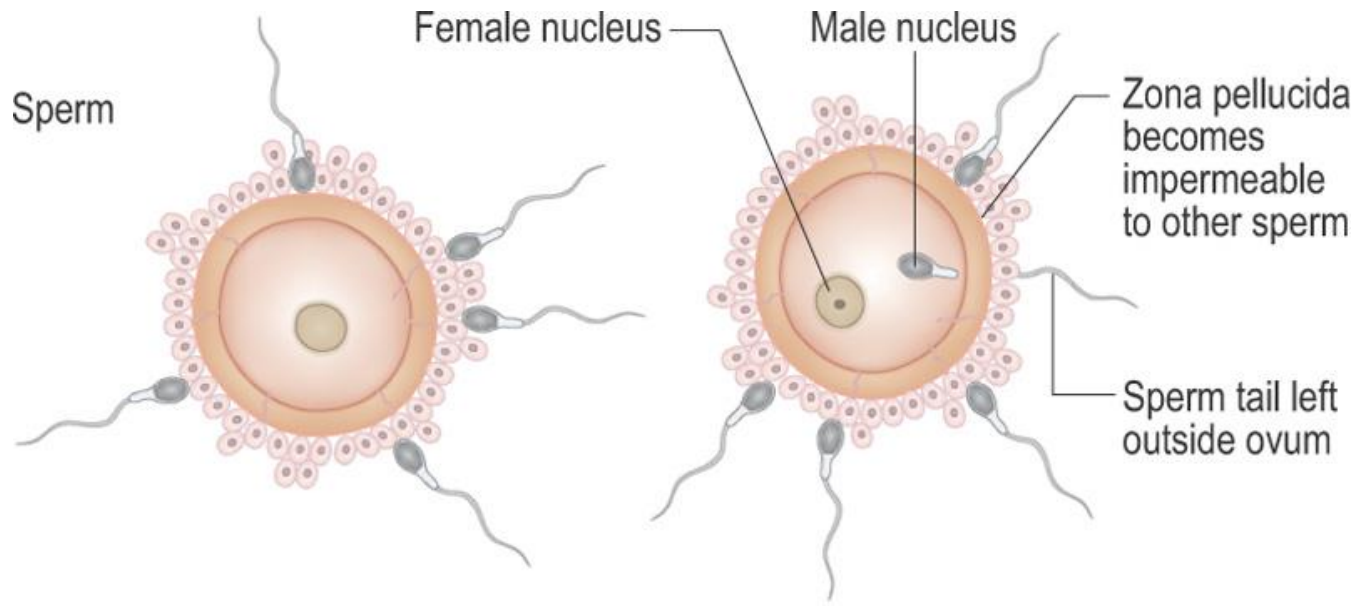
- Copulation: act of breeding; intromission, thrusting, and ejaculation
 - Copulation triggers oxytocin release from posterior pituitary gland of the female
 - Oxytocin causes contraction of smooth muscle of the female reproductive organs
- Semen is usually deposited in the upper portion of the vagina
 - Spermatozoa transported by swimming, by contractions of uterus and oviducts, and by action of cilia in oviducts

Fertilization

- Capacitation: series of changes spermatozoa undergo in the female reproductive tract
 - Changes in ion movement through the cell membranes; increase in cells' metabolic rates
 - Release of digestive enzymes from acrosome
 - Help the spermatozoa penetrate through layers surrounding the ovum to accomplish fertilization

Fertilization

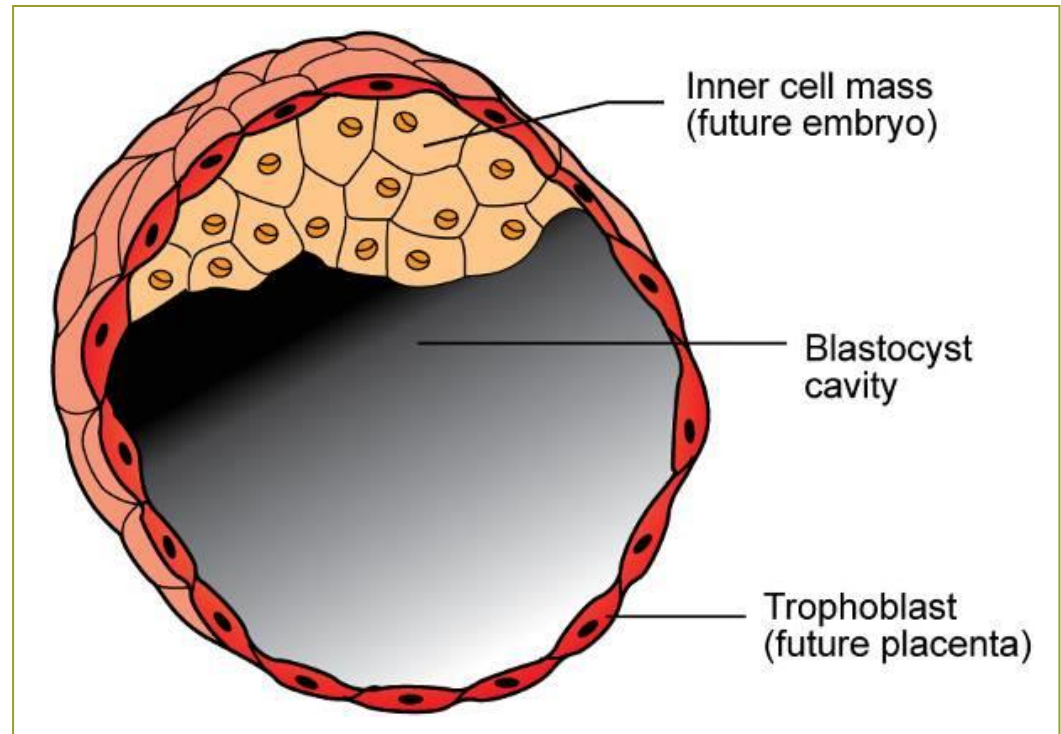
- Large number of spermatozoa find and swarm around the ovum in the oviduct
- Some begin tunneling through the layers surrounding the ovum
 - Aided by the digestive enzymes of their acrosomes
- Once a single spermatozoon penetrates cell membrane of the ovum, a change in the membrane blocks other sperm from entering



Cleavage

Figure 18-2, Page 407

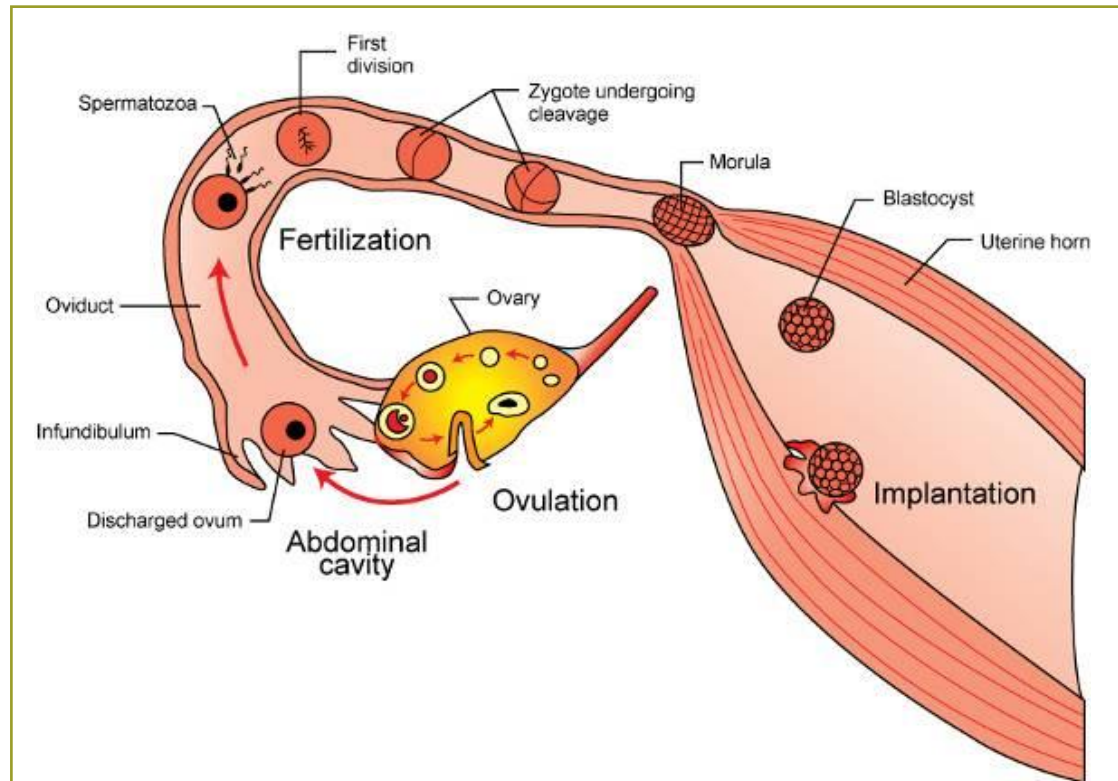
- Rapid mitosis of zygote
- Overall size of zygote does not change
- Morula: solid mass of cells
- Blastocyst: hollow ball of cells



