Artificial Insemination

Level-I

Learning Guide #11

Unit of Competence: Identify the Reproductive Anatomy and Physiology of Dairy Cattle

Module Title Identifying the Reproductive Anatomy and Physiology of Dairy Cattle

LG Code: AGR ATI1 M03 0919 LO2-LG-11

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LO 2: Identify location and function of uro-genital organ

Instruction Sheet	Learning Guide # 11

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Recognizing components, location and function of uro-genital system
- ✓ Identifying organs of female and male reproductive systems and their respective locations
- ✓ Describing functions of Primary and accessory sex organs
- ✓ Indicating clinical importance of urogenital
- ✓ Describing form and structures of the mammary gland

Recognizing mechanisms of milk synthesis and secretion This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Recognize components, location and function of uro-genital system
- ✓ Identify organs of female and male reproductive systems and their respective locations
- ✓ Describe functions of Primary and accessory sex organs
- ✓ Indicate clinical importance of urogenital
- ✓ Describe form and structures of the mammary gland

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3,
4. Accomplish the “Self-check 1, Self-check 2 and Self-check 3” **in page -3, 6, 8,** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1,” **in page -9.**
6. Do the “LAP test” **in page – 10** (if you are ready)

Information Sheet-1	Identify location and function of uro-genital organs

1.1. Definition of Uro-Genital Organs

1.1.1. Urinary system

The urinary system consists of two kidneys, two ureters, the urinary bladder, and the urethra. The system of tubules in each kidney coalesces into a single muco muscular tube, the ureter, which extends caudal to empty into the urinary bladder, a distensible reservoir for the storage of urine. When full, the urinary bladder discharges the urine through the urethra to the outside of the body.

The kidneys are paired reddish-brown organs that filter plasma and plasma constituents from the blood and then selectively reabsorb water and useful constituents from the filtrate, ultimately excreting excesses and plasma waste products. The kidneys of most animals are roughly bean-shaped, with the exceptions among domestic animals of the heart-shaped right equine kidney and the distinctively lobulated kidneys of the ox. The kidneys are in the dorsal part of the abdominal cavity on each side of the aorta and caudal vena cava, just ventral to the first few lumbar vertebrae.

In most domestic animals, the right kidney is slightly more cranial than the left, with the cranial pole of the right kidney lying snugly in a complementary fossa of the liver. The left kidney tends to be more pendulous in ruminants, the fore stomach may push the left kidney to the right as far as the median plane or beyond, particularly when the rumen is full.

Ureters, Urinary Bladder and Urethra

The ***ureter*** is a muscular tube that conveys urine from the kidney to the urinary bladder. The smooth muscle of the ureter undergoes peristaltic waves of contraction that encourage the flow of urine to the urinary bladder. Each ureter originates at the renal pelvis (or the major calices of the bovine kidney) and empties into the urinary bladder near its neck at the trigone.

The manner in which the ureter passes obliquely through the wall of the urinary bladder creates a valve to prevent reflux flow of urine to the kidney.

*The **urinary bladder*** is a hollow muscular organ that varies in size and position with the amount of urine it contains. The empty, contracted bladder is a thick-walled, piri form organ on the floor of the pelvic cavity. As it fills with urine, its wall thins, and it enlarges craniad toward and then into the abdominal cavity. The neck of the bladder is continuous with the urethra caudally. The smooth muscle of the urinary bladder wall is arranged in three sheets; at the neck of the bladder these may form a smooth muscle sphincter that controls passage of urine into the urethra, although the precise role of the intramural muscle of the urinary bladder in creating a true sphincter is debated.

The ***pelvic urethra*** extends from the urinary bladder across the floor of the pelvic canal to the ischial arch. In female animals, it opens onto the floor of the vaginal vestibule. In the male animal, it receives the ductus deferens and ducts from the accessory sex glands, then passes through the penis as the penile urethra. In both sexes, the pelvic urethra is surrounded by a true sphincter, the striated skeletal m. urethralis, over which the animal exercises voluntary control. The m. urethralis is innervated by the pudendal nerve.

Micturition is the term for expulsion of urine from the bladder. It normally is a reflex activity stimulated by stretch receptors in the bladder wall that respond to distension of the urinary bladder created by the constant inflow of urine by way of the ureters. The bladder relaxes to accommodate a gradual increase in urinary volume until the stretch becomes great enough to stimulate reflex centers in the spinal cord which in turn relax the smooth muscle sphincter in the neck of the bladder and contract the muscle wall of the urinary bladder by way of sacral parasympathetic nerves. However, reflex emptying of the bladder can be prevented by voluntary suppression of the reflex and control of the m. urethralis surrounding the proximal urethra.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Explain The components of urinary Systems in cattle (4 points)
2. (3 points)

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet 2	Identifying organs of female and male reproductive systems and their respective locations

2.1. Reproductive system of livestock

2.1.1. Male reproductive system

The male reproductive system has several interconnected working parts that must function together for successful mating to occur. In the reproductive system of a male mammal, the major organs are the testicles, epididymis, scrotum, vas deferens, urethra, seminal vesicles, prostate gland, Cowper's gland, and penis.

- **Testicles** (the left and right) are the essential male generative glands or gonads, which along with the epididymis and its associated structures lie in the scrotum in each of the domestic animals. It plays a major role in animal reproduction by producing sperm, or the male sex cells, also called spermatozoa. Testicles also produce a hormone, testosterone, which causes the appearance and behavior of the animal to have masculine traits. Every male animal has two testicles. Sperm cells enter the epididymis attached to each testicle. They are stored there while they mature.

- The **scrotum** is a two-lobed sac that contains and protect

- ts the two testicles. It also regulates the temperature of the testicles, which must be maintained below body temperature. When the environmental temperature is lower than the desired temperature, the scrotum contracts, pulling the testicles toward the body for warmth. When the environmental temperature is higher than the desired temperature, the scrotum relaxes, permitting the testicles to drop away from the body. This temperature regulation is greatly important to the reproductive process because of its effect on the production and vitality of sperm.

Structure of the Scrotum

1. Externally covered by skin, which is thin, elastic relatively hair less, lack sub cutaneous fat and is supplied with sweat and sebaceous glands. At the median plane

there is longitudinal raphe which marks the septum scroti (externally, a median groove marks the division into right and left compartments).

