Department of Primary Industries

Dairy Australia

Industry insights- Dairy production

Supporting document

NSW DPI Schools Program

www.dpi.nsw.gov.au

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This resource is a collaboration between NSW Department of Primary Industries and Dairy Australia.

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Dairy Australia

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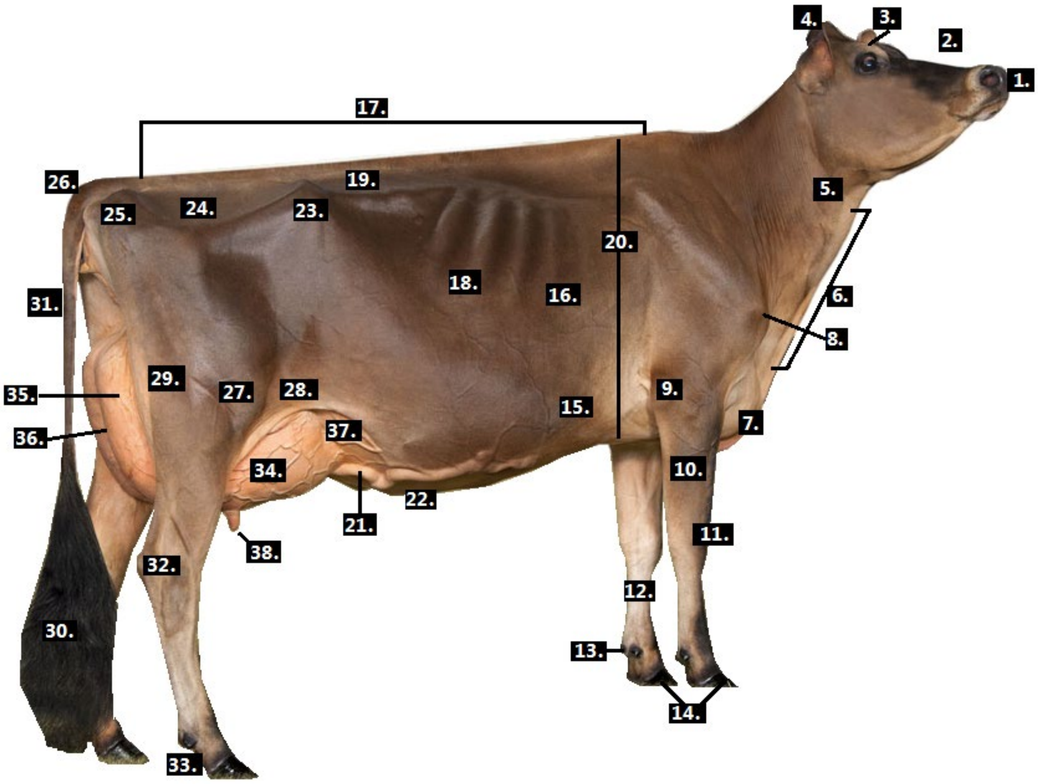
Contents

Dairy Production

Cow anatomy

Label the parts of the dairy cow using the NSW DPI 'Dairy Production' poster.



1	11	21	31
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Dairy breeds

- Use the QR code go to Dairy Australia – Breed, milk Quantity and Milk Quality to complete the interactive activities and see different dairy breeds.
- Use the 'Dairy Production' poster to identify common breeds of dairy cows. Research the origin and features of each breed pictured in the following table. Suggested references include: 'Australian Dairy Cows' (Dairy Australia) and 'Different breeds of cows' (Lactalis Australia).

<table>
<tr><td rowspan="4">
Figure 1 Source: Genetics Australia</td><td>**Breed:**</td></tr>
<tr><td>**Origin:**</td></tr>
<tr><td>**Average production (L/day) in Australia:**</td></tr>
<tr><td>**Cow characteristics:**
- **Frame size:**
- **Average mature cow weight:**
- **Colour:**</td></tr>
<tr><td colspan="2">**Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) and milk lactose (%) where possible)**</td></tr>
</table>

<table>
<tr><td rowspan="4">
Figure 2 Source Genetics Australia</td><td>**Breed:**</td></tr>
<tr><td>**Origin:**</td></tr>
<tr><td>**Average production (L/day) in Australia:**</td></tr>
<tr><td>**Cow characteristics:**
- **Frame size:**
- **Average mature cow weight:**
- **Colour:**</td></tr>
<tr><td colspan="2">**Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) and milk lactose (%) where possible)**</td></tr>
</table>