Implantation

Figure 18-1, Page 407

- Enzymes produced by the blastocyst dissolve away a small pit in the endometrium
- Blastocyst attaches to endometrium in this pit



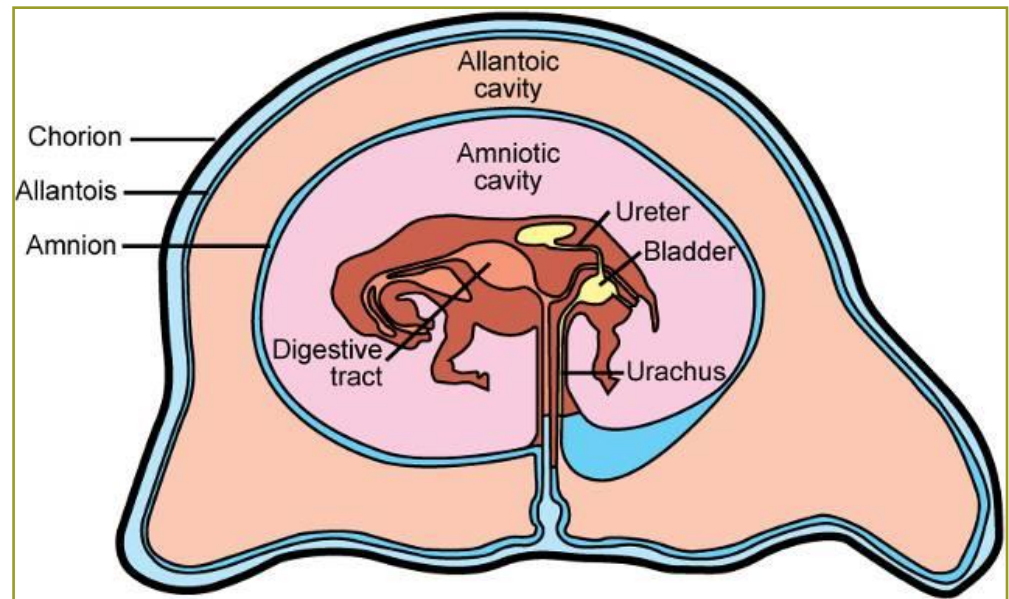
Implantation

- In multiparous (litter) species, the multiple blastocysts randomly space along the horns and body of the uterus
- Placenta begins to form as soon as the blastocyst implants in the uterus

The Placenta

Figures 18-3 & 18-4, Page 408

- Multi-layered fluid-filled sac around embryo
- Connected to embryo by umbilical cord
- Where attached to uterus lining, exchange of nutrients & waste takes place
- 2 sacs
 - Amniotic sac
 - Allantoic sac

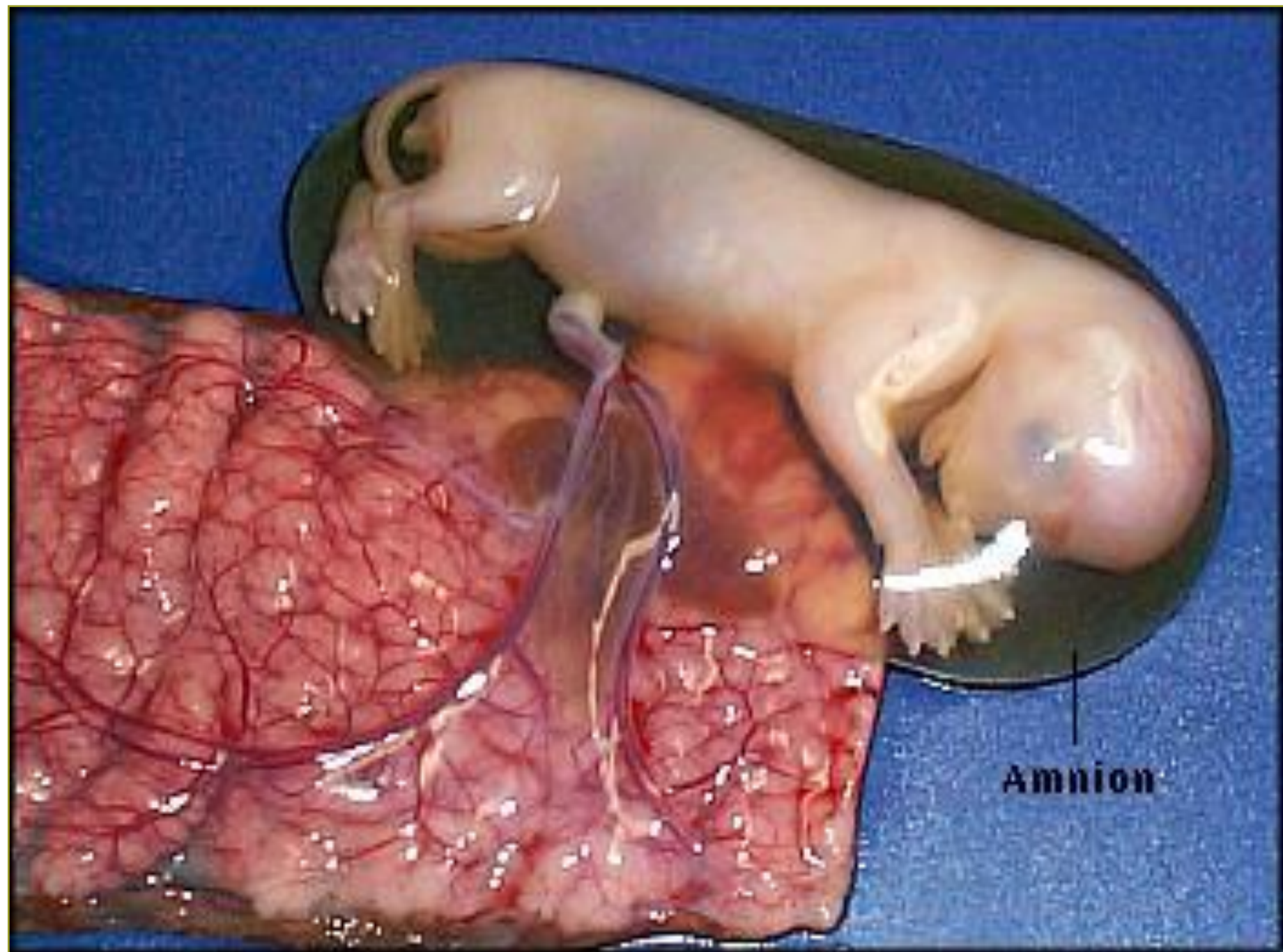


Placenta

- Multilayered, fluid-filled, membranous sac
- Outermost layer of placenta attaches to uterine lining in some areas
 - Fetal and maternal blood vessels are in close proximity to each other in this area
 - Site of exchange of blood nutrients and wastes