2. Tunica dartos- a tough fibromuscular layer attached to the skin. composed of under skin muscle and fibro-elastic tissue that divides the scrotum in to two halves or sacs which contracts during cold weather and relaxes in hot weather (temperature regulation)
3. Scrotal (spermatic) Fascia- has many layers
4. External Cremaster muscle
5. Tunica Vaginal communis (Parietal layer of the vaginal tunic)
6. Tunica vaginal propria (visceral layer of vaginal tunic that covers the outer portion of testicles and epididymis
7. Tunica albuginea.

   The scrotum provides testicular temperature from 4-7^{0}C cooler than the general body temperature under normal.

- Vas deferens is a transportation tube that carries the sperm-containing fluid from each epididymis to the urethra.
- The urethra is the large, muscular canal extending from the urinary bladder to the end of the penis.
- Accessory sex glands add volume and nutrients to the sperm-rich fluid coming from the epididymis.
- The seminal vesicles open into the urethra to produce a fluid that protects and transports sperm.
- The prostate gland is near the urethra and the bladder. It produces a fluid that mixes with the seminal fluid throughout animal reproduction. The mixture of seminal and prostate fluids and sperm is called semen.
- The Cowper's gland produces a fluid that moves down the urethra ahead of the seminal fluid. This fluid cleans and neutralizes the urethra, helping protect the sperm as they move through.
- The penis deposits the semen within the female reproductive system. The urethra in the penis is surrounded by spongy tissue that fills with blood when the male is sexually aroused. This causes an erection, which is necessary for copulation, or mating, to occur.

- The sigmoid flexure, commonly found in bulls, rams, and boars, and the retractor muscle extend the penis from the sheath, a tubular fold of skin.
- The glans penis at the tip of the penis acts as a sensory organ.

The spermatic cord- the testicle is fixed in scrotum by the spermatic cord and scrotal ligament. This cord starts from internal abdominal ring of inguinal canal to testis. The spermatic cord is composed of: -

1. Testicular (spermatic) artery
2. Testicular (spermatic) vein- constitutes close-meshed pampiniform plexus in which the arteries are embedded. The plexus reduces to a single vein and joins the caudal venacava
3. Cremaster muscle
4. Lymphatic vessels
5. Nerves
6. Vaginal tunic
7. Vas deferens.

Note; the spermatic cord is the structure which is important during castration of animals; it should be properly ligated in open castration (equine) and closed with burdizzo in closed castration.

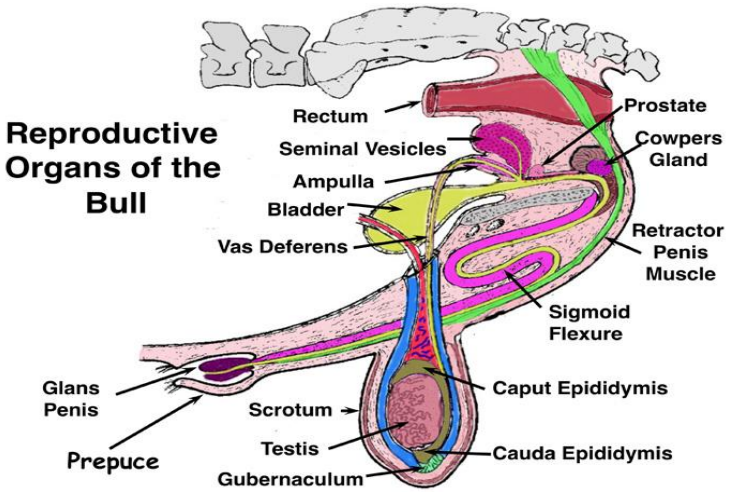

Figure 1. Male Reproductive Organs

2.1.2. The Female Reproductive System

The female mammal has a complex system of organs that compose the reproductive system. Some major organs that make up the female reproductive tract are the ovaries, oviducts, uterus, vulva, bladder, clitoris, and vagina.

A female mammal typically has two **ovaries**. Within each ovary are hundreds of tiny follicles, or cavities, where the ova are produced. The ova, or eggs, are the female sex cells. Each ovum is the largest single cell in the body. The ovaries also produce the female sex hormones, estrogens and progesterone.

Oviducts or fallopian tubes: are tubes that carry the ova from the ovaries to the uterus. They reside close to the ovaries but are not attached to them.

Infundibulum: is the funnel shaped end of each oviduct nearest an ovary. At ovulation a follicle ruptures, releasing an ovum that is caught by the infundibulum.

The **uterus** of a mammal is a Y-shaped structure consisting of the body, two uterine horns, and the cervix. It lies in a nearly horizontally position on top of the bladder. The ***myometrium*** is a muscle layer; the ***endometrium*** is the lining. The size and shape of the uterus vary with the species. The upper part of the uterus consists of two uterine horns that progress to the oviducts, or fallopian tubes. In most species, except the horse, pregnancy occurs in the uterine horns. In the horse, however, pregnancy occurs in the body of the uterus.

The uterus is the site where the fetus grows until parturition, or birth. The uterus of a mammal that normally produces a large number of offspring at each breeding cycle has relatively large horns and a small body. In contrast, the uterus of a mammal that normally produces a single offspring or twins has smaller horns and a larger body.

Cervix is the lower outlet of the uterus. It is composed primarily of connective tissue and constitutes the gateway between the uterus and the vagina. Like the rest of the reproductive

tract, the cervix is lined with mucosal cells, which make significant changes as the animal goes from one estrous cycle to another during pregnancy, or gestation.

Vulva: is the external opening of the reproductive and urinary systems. The exterior, or the visible parts of the vulva, consists of two folds called the labia majora (are fleshy and they homologous with the scrotum in the male). Inside the labia majora are two folds called the labia minora (are homologous with the shaft of the penis in male).

Clitoris is the sensory and erectile organ of the female (is homologous with the glans penis in males). It is just inside the vulva. The clitoris develops from the same embryonic tissue as the penis in the male and produces sexual stimulation during copulation.

Lastly, the **vagina** serves as the female organ of copulation at mating and as the birth canal at parturition. It is the passage between the cervix and the vulva.