Figure 3 Source Genetics Australia

Breed:

Origin:

Average production (L/day) in Australia:

Cow characteristics:

- **Frame size:**
- **Average mature cow weight:**
- **Colour:**

Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) and milk lactose (%) where possible)

Figure 4 Source Genetics Australia

Breed:

Origin:

Average production (L/day) in Australia:

Cow characteristics:

- **Frame size:**
- **Average mature cow weight:**
- **Colour:**

Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) and milk lactose (%) where possible)

Figure 5 Source Genetics Australia

Breed:

Origin:

Average production (L/day) in Australia:

Cow characteristics:

- **Frame size:**
- **Average mature cow weight:**
- **Colour:**

Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) where possible)

<table>
<tr><td rowspan="4">
Figure 6 Source Genetics Australia</td><td>Breed:</td></tr>
<tr><td>Origin:</td></tr>
<tr><td>Average production (L/day) in Australia:</td></tr>
<tr><td>Cow characteristics:
• Frame size:
• Average mature cow weight:
• Colour:</td></tr>
<tr><td colspan="2">Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) where possible)</td></tr>
</table>

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<tr><td rowspan="4">
Figure 7 Source Genetics Australia</td><td>Breed:</td></tr>
<tr><td>Origin:</td></tr>
<tr><td>Average production (L/day) in Australia:</td></tr>
<tr><td>Cow characteristics:
• Frame size:
• Average mature cow weight:
• Colour:</td></tr>
<tr><td colspan="2">Milk quality and quantity characteristics: (include milk fat (%); milk protein (%) where possible)</td></tr>
</table>

Milk processing, marketing and value adding

Use the 'Dairy Production' poster to answer the following.

1. **List the three processes used to treat milk in its raw state to reduce potentially harmful bacteria present and make it safe for the consumer.**

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   ____

2. **Describe the process of pasteurisation.**

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3. **Describe the process of homogenisation.**

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4. **Define value-adding and include an example of a value-added dairy product.**

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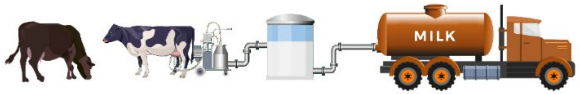
5. **Milk is processed to create a range of value-added products. The processes are either physical or microbial.**
   - **Physical processing:** includes separation, churning and dehydration but does not use microbes or chemicals**.**
   - **Microbial processing:** involves altering the chemical composition of the milk through fermentation and coagulation to create a new product.

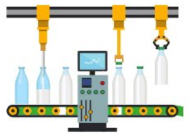
   Complete the table by describing how each value-added product is created and identifying whether it is a result of physical or microbial processing.

Processing dairy products		
Dairy Product	Description of process	Physical/microbial
Skim/lite milk		

Yoghurt		
Powdered milk		
Cream		
Cheese		
Butter		

6. **Use the following images and the 'Dairy Production' poster to create a milk production and marketing chain. Include:**
   - **A title and description at each step of the chain, explaining what is occurring**
   - **Arrows linking each step to the next**





Read the following extract from Dairy Australia, '[In Focus 2019- A world competitive industry]'

A world competitive industry

Australian dairy farmers operate in an open market and have done so since industry deregulation in 2000–01. The nature of this open market means Australia's domestic dairy market is linked to international trends with minimal government intervention. Australia is both a major exporter and importer of dairy products (predominantly from New Zealand). Hence, although most Australian dairy is consumed domestically, international markets and events have a major influence on Australian farmgate milk prices.