Placenta

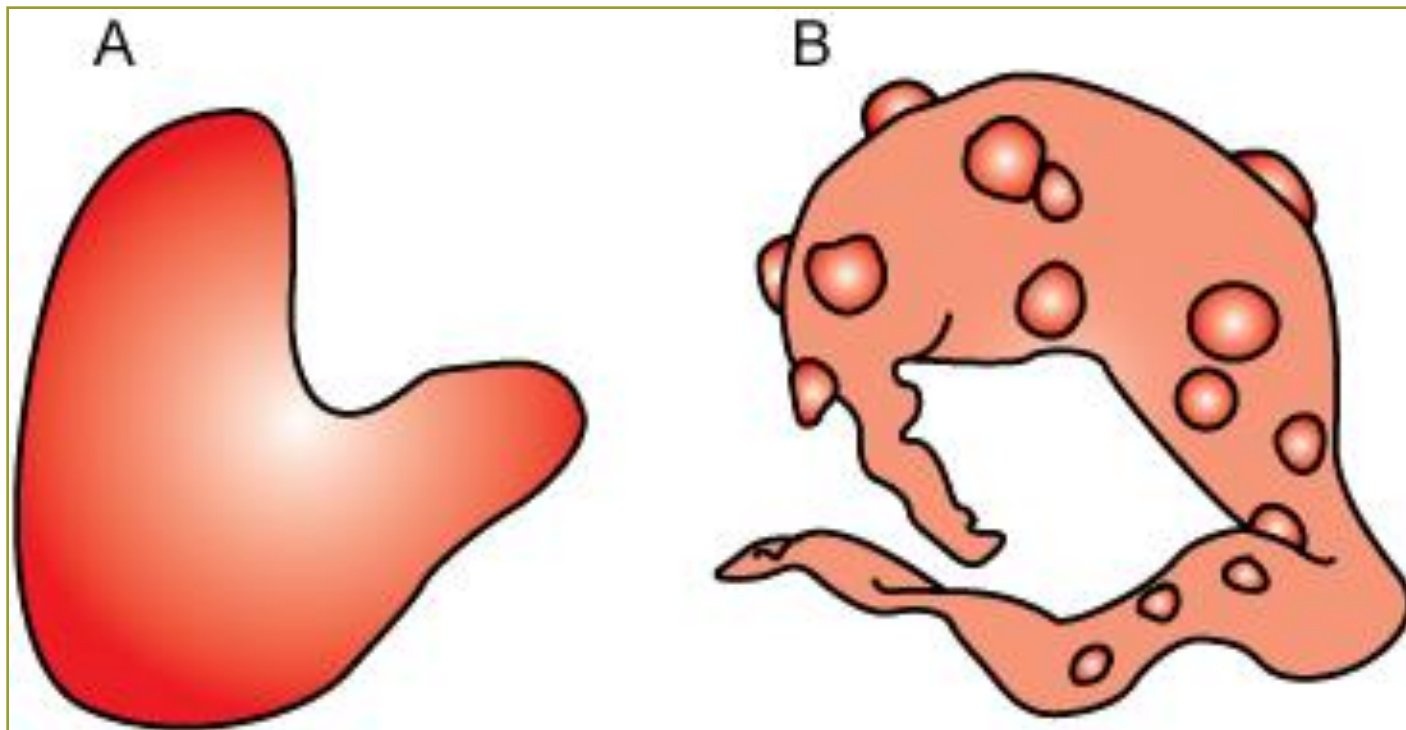
- Amnion: membranous layer immediately surrounding the fetus
 - Forms the amniotic sac
 - Fetus floats in amniotic fluid inside the amniotic sac
- Allantois: layer surrounding amniotic sac; forms the allantoic sac, which accumulates wastes



Placental Attachments

Figure 18-4, Page 408

- (A) Diffuse attachment – horse and pig
- (B) Cotyledonary attachment – ruminants

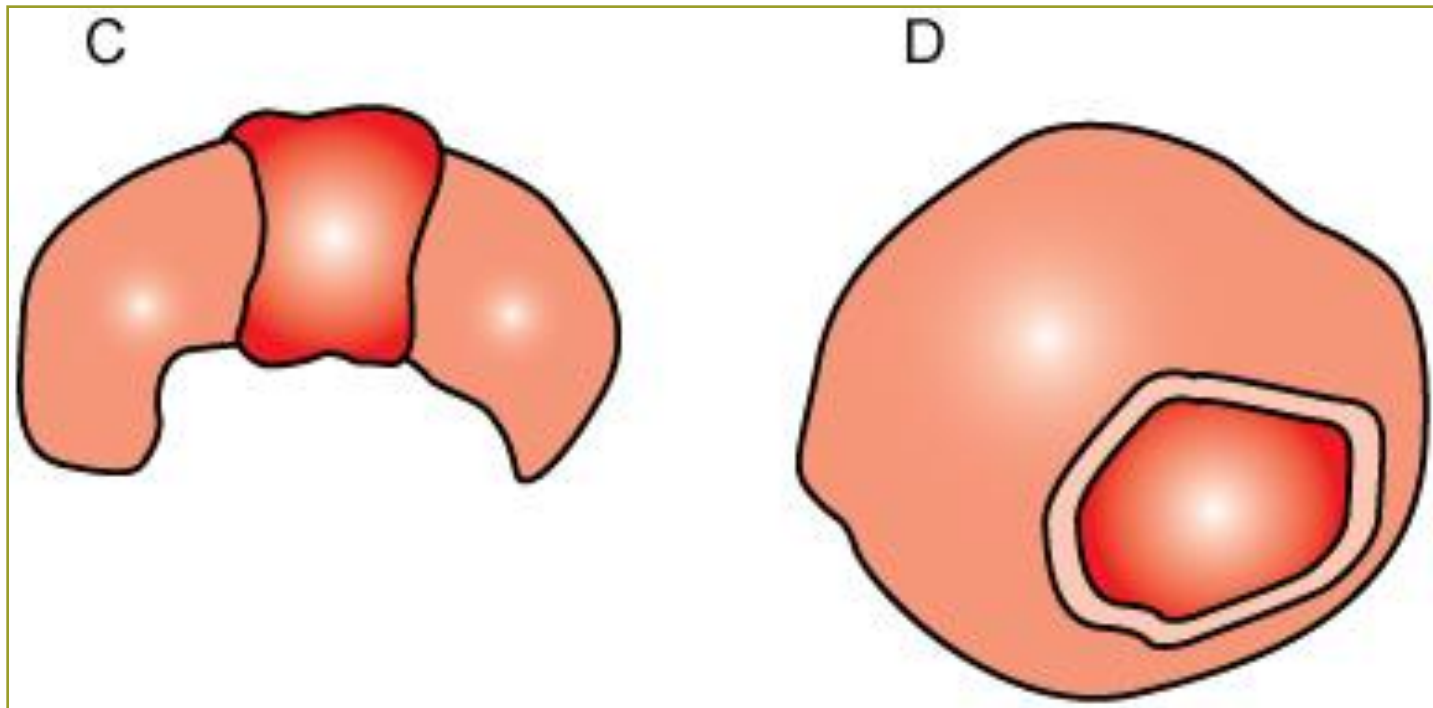


Placental Attachments

Figure 18-4, Page 408

(C) Zonary attachment – dog & cat

(D) Discoid attachment – primates, rodents



Pregnancy

- Gestation period: time from fertilization of ovum to delivery of newborn
- Divided into three segments (trimesters):
 - First trimester – embryonic period
 - Placenta develops
 - Second trimester – fetal period
 - Body tissues, organs, & systems develop
 - Third trimester – fetal growth period