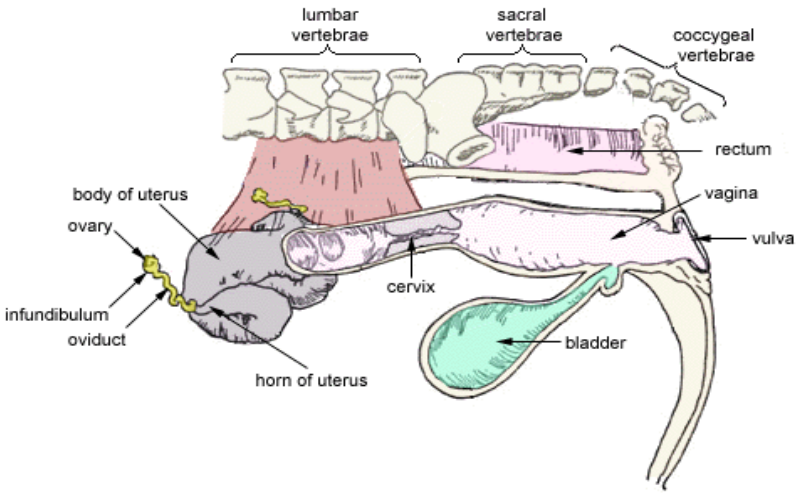

Figure 2. Anatomy of female reproductive organ

2.1.3. PHYSIOLOGY OF FEMALE REPRODUCTION

Puberty - Is the period during which reproductive organs first become functional. This differs among the different species. Mare (2 year) Heifers (7-15 month), ewes, sows, bitch

(6 month) . Great variations can be found with in a single species depending up on climate, Nutrition, Heredity etc.

Oogenesis - Is the formation of the haploid ova by meiosis cell division in the ovary. Oogenesis is completed during the embryonal development. The ova kept dormant until the animal reaches to puberty. The ova develops on the cortex of the ovary. The period of development continuous cyclicaly through out the fertile life. The interval from the beginning of one heat period to the beginning of the next heat period is called estrus cycle. The estrus cycle period varies in different species.

Species	Estrus cycle	Gestation period	Duration of estrus
Cow	21 days	9 month	14-18 hrs
Mare	21 days	11 month	5 days
Ewe	17 days	5 month	3-84 hrs
Sow	21 days	3 month (114 days) 3 week 3 days	15-95 hrs

Based on the cycle animals are grouped in to 3 different groups

1. Monoestrus - once in a year
2. Diestrus – twice in a year
3. Polyestrus – many times in a year

    a. Seasonal polyestrous
    b. Year round polyestrous

The estrus cycle has four phases :

A. **Proestrus -** Period of the building up where follices increase in size, vaginal wall thickens and uterine vascularity increase.

A. **Estrus -** Period of heat and greatest receptivity to male, rupture of ovarian follicle in most farm animals.

B. **Metestrus -** Formation of the corpus luteum, change in vaginal wall and uterus.

C. **Diestrus -** Short period of inactivity before the next proestrus period during the breeding season of polyestrus.

The **oestrous cycle** is the sequence of hormonal changes that occurs through the **ovarian cycle**. These changes influence the behaviour and body changes of the female (**Figure 7**).

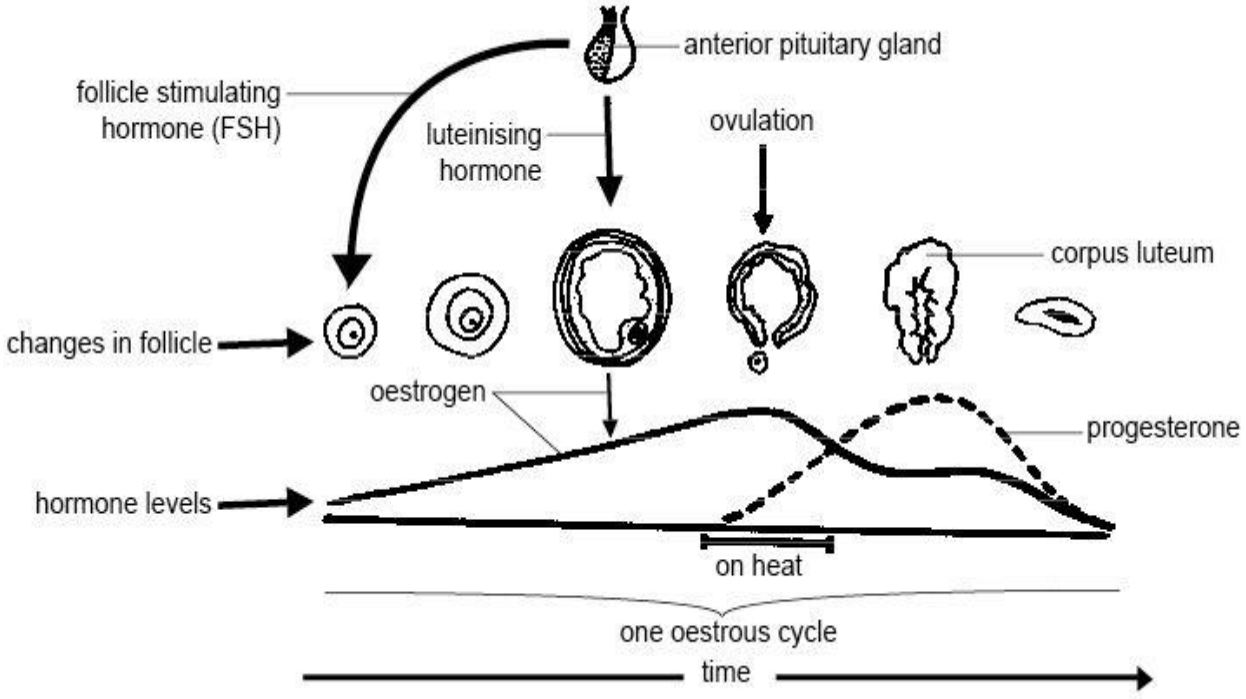

Figure 3. - The oestrous cycle

The first hormone involved in the oestrous cycle is **follicle stimulating hormone (F.S.H.),** secreted by the **anterior pituitary gland** . It stimulates the follicle to develop. As the follicle matures the outer cells begin to secrete the hormone **oestrogen** and this stimulates the mammary glands to develop. It also prepares the lining of the uterus to receive a fertilized egg. Ovulation is initiated by a surge of another hormone from the anterior pituitary, **luteinizing hormone (L.H.).** This hormone also influences the development of the corpus luteum, which produces **progesterone**, a hormone that prepares the lining of the uterus for the fertilized ovum and readies the mammary glands for milk production. If no pregnancy takes place the corpus luteum shrinks and the production of progesterone decreases. This causes FSH to be produced again and a new oestrous cycle begins.