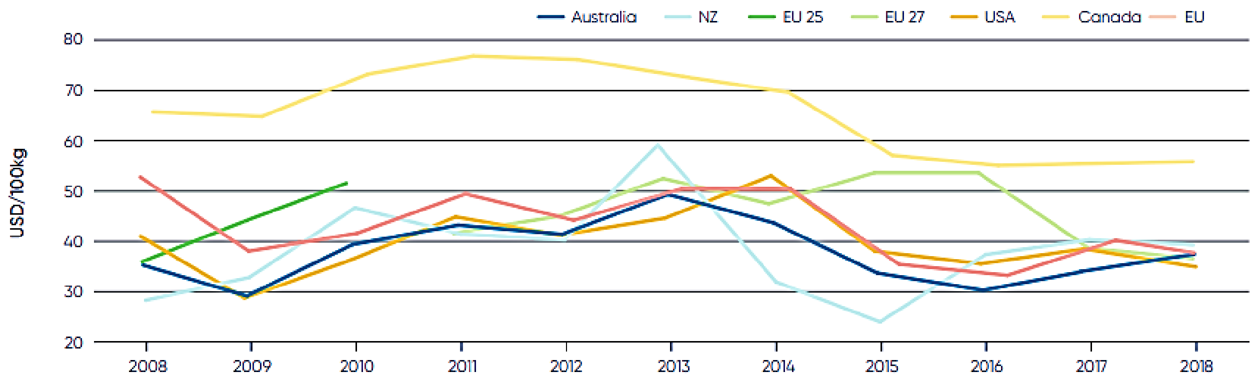
Australian dairy farmers received an average of close to US$37 per 100 kg of milk in 2018–19. This price is below that of major producing countries in the European Union and New Zealand. Although it is above the price farmers in the United Stated got paid for their milk last year. This relatively low price partly reflects lower levels of government support provided to Australian farmers compared to other counterparts.

Historically, Australia has been considered a low-cost producer of dairy products. In recent years, farm cost structures have increased in response to the need to adapt to drier conditions. This has resulted in increased expenditure on purchases of supplementary feed and temporary water allocations – particularly in northern Victoria and southern New South Wales. Total milk production and farm cost structures have not yet returned to levels of the early 2000s. Whilst local milk production has contracted since deregulation, the size of the domestic market has increased, due to continued population growth. As a result, the share of milk that is exported, and Australia's share of international dairy trade, has contracted.

As shown in Figure 2, the price received by farmers around the world has continued to converge. Farmgate prices now more closely reflect global dairy commodity price trends due to the removal of many market distorting industry policies, progressive deregulation and increased global trade.

Whilst broadly tracking other producers, Canada's dairy farmers operate in a highly regulated environment. This system determines prices, production and imports according to a scheme known as supply management.

Figure 2 International farmgate milk prices (USD/100kg)



Source: Dairy Australia

Use the extract from Dairy Australia, '[In Focus 2019- A world competitive industry',] to answer questions 7-12.

7. When did deregulation in the Australian dairy industry occur?

8. What is deregulation and what impact did it have on Australian dairy production? Suggested reference: 'History of Australian dairy industry deregulation'(Dairy Australia).

9. In other countries around the world, governments intervene in dairy production by regulating milk prices and providing subsidies to producers. From the reading, list some of the countries where this occurs.

10. What was the average Australian farm gate price of milk/100kg in 2018-2019?

11. According to the International Farm Comparison Network (IFCN) Dairy Research Network, the cost of milk production in Australia in 2018 fluctuated between US$35-40 per 100 kg.
    A) Calculate the profit US$/100kg of milk in Australia (2018-2019).
    B) What are some of the factors which might have contributed to these production costs in 2018-2019?

12. Compare milk farmgate price (US$/100kg) trends between Australia and other countries between 2017-2018 in Figure 2.

13. Over the last thirty years there has been a gradual decline in the number of owner-operated, small, non-corporate Australian dairy farms. Identify social and economic implications to Australian consumers if we lost dairy production in Australia?

14. As a consumer, what can you do to support the Australian dairy industry?

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15. The Australian dairy industry is a very efficient industry and a net exporter. Most of the milk produced supplies the domestic market with the excess going overseas to export markets. Access the NSW DPI '2018 Performance Data Insights, Milk' information and use the interactive graph, 'NSW milk export value by market,' to complete the table below on Australia's 5 main milk export markets.

Export market (country)	Value of exports ($)

16. Identify the continent that consumes the most of Australia's dairy exports. Explain why that area is our major Australian dairy export market destination?

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Cattle reproduction and reproductive technologies

Understanding the anatomy and physiology of the cow or heifer's reproductive system is fundamental to cattle management. Knowledge of the oestrous cycle, oestrous synchronisation, artificial insemination and embryo transfer, assist producers manage the breeding program for their herd.

17. Use the internet to define the following terms

A. Gestation period including the average gestation period of a cow.

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B. Oestrous period including the average oestrous period of a cow.

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C. Standing heat including the average standing heat length of a cow.