Average Gestation Periods

Table 18-1, Page 409

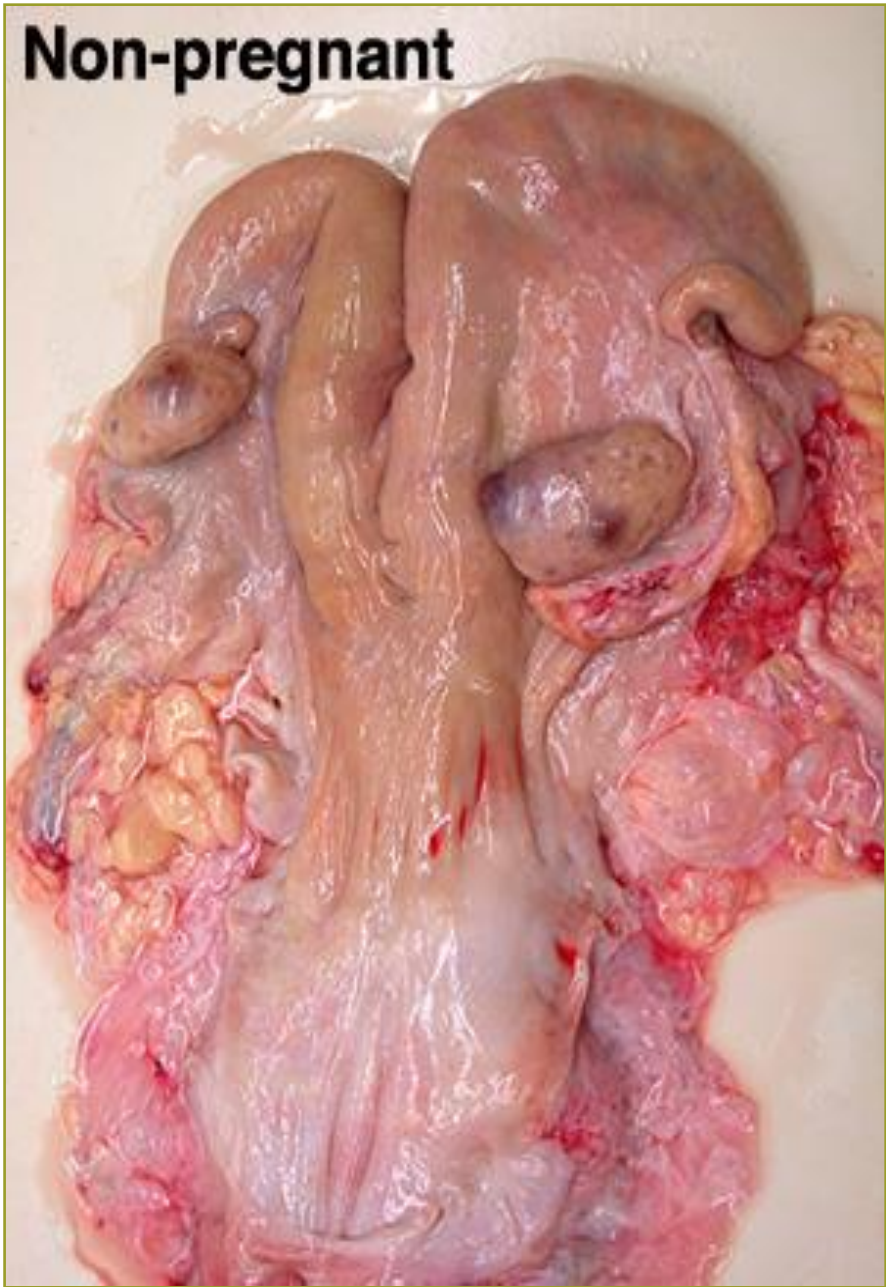
Species	Gestation Period (Months)	Average No. of Young
Bovine	9 months	1
Canine	2 months	4–10
Equine	11 months	1
Feline	2 months	4-6
Ovine	5 months	1–2

Pregnancy Diagnosis

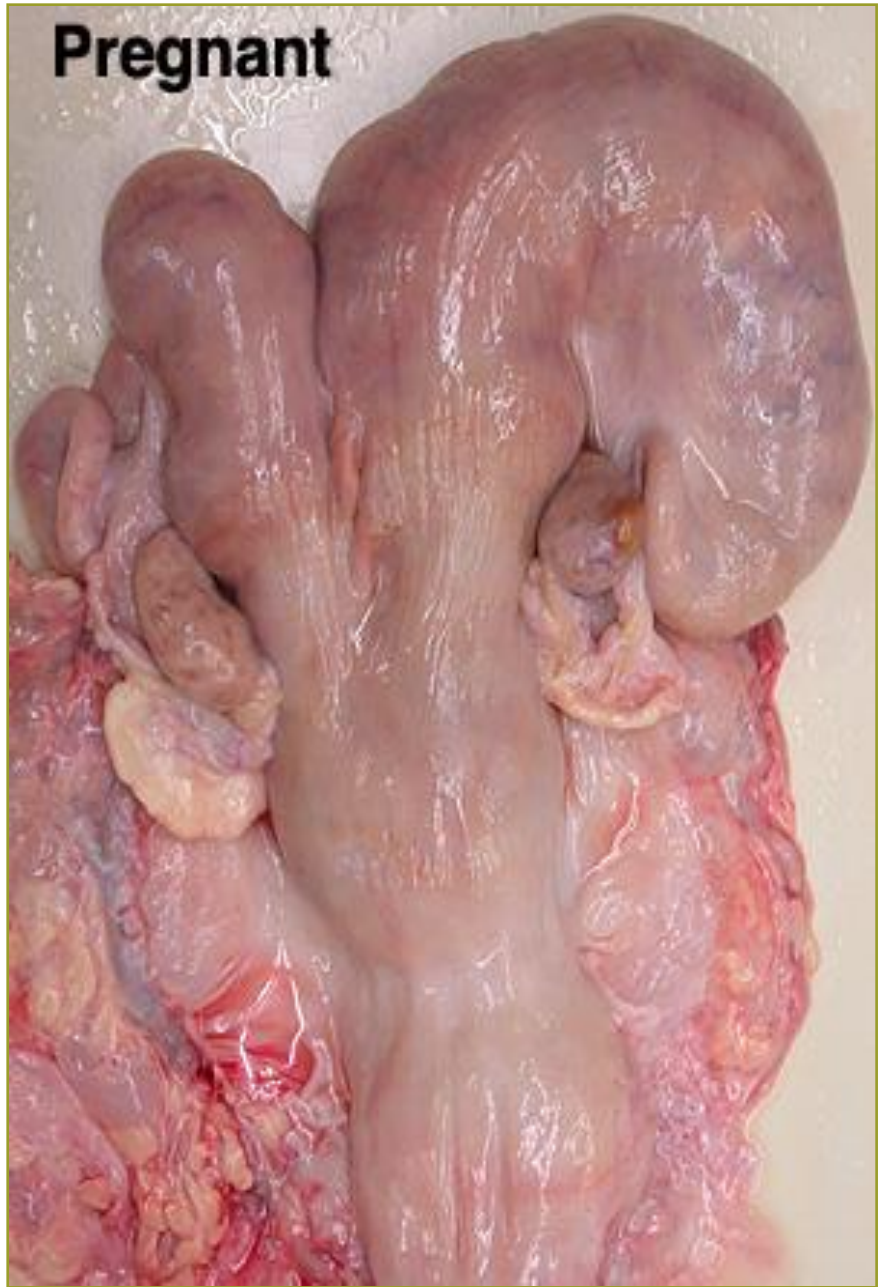
- Rectal palpation
 - Horses, cows



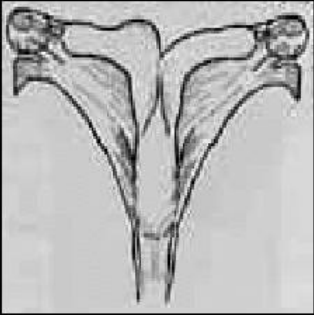
Non-pregnant



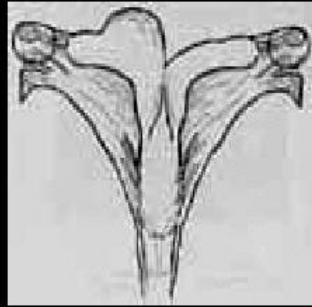
Pregnant



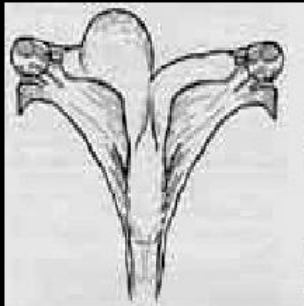
Horse



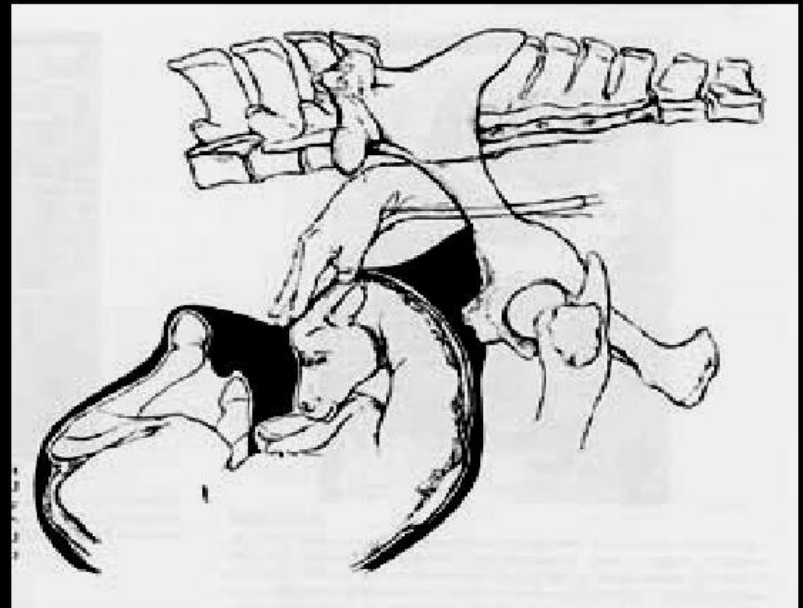
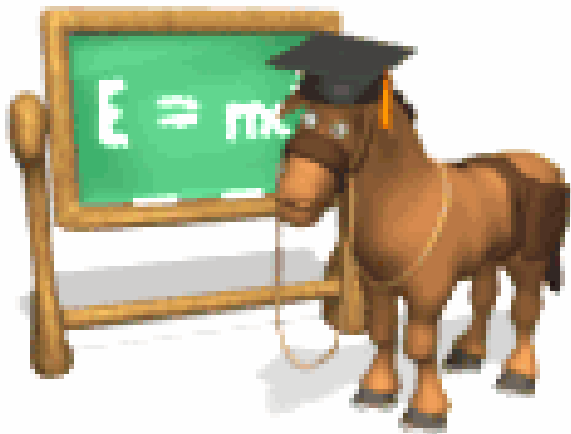
25 - 30 days