Alternatives which may follow metestrus.

1. Pregnancy - Period of gestation
2. Anestrus – Long period of inactivity between sexual season
3. Pseudo pregnancy – Changes similar to pregnancy but no embryo or fetal is present.

Ovulation - The process by which one or more female cell or egg are released from matured ovarian follicles.\

Fertilization - Is the union of the female gametes to the male gametes to form one single cell called zygote. The zygote starts to divide with in the oviduct and also form a protection cover called zona pellucida and this reach to the uterus 3-4 days in domestic animals except in dog and cat 5-18 days.

Gestation period - The period from the time of fertilization to the period of parturition. The initiation of parturition is based on different factors the actual condition to each species is not known it is postulated:

1. When size & weight of the fetus increases the fetus lacks sufficient nutrients from the mother.
2. As the size & weight of the uterus increases the mother unable to carry the fetus.
3. The increase in estrogen & decrease progesterone hormone.

During parturition there is a normal ways of presentation, posture and position to the species any abnormality leads the animal to the condition known as dystocia (difficulty in birth). Anterior presentation of the forelimbs & the head is the normal ways of presentation.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

(2 points each for choose part)

1. Of the following one plays a role in producing spermatozoa.
   A, Scrotum B, Testicles C, Cervix D, Vagina
2. Among the following one is a two lobed sac plays a role in protecting two testicles
   A, Vagina B, Scrotum C, Uretera D, None
3. Of the given alternative which one add volume and nutrient to the sperm
   A, Cowper's gland B, Accessory glands C, Urethra D, None
4. A female mammal have ___ ovaries
   A, 4 B, 2 C, 6 D, 3
5. A tube that carries ova from ovaries to uterus
   A, Infundibulum B, Oviduct C, myometrium D, None
6. Explain the components of spermatic Cords. (4 points)
7. Describe the reproductive system of males (4 points)
8. Describe the reproductive system of females (4 points

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

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Information sheet 3.	Describing functions of Primary and accessory sex organ

3.1. Describing functions of Primary and accessory sex organs

Primary sex organs in males and females are generally known as gonads.

A, Sex organs in males

In the case of male reproductive system the primary sex organs are a pair of testes (singular: testis) lying outside the abdominal cavity, enclosed in a sac called the scrotum. The placement of testes outside the body results in the temperature of the testes being lower than that of the rest of the body, a condition favorable to produce healthy sperms.

Secondary sex organs in a male are seminiferous tubules, epididymis, sperm duct, seminal vesicles, prostate gland, Cowper's gland and penis**.**

B, Sex organs in females

Primary sex organs in a female consist of a pair of ovaries which are oval bodies lying at the back of the abdomen below the kidney. Each ovary consists of many ovarian follicles. Each follicle can produce an egg.

The secondary sex organs in a female are fallopian tubes, uterus, and vagina

The male accessory sex glands produce the bulk of the ***ejaculate***, or ***semen***, the medium for transport of sperm. Semen provides favorable conditions for nutrition of sperm and acts as a buffer against the natural acidity of the female genital tract.

The accessory sex glands include the :-

- Ampulla of the ductus deferens
- Vesicular gland
- Prostate gland and
- Bulbourethral gland.

Except for the prostate, these glands are paired. There is considerable variation in shape and size of the various accessory sex glands among species, but the relative location is similar in all animals .

I. Ampullae

The **ampullae** are glandular enlargements associated with the terminal parts of the ductus deferentia. They are well developed in the stallion, bull, and ram and absent in the boar. Glands of the ampullae empty into the ductus deferentia and contribute volume to the semen.

II. *Vesicular Glands*

The ***vesicular glands*** (formerly called seminal vesicles) are paired glands associated with the genital fold. In most domestic species, each vesicular gland merges with the ipsilateral ductus deferens, creating the short ***ejaculatory duct*****,** which empties into the pelvic urethra. In the boar, the vesicular glands open into the urethra separately from the ductus deferentia. The vesicular glands of the stallion are hollow, pear-shaped sacs; those of the bull, ram, and boar are lobulated glands of considerable size.

III. Prostate Gland

The ***prostate gland*** is an unpaired gland that more or less surrounds the pelvic urethra. In farm animals the prostate gland comprises various combinations of diffuse and compact parts extending along the pelvic urethra under cover of the urethral muscle. The multiple ducts of the prostate gland open in two parallel rows, one on each side of the lumen of the urethra. The prostate produces an alkaline secretion that gives semen its characteristic odor. In older intact male animals, the prostate may become enlarged and interfere with urination.

IV. Bulbourethral Glands

The ***bulbourethral*** (formerly Cowper's) ***glands*** are paired glands on either side of the pelvic urethra just cranial to the ischial arch but caudal to the other accessory glands. Bulbourethral glands are especially large in the boar.

The ***prepuce*** is an invaginated fold of skin surrounding the free extremity of the penis. The outer surface is fairly typical skin, while the inner mucous membrane consists of a preputial

layer lining the prepuce and a penile layer covering the surface of the free extremity of the penis.

The Penis

The male organ of copulation, the ***penis***, may be divided into three general areas:

- ***Glans***, or free extremity
- Main portion, or ***body*** and
- Two ***crura***, or roots,

The Testes

Sperm need temperatures between 2 to 10 degrees Centigrade lower and then the body temperature to develop. This is the reason why the testes are located in a bag of skin called the **scrotal sacs** (or **scrotum**) that hangs below the body and where the evaporation of secretions from special glands can further reduce the temperature. In many animals (including humans) the testes descend into the scrotal sacs at birth but in some animals they do not descend until sexual maturity and in others they only descend temporarily during the breeding season. A mature animal in which one or both testes have not descended is called a **cryptorchid** and is usually infertile.

The problem of keeping sperm at a low enough temperature is even greater in birds that have a higher body temperature than mammals. For this reason bird's sperm are usually produced at night when the body temperature is lower and the sperm themselves are more resistant to heat.

The testes consist of a mass of coiled tubes (the **seminiferous** or **sperm producing tubules**) in which the sperm are formed by meiosis (Fugure 3). Cells lying between the seminiferous tubules produce the male sex hormone **testosterone**.