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D. Nonseasonal breeder

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E. Polyestrous

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F. Artificial insemination (A.I.)

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G. Embryo transfer (E.T.)

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H. Oestrous synchronisation

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Reproductive anatomy in females

The cow's reproductive tract consists of:

- Vulva
- Vagina
- Cervix
- Uterine body
- Two uterine horns
- Two oviducts
- Two infundibula (fimbria). (Infundibulum=single, infundibula=plural)
- Two ovaries

Figure 8 shows the anterior view of a cows' reproductive tract.

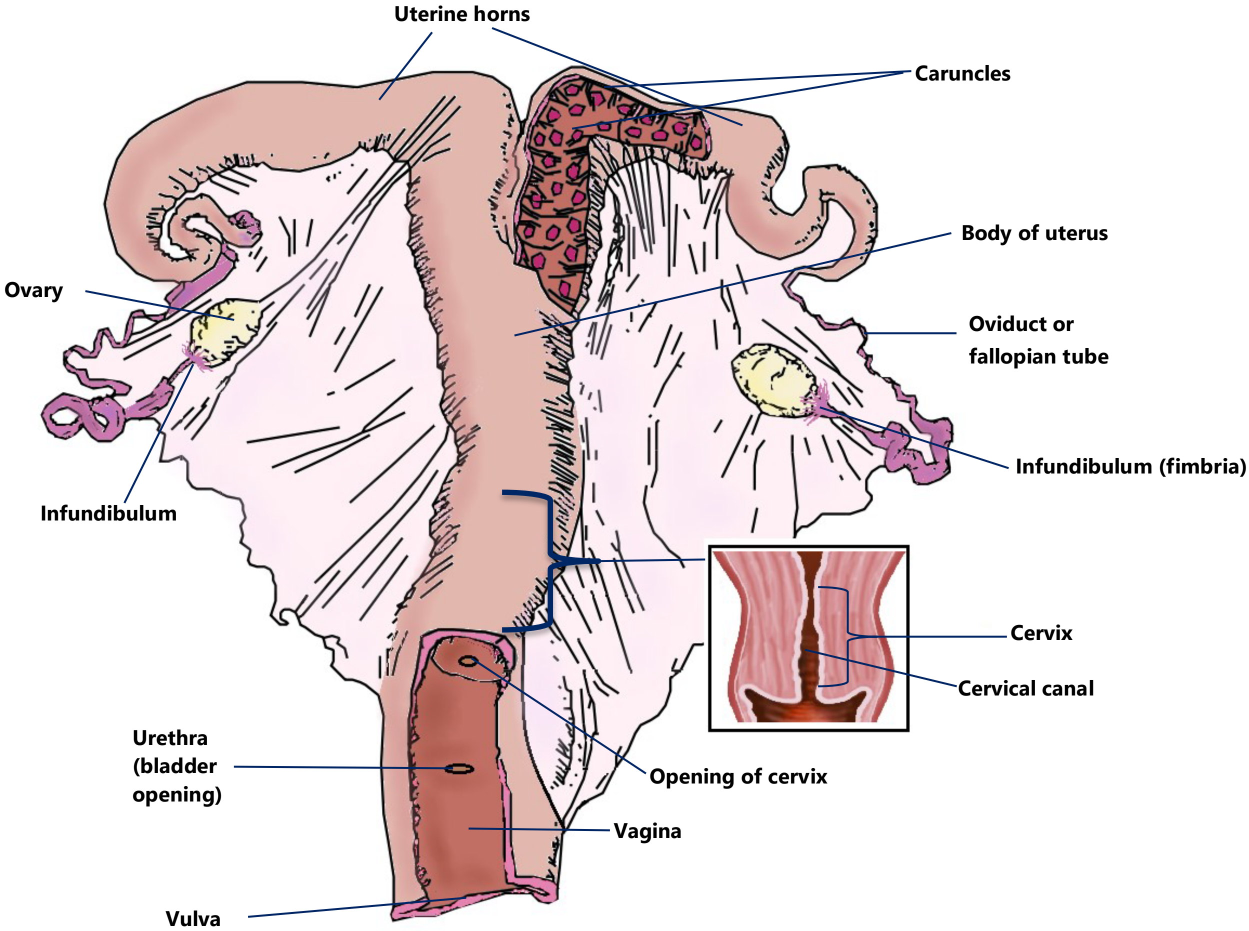