35 - 40 days



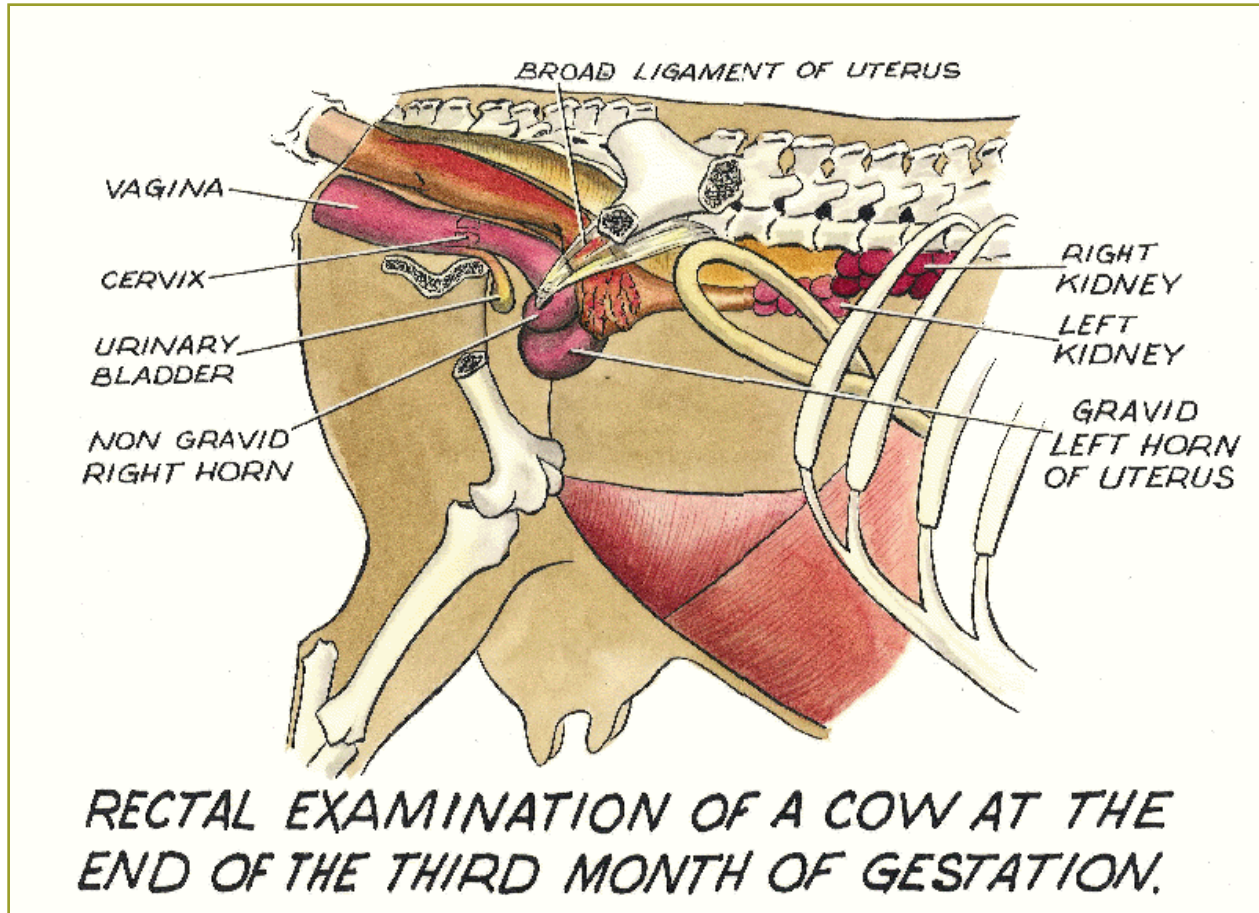
45 - 50 days

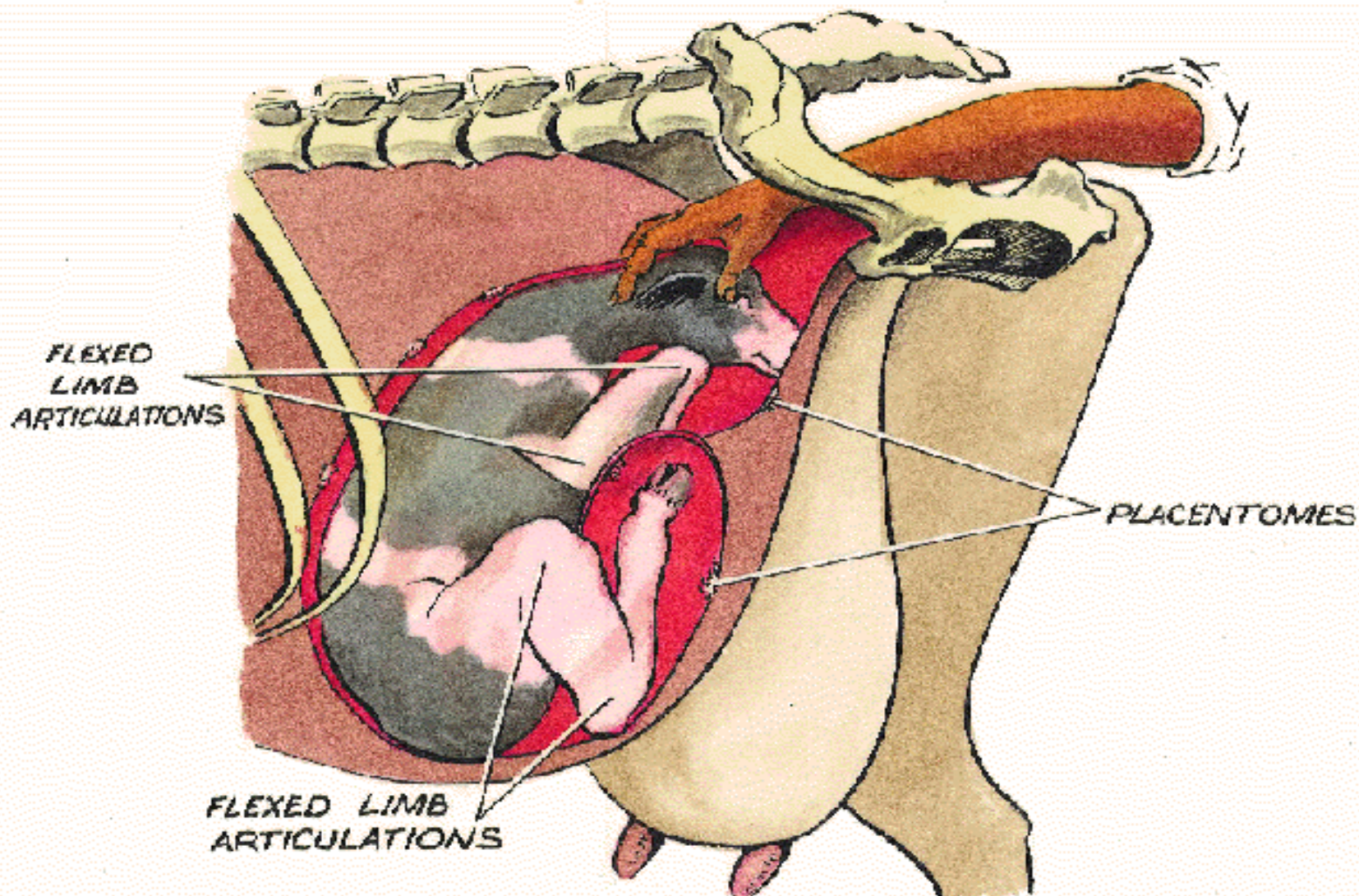


Last trimester of pregnancy



Cow

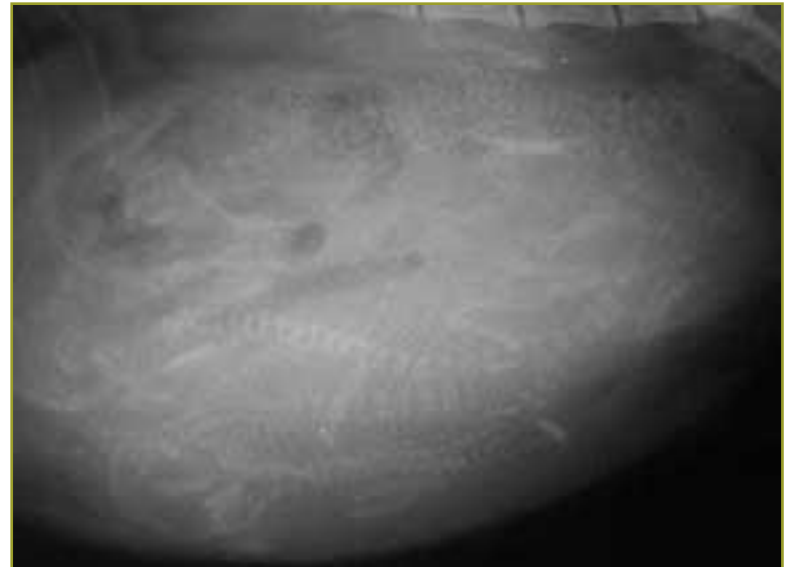


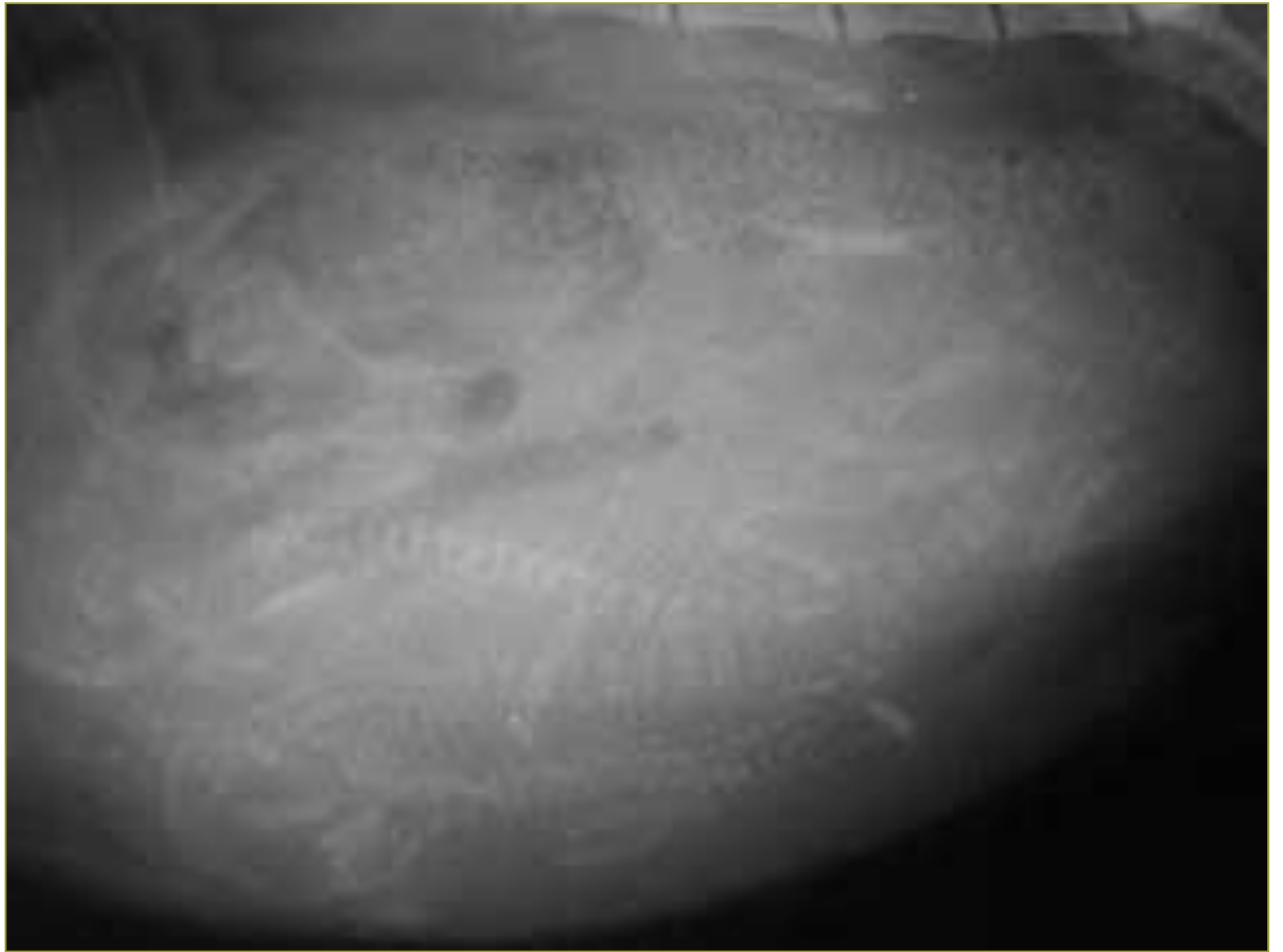


RECTAL EXAMINATION OF A COW APPROACHING TERM. RUMINANT STOMACH REMOVED.

Dogs & Cats

- Absence of heat (cats)