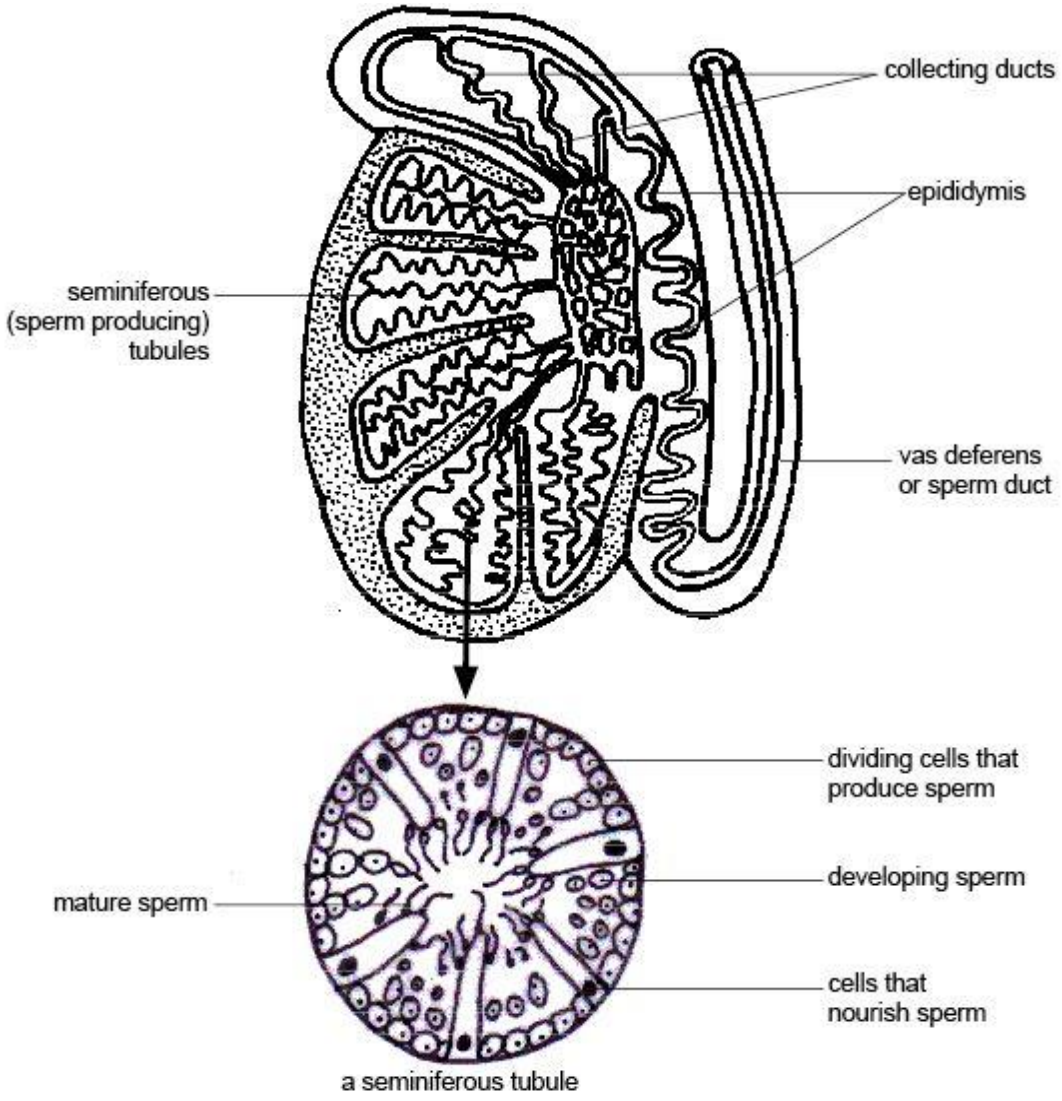

Figure 3 - The testis and a magnified seminiferous tubule

Semen

Semen consists of 10% sperm and 90% fluid and as sperm pass down the ducts from testis to penis, (accessory) glands add various secretion

Penis Form and Shape

Dogs, bears, seals, bats and rodents have a special bone in the penis which helps maintain the erection (see Figure 1 above). In some animals (e.g. the bull, ram and boar) the penis has an “S” shaped bend that allows it to fold up when not in use. In many animals the shape

of the penis is adapted to match that of the vagina. For example, the boar has a corkscrew shaped penis, there is a pronounced twist in bulls' and it is forked in marsupials like the opossum. Some have spines, warts or hooks on them to help keep them in the vagina and copulation may be extended to help retain the semen in the female system. Mating can last up to three hours in minks, and dogs may "knot" or "tie" during mating and cannot separate until the erection has subsided.

Sperm

Sperm are made up of three parts: a ***head*** consisting mainly of the nucleus, a ***midpiece*** containing many mitochondria to provide the energy and a ***tail*** that provides propulsion (see Figure 3).

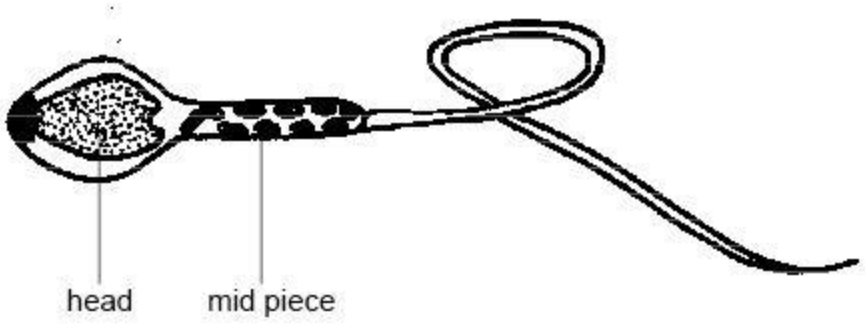

Figure 3 - A sperm

A single ejaculation may contain 2-3 hundred million sperm but even in normal semen as many as 10% of these sperm may be abnormal and infertile. Some may be dead while others are inactive or deformed with double, giant or small heads or tails that are coiled or absent altogether.

When there are too many abnormal sperm or when the sperm concentration is low, the semen may not be able to fertilize an egg and the animal is infertile. Make sure you don't confuse infertility with impotence, which is the inability to copulate successfully.