- Abdominal palpation – ~28 days after breeding
- Xrays in last 8-10 days
- Blood tests?





Parturition (Labor)

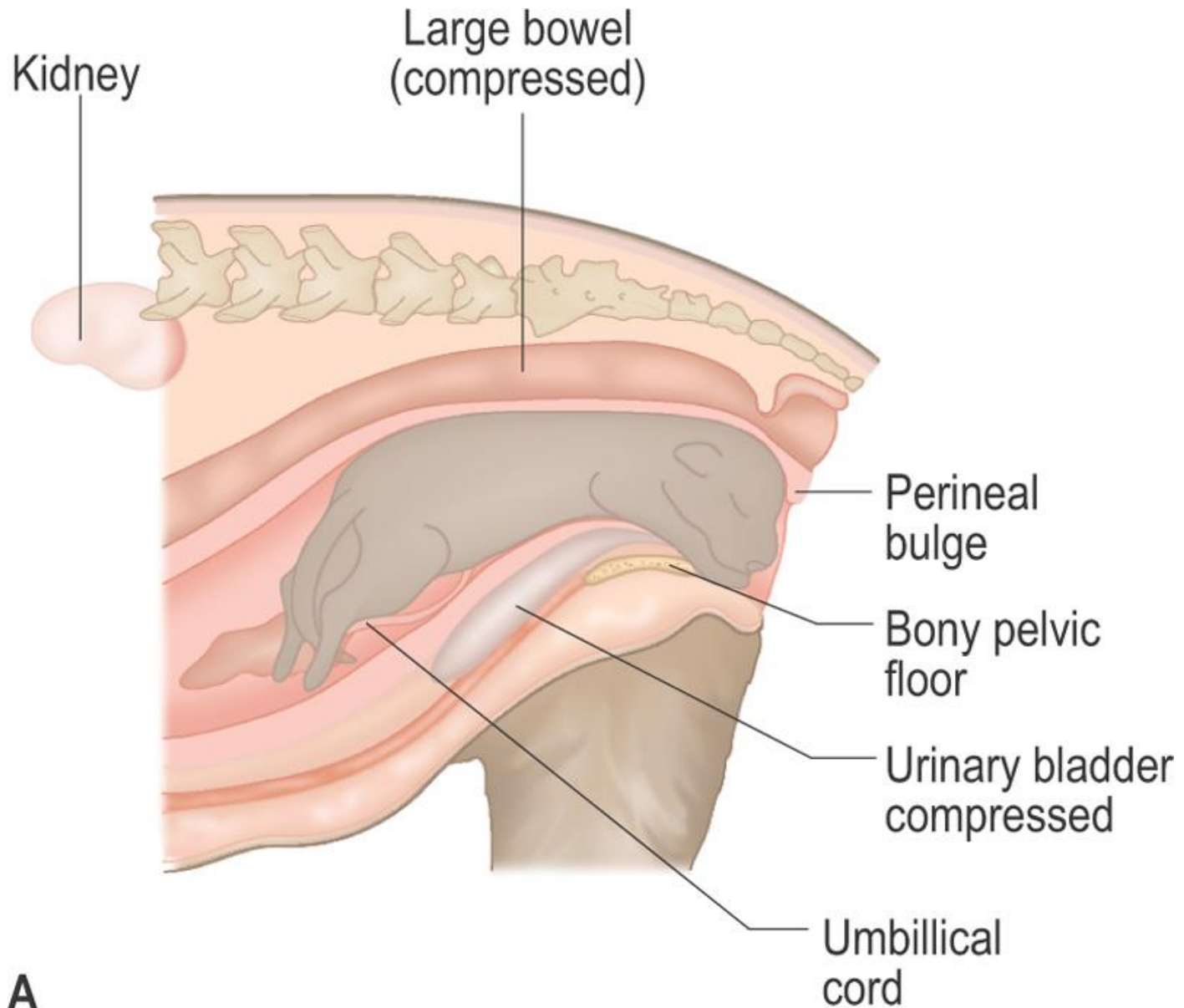
- The birthing process
- Multiple factors trigger parturition
 - Size and weight of uterus
 - Hormonal changes
- Fetal changes at birth
 - Lungs expand and start functioning
 - Foramen ovale and ductus arteriosus close

Parturition

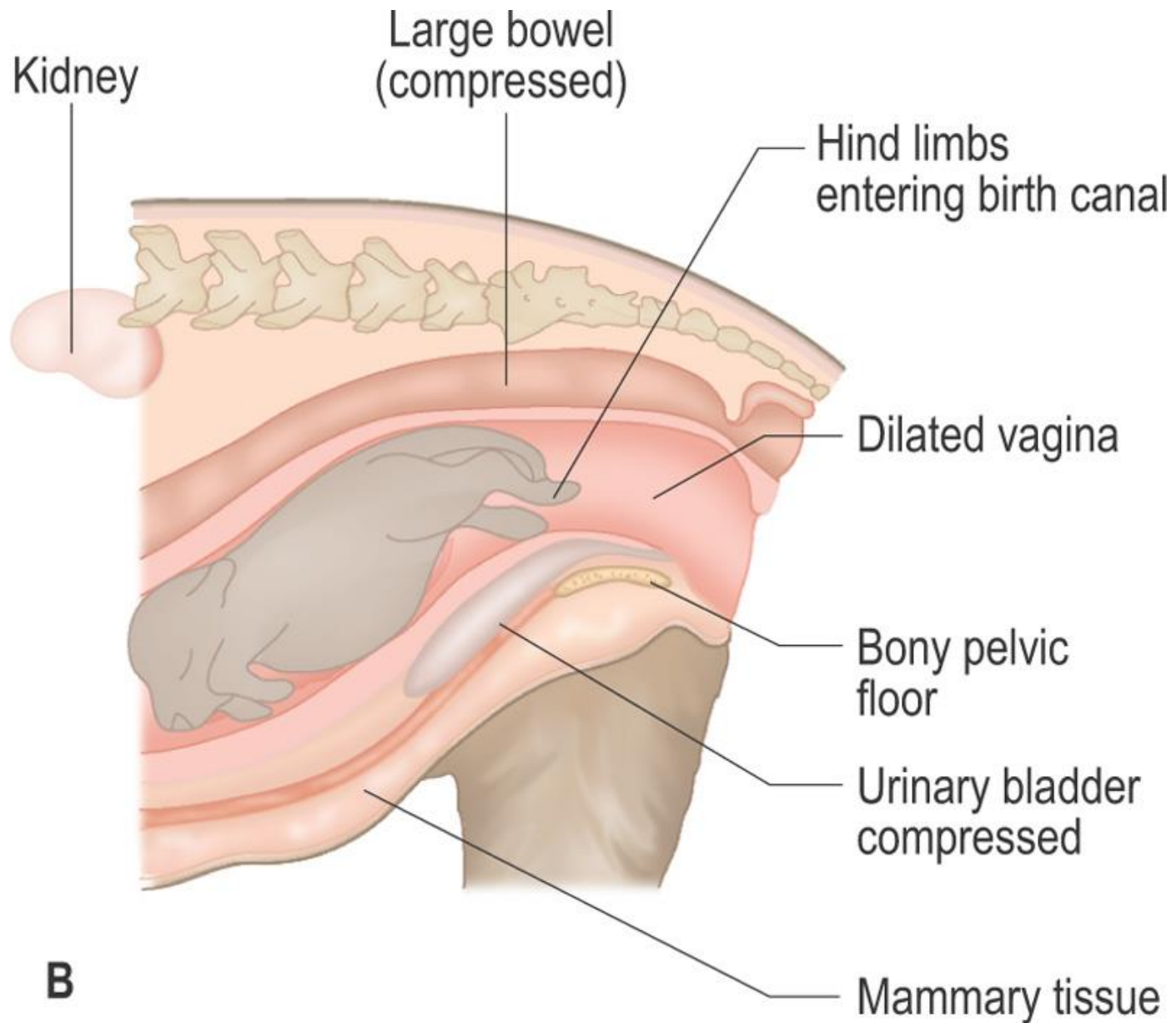
- 2 hormones
 - Estrogen – increases myometrium sensitivity to oxytocin
 - Oxytocin
 - Myometrium contractions
 - Milk letdown

Labor – Comparative Physiology

Species	Term	Newborn	Litter?	Breach OK?
Canine	Whelping	Pups	Yes	Yes
Feline	Queening	Kittens	Yes	Yes
Equine	Foaling	Foals	Twins bad	No
Bovine	Calving	Calf	Twins ok	No
Ovine	Lambing	Lambs	Twins good	No
Porcine	Farrowing	Piglets	Yes	Yes



A



Stages of Labor

First stage – uterine contractions

Second stage – delivery of the newborn

Third stage – delivery of the placenta

Uterine Contractions

- Myometrium contracts and presses fetus down against the cervix
- Sustained contractions cause the cervix to gradually dilate

Delivery of the Newborn

- Results from combination of strong uterine and abdominal muscle contractions
- Rupture of amniotic and allantoic sacs of the placenta usually precedes actual delivery of the newborn

Delivery of the Placenta

- Placenta separates from wall of the uterus and is expelled by weaker uterine contractions
- Post-partum examination – very important!

Involution of the Uterus

- Uterus gradually returns to its non-pregnant size
- Endometrium sloughs into lumen of uterus at sites of placental attachment
- Myometrium continues mild contractions to move remaining uterine contents out through birth canal
- May take from a few weeks to a month or more for involution to be complete

Mammary Glands & Lactation

- Specialized skin glands
 - Colostrum – passive immunity
 - Milk
- Present in both males & females
- Undeveloped until puberty
- Lactation
 - Milk production
 - Begins towards end of pregnancy
 - Continues as long as gland is emptied