Sperm do not live forever. They have a definite life span that varies from species to species. They survive for between 20 days (guinea pig) to 60 days (bull) in the epididymis but once ejaculated into the female tract they only live from 12 to 48 hours. When semen is used for artificial insemination, storage under the right conditions can extend the life span of some species.

I. Accessory Glands

Three different glands may be involved in producing the secretions in which sperm are suspended, although the number and type of glands varies from species to species.

a. **Seminal vesicles** are important in rats, bulls, boars and stallions but are absent in cats and dogs. When present they produce secretions that make up much of the volume of the semen, and transport and provide nutrients for the sperm.

b. **Prostate gland** is important in dogs and humans. It produces an alkaline secretion that neutralizes the acidity of the male urethra and female vagina.

c. **Cowper's glands** (bulbourethral glands) have various functions in different species. The secretions may lubricate, flush out urine or form a gelatinous plug that traps the semen in the female reproductive system after copulation and prevents other males of the same species fertilizing an already mated female. Cowper's glands are absent in bears and aquatic mammals.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Primary sex organs in females and Males Are known as
2. A, Gonads B, Dendirities C, None
3. Describe the primary and accessory sex organs in female (4 points)
4. Describe the primary and accessory sex organs in female (4 points)

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information sheet 4	Indicating clinical importance of urogenital

4. Indicating clinical importance of urogenital

The urogenital system includes both the reproductive organs and the excretory organs. They are considered together because they share some common ducts. We will begin by exploring the excretory system, which is comprised of the kidneys, ureters, urinary bladder, and urethra. The kidneys function to eliminate nitrogenous wastes produced during the breakdown of proteins, regulate water balance, pH and the ionic composition of the body fluids. These bean-shaped organs are located in the abdominal region adjacent to the dorsal body wall.

- As you remove the mesentery and fat that surround the left kidney watch for the adrenal gland, which lies in the fat anterior to the kidney. Avoid damaging to the artery, vein, and ureter that enter the concave surface or hilus of the kidney (Fig. 5.2, arrow).
- Make a longitudinal section of the kidney with a scalpel or razor blade and separate the two halves (Fig. 5.1) Note the following structures:

Cortex (1). The cortex is the light outer layer of the kidney. This is where blood coming from the renal artery is filtered and enters the nephron or functional unit of the kidney. The cortex contains the glomerulus and the convoluted tubules.

Medulla (2). The medulla is the dark tissue below the cortex. It contains the loop of Henle. As the filtrate passes through the renal tubules water, ions, nutrients and other substances are reabsorbed by capillaries and leave the kidneys via the renal veins. The collecting ducts, where urine is concentrated also pass through the medulla.

Figure 5.1. Section through a cat kidney.

Figure 5.2. Urogenital system.

Renal papilla (3). The renal papilla forms the inner edge of the medulla and is the point where the collecting ducts converge. Urine drips from the renal papilla into the expanded end of the ureter.

Renal pelvis (4). This funnel shaped expansion of the ureter within the hilus collects urine and drains it into the ureter.

Ureter (5). The ureter carries urine posteriorly toward the urinary bladder. Trace the ureter caudally and locate the point where it enters the bladder.

Bladder (6). A small muscular bladder collects and stores the urine. Smooth muscles in the bladder wall control the movement of material.

The bladder is suspended in the body cavity by a mid-ventral mesentery and paired lateral mesenteries.

Urethra. From the bladder the urine moves into the urethra. You will be able to trace this later as we examine the reproductive structures.

Adrenal Gland (7). This endocrine gland is located cranial to the kidney. It prepares the body for stress, regulates metabolism, and affects sexual development.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Primary sex organs in females and Males Are known as
2. A, Gonads B, Dendirities C, None
3. Describe the primary and accessory sex organs in female (4 points)
4. Describe the primary and accessory sex organs in female (4 points)

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information sheet 5	Describing form and structures of the mammary gland

5.1. THE MAMMARY SYSTEM

Mammary gland of animal is called as udder . Udder is made up of four quarters, each quarter having a single teat. There are two front (fore) quarter and two hind (rear) quarter. Udder is modified sweat gland located out side of the abdominal cavity. The right and left half is separated by the suspensary ligament internally & by intramammary groove externally. There are 3 structures that support the udder.

1. Median suspensary Ligament
2. Two Lateral suspensary Ligament
3. Skin

Based on their location there are 3 types of mammary glands:

1. Inguinal mammary gland - They are found in ruminants & equines.
2. Abdominal mammary gland - In the abdominal area in bitch, sow & cat
3. Pectoral mammary gland - Develops over the chest (man breast) , elephant.

Mammary gland of the cow / udder/ is consists of four quarters and these are independent with each others. The blood supply, Nerve Supply, Venous drainage & lymphatic drainage are all much common to both quarters however; the milk from one teat is produced by the glandular tissue of that respective quarter. Each quarter is made up of secretary& supportive connective tissues. The secretary tissue is made up of a numbers of alveoli Alveolis sinner layer is made up of secretary cells. So alveoli are responsible for secretion of milk. Alveoli also have myoepithelial cells which has muscle fiber. This my epithelial cell is responsible for contraction of alveoli and let down of milk. After the milk passes in different ducts. The milk cistern open in to teat cistern teat cistern open in to teat canal. Teat canal is a canal in the center of teat surrounding to teat canal there are many sphincter muscles which prevents leakage of milk and entry of bacteria.

5.2. PHYSIOLOGY OF MAMMARY GLAND.

The term lactation includes both milk secretion and milk removal (milk letdown, ejection). For production of 1 ml of milk 400- 500 ml of blood must pass through udder when blood pass through capillary the secretary cell of alveoli leak many type of different component of milk. Water directly secreted in alveoli from blood milk fat is synthesized from fatty acids. Lactose is synthesized from glucose. Protein is synthesized from amino acids minerals & vitamins are secreted directly from blood to milk. Milk secreted by alveoli is accumulated in udder & create a pressure.

Action of Hormones

Estrogen stimulates the growth of the duct and mammary gland. Progestron stimulates the growth of true secretary alveoli during pregnancy. Prolactin & growth hormone maintain Lactation (period of milk production)

Let down of milk

Ejection of milk to the teat cistern and teat canal is called as Letdown of milk. Oxytocin is the major hormone responsible for Let down of milk. It is produced by hypothalamus of brain and stored in piturary glands milking, washing or suckling by calf will stimulate the udder . At this time the udder will send impulses (messages) to brain & the brain will activate the pitutary gland. The pituitary gland secretes the oxytocin and will reach to udder through blood. The oxytocin will make the myoepithelial cell (wall of alveoli) to contract. This contraction will force the milk to teat cistern and teat canal through canal of various duct. Finaly from the teat milk is milked out or suckled by calf.

Milk ⟶ Is the normal secretion of mammary glands of mammal. Due to its high Nutritive valve milk is also called "almost" complete food. It is an opaque with fluid containing casein (milk protein), Lactose (milk sugar), cream (milk fat). It is also contains Enzymes, minerals like ca, p, Nacl & colostrums.

Colostrums⟶ Is the first milk produced 6-12 days after parturition. It has laxative property because it contains globules& Nitrogenous substances.

5.3. The mammary gland (udder)

Mammary glands are specialized secreting glands that identify the class mammalian. The glandular epithelium is composed of true secretory cells which utilizes the bloodstream as a substrate. The activity of milk gland is periodic and normally is related to parturition. They are located outside the abdominal cavity. The number of glands varies in different species.

The udder is composed of two halves. The right and left divided by medial suspensory ligament. Each half is divided into two separate quarters by thin membrane. There is no communication among the four quarters. This is helpful in minimizing the spread of infection within the udder. Each quarter is composed of secretory tissue. Secretory tissue consists of numerous alveoli. Each alveolus is supplied with tiny capillaries, which lie outside the secretory cells. There is small muscle fiber called myoepithelial cell around each alveolus, which cause contraction of alveoli and produce letdown of milk.

5.2. Describing form and structures of the mammary gland

The are modified ***mammary glands*** sudoriferous (sweat) glands (also called ***mammae***) that produce milk for the nourishment of offspring. They develop from bilateral thickenings of ventrolateral ectoderm of the embryo, the so-called milk lines, which are more correctly referred to as ***mammary ridges***.

5.2.1. Mammary Glands of the Cow

The udder of the cow comprises four individual glands, referred to as ***quarters***. The skin of the udder is covered with fine hair; however, the teat is completely hairless. The right and left halves of the udder each consist of a cranial (front) quarter and a caudal (hind) quarter.

Each side of the udder is almost completely independent of the other insofar as blood supply, nerve supply, and suspensory apparatus are concerned (discussed later). Ventrally, the two halves of the udder are demarcated by a longitudinal furrow, the ***intermammary***

groove, which corresponds to a median septum of connective tissue dividing left and right halves. Because of the relative isolation of each side, half of the udder can be removed surgically without damaging the other half, as might be done to treat an aggressive tumor. The two quarters in each half are separate from one another as far as the gland tissue and duct system are concerned. Thus, all the milk from one teat is produced by the glandular tissue of that quarter. The vasculature, nerve supply, and lymphatic drainage, however, are common to both quarters of a given half. The parenchyma of the lactating mammary gland consists of secretory tissue and the ducts of the gland (Fig. 29-1). The secretory units, the ***alveoli***, are lined by a simple epithelium that varies from columnar to cuboidal in height. The alveoli are the chief structures for actual milk production, although the initial portion of the associated duct is also lined with secretory epithelium.

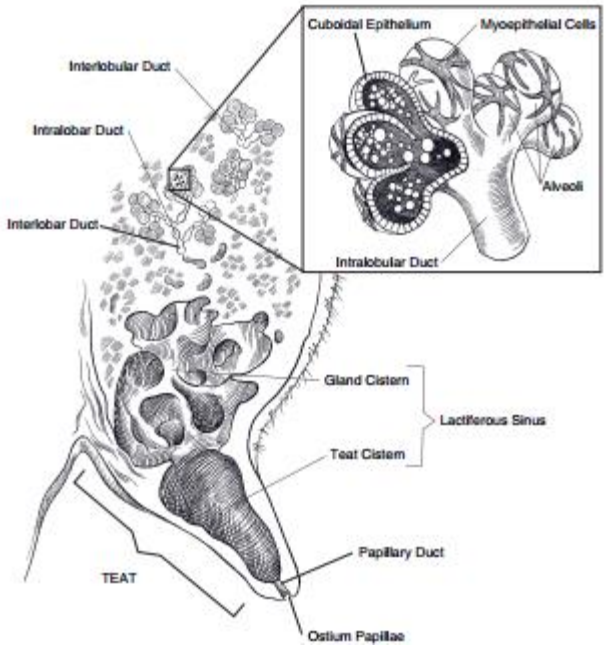

Fig __ Anatomy of the bovine Udder

Suspensory Apparatus

The udder of a lactating dairy cow can weigh as much as 60 kg, so the organ is supported by a dense system of fibroelastic ligaments called the ***suspensory apparatus***. The primary supportive elements of the suspensory apparatus are its two medial laminae, which take their origin together from the linea alba of the abdominal wall and the symphysis of the pelvis (Fig. 29-2 above). Each medial lamina passes ventrad between the two halves of the udder so that one layer intimately covers the medial side of each half. The

two medial laminae can be readily separated, as they are united only by a small amount of loose areolar connective tissue;

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Explain the use of Mammary Gland

Answer Sheet

Name: _____ Date: _____

Short Answer Questions

Information sheet 6	Recognizing mechanisms of milk synthesis and secretion

5. Recognizing mechanisms of milk synthesis and secretion

5.1.Composition of Milk

Milk contains all of the nutrients necessary for survival and initial growth of mammalian neonates. The nutrients in milk include sources of energy (lipids and carbohydrates), proteins to provide amino acids, vitamins, minerals (ash) for electrolytes, and water. The relative amounts of these nutrients in milk vary among species(Table 29-1).

Diet and the stage of lactation also affect the composition of milk. Diets high in non-fiber carbohydrate sources of energy are associated with increases in the percentage of lipids in the milk. Diets high in protein promote a slight increase in the percentage of protein in the milk, but this effect is much less than the effect of energy on milk lipid content. The amount of carbohydrates in milk (lactose, or milk sugar) does not routinely change with diet. The percentage of lipids and protein in milk is also highest early in lactation. In cattle the percentages are relatively high in the first few weeks after calving and then decrease over the next 3 to 4 months. Later in lactation, the concentrations of lipids and proteins again increase as total daily production (pounds of milk per day) decreases.