Mammary Glands – Comparative Anatomy

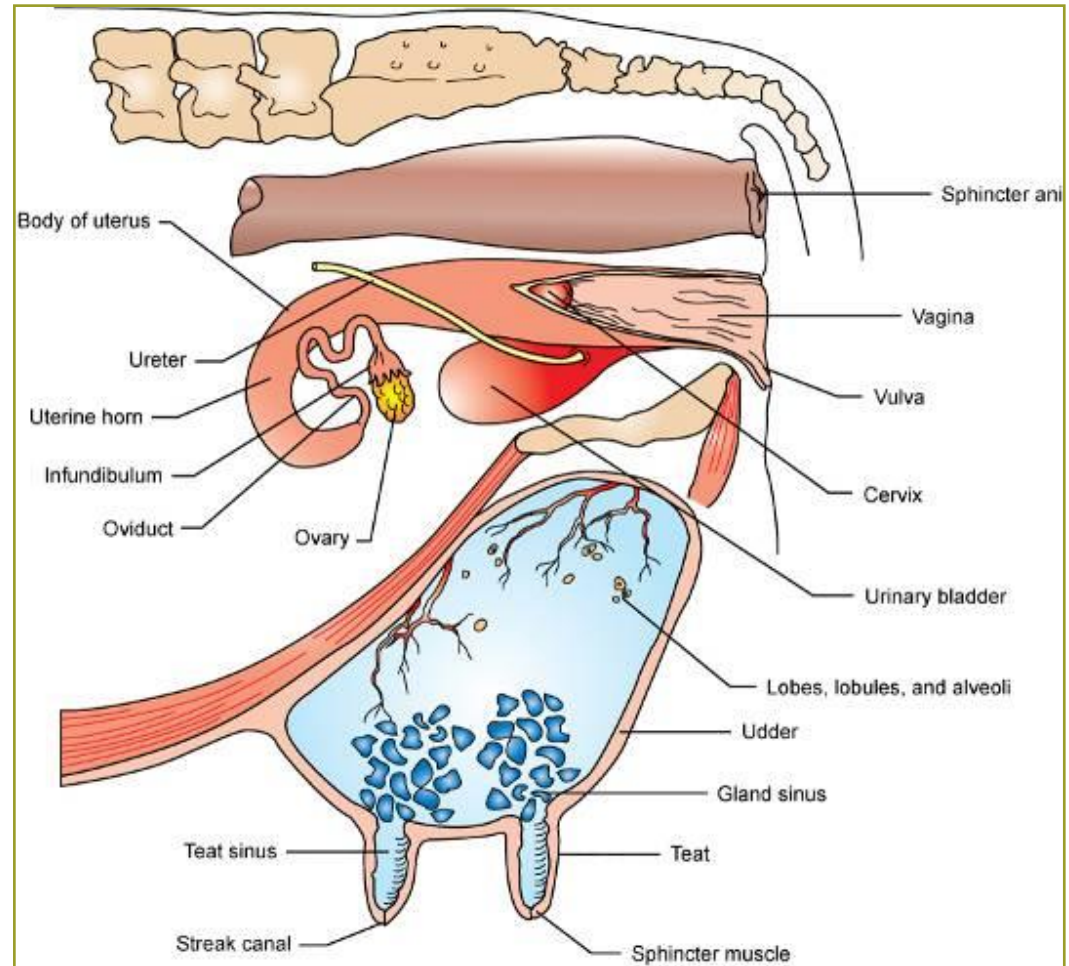
Table 18-2, Page 411

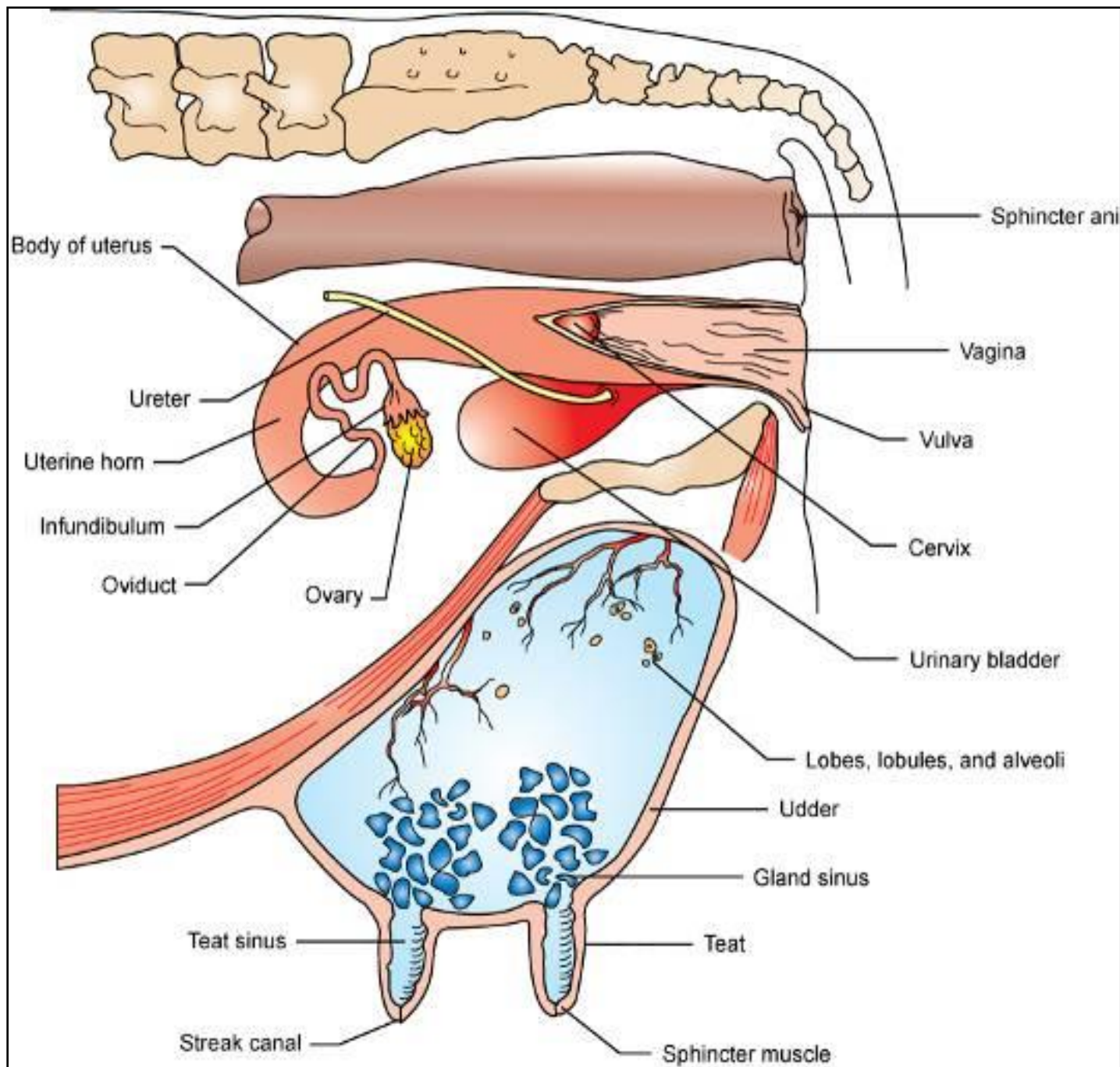
Species	Usual Number of Glands	Location of Glands	Number of Openings in Teats or Nipples
Cats	10	Inguinal, abdominal, and thoracic regions	3–7
Cattle	4	Inguinal	1
Dogs	10	Inguinal, abdominal, and thoracic regions	8–20
Goats	2	Inguinal region	1
Horses	2	Inguinal region	2–4
Humans	2	Thoracic region	15–24
Pigs	14	Inguinal, abdominal, and thoracic regions	2–3
Sheep	2	Inguinal region	1

Udder of Cow

Figure 18-5, Page 412

- Four mammary glands (quarters)
- Quarters are completely separate units from each other
- Each quarter has its own milk-secreting systems and ducts leading down to separate teats





Cow Udder

Figure 18-5, Page 412

- 4 separate mammary glands (quarters)
- Nipples are called “teats”



Mares, Ewes, Goats

Table 18-2, Page 411



- 2 mammary glands in one udder



Mammary Gland Development

- Mammary glands develop in response to hormones produced at puberty
- Prolactin and growth hormone directly encourage mammary gland development
- Estrogen and progesterone encourage the mammary alveoli and duct systems to develop

Colostrum

- Pre-milk secretion
- Contains large amounts of proteins, lipids, amino acids, and vitamins
- Supplies important nutrients to newborn
- Imparts "passive immunity" – transfer of preformed antibodies from dam to newborn

Lactation

- Physical stimulation of teat or nipple and regular removal of milk from the gland stimulates anterior pituitary to continue production of hormones that keep lactation going
- Lack of hormonal stimulation combined with increased pressure in the mammary gland gradually causes lactation to cease

Milk Letdown

- Milk accumulates high up in the mammary gland in mammary alveoli and small ducts
- Physical stimulation of the nipple or teat sends sensory nerve impulses that cause release of oxytocin from posterior pituitary

Test Yourself
KNOW THESE IN EVERY CHAPTER!

Pages 407, 409, 410, 413

Clinical Applications

Pages 408, 410, 413