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Milk Secretion

The epithelial cells lining the alveoli of mammary glands are the cells primarily responsible for the secretion of milk. The appearance of these cells varies as they synthesize and release the lipids, proteins, and lactose of milk. After the cells actively secrete the constituents of milk and the lumen of the alveoli are filled with milk, the epithelial cells shrink and are described as a simple low-cuboidal epithelium (Fig. 29-5). At this stage, their secretory activity is relatively low. Shortly after the stored milk is removed, the epithelial cells increase their secretory activity and begin to refill the alveoli.

Early in the secretory phase the cells assume a more columnar appearance and then gradually reduce to cuboidal as milk fills the alveoli. Small, apparently nonfunctioning alveoli can be found in dry mammary glands, and there is a relative increase in the amount of interstitial loose connective tissue (Fig. 29-4). Milk lipids are synthesized and packaged

into secretory droplets, which are extruded from the luminal surface of the cell into the alveoli (Fig. 29-6). As they are released, a mem

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Milk Ejection

Removal of milk from the mammary gland is dependent on a functional milk ejection reflex. This is a neurohormonal-dependent process. The ejection of milk results from a nervous stimulus that an animal associates with milking or suckling activity, such as manual massage of the udder teats, suckling, or sight and smell of the calf. The milking machine itself can also stimulate the reflex. The neural stimulus reaches the central nervous system and causes the posterior lobe to release. Oxytocin reaches the mammary gland and myoepithelial cells, and contraction of these cells forces milk from the alveoli into the duct system. Milk then flows freely into the larger ducts and cisterns. Adrenalin inhibits milk ejection primarily by reducing blood flow to the gland so that sufficient concentrations of oxytocin cannot reach the receptors on the myoepithelial cells .

The posterior pituitary hormones are produced in the hypothalamus and travel to the posterior pituitary where they are stored until release . The paraventricular nuclei are particularly involved with oxytocin production. However, the supraoptic nuclei can also release oxytocin.

Oxytocin is a peptide containing eight amino acids. It has a molecular weight of about 1,000 daltons. Vasopressin is a similar molecule and has some oxytocic properties, but oxytocin appears to have five to six times more activity in causing milk ejection than does vasopressin. Also, considerably more oxytocin than vasopressin is released during milk ejection.

Mammary Involution

Regression or involution of the mammary gland takes place after the peak of lactation and after cessation of milking or suckling . The in volutionary process is more drastically affected by cessation of milk removal than it is after peak lactation . Involution is thought to be due to decreases in cell numbers, the decline in rate of milk synthesis of remaining cells, or both.

There are characteristic changes in mammary histology during the involutionary process, including decreases in the size of the alveoli, the number of alveoli per lobule, the total number of alveoli and

lobular volume, and the number of cells per alveolus. Complete lobules disintegrate in parts of the mammary gland during advanced involution, and by the end of involution, the gland resembles that of the virginal state. However, the essential lobular structure of the gland is still recognizable.

Milk Protein Synthesis

There are a number of proteins that are specific to milk. Among the major ones are casein, alpha-lactalbumin, and beta-lactoglobulin. Most of the milk proteins are synthesized within the mammary gland. Gamma-casein, blood serum albumin, and the immune globulins are absorbed as pre-formed proteins from the blood.

Most of the protein synthesized by the epithelial cells is synthesized from amino acids that are absorbed from the bloodstream. This has been determined by measuring arteriovenous differences across the mammary gland and relating uptake by the mammary gland to the composition of amino acids in milk protein.

Milk Fat Synthesis

Fat is the most variable component of milk. Both the percentage composition of fat and the fatty acid composition of triglycerides within and among species vary. Most milk fat is made up of triglycerides. Glucose, acetate and beta-hydroxybutyrate, triglycerides of the chylomicra, and low-density lipoproteins from blood serve as major precursors for milk lipids. The beta-hydroxybutyrate is also used for fatty acid synthesis . The ruminant mammary gland cannot effectively utilize acetyl-CoA formed from glucose in the mitochondria.

The short-chain fatty acids from C4 to C14 and some palmitic acid are synthesized within the mammary gland from acetate derived as absorbed acetate in the ruminant or from glucose in the nonruminant. About 30 percent of palmitic acid is derived from acetate, and the remainder comes from triglycerides of blood. Stearic and oleic acids come primarily from plasma triglycerides. Stearic acid is absorbed in greater quantities from blood than is oleic acid, yet oleic acid is the most prevalent C18 fatty acid in milk. Stearate can be converted to oleic acid by the bovine, caprine, and swine mammary glands. Oleic acid cannot be saturated to form stearate.

Free glycerol from the bloodstream provides less than 10 percent of the glycerol portion of milk triglycerides. Most glycerol comes from glycerol-3-phosphate from glycolysis and the remainder from lipoprotein glycerides .

The malonyl-CoA pathway appears to be the predominant route of fatty acid synthesis. Two pathways for esterification of fatty acids may be present in the mammary gland: the phosphatidic acid pathway, which is the most common, and formation of 1,2-diglyceride from acylation of 2-monoglyceride.

Lactose, Minerals, and Vitamins

The major sugar of milk is lactose. Lactose is a disaccharide made up of a glucose and a galactose molecule. The primary precursor of lactose is glucose. The glucose molecule is phosphorylated to form glucose-6-phosphate, which is then converted into glucose-1-phosphate. The glucose-l-phosphate, in the presence of uridine triphosphate, forms uridine diphosphate (UDP) glucose, which is converted to UDP galactose. The UDP galactose is united with free glucose to form lactose with the liberation of UDP. The last step is catalyzed by the enzyme lactose synthetase. This is a unique enzyme that is composed of two subunits: the common galactosyl transferase and the milk protein alpha-lactalbumin.

The major mineral constituents of milk are calcium, phosphorus, potassium, chlorine, sodium, and magnesium. Potassium, chlorine, and sodium are in soluble form. Phosphates, citrates, and casein bind various minerals such as calcium and sodium. The buffering capacity of milk is due to citrates, phosphates, and bicarbonates, along with the proteins in the milk. Serum calcium is in equilibrium with bone calcium, making it difficult to increase the calcium content of the milk by increasing the calcium content of the feed. Inorganic phosphate of blood serum is the precursor of milk phosphates.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Explain the milk ejection procedure (2points)

Answer Sheet

Name: _____ Date: _____

Short Answer Questions

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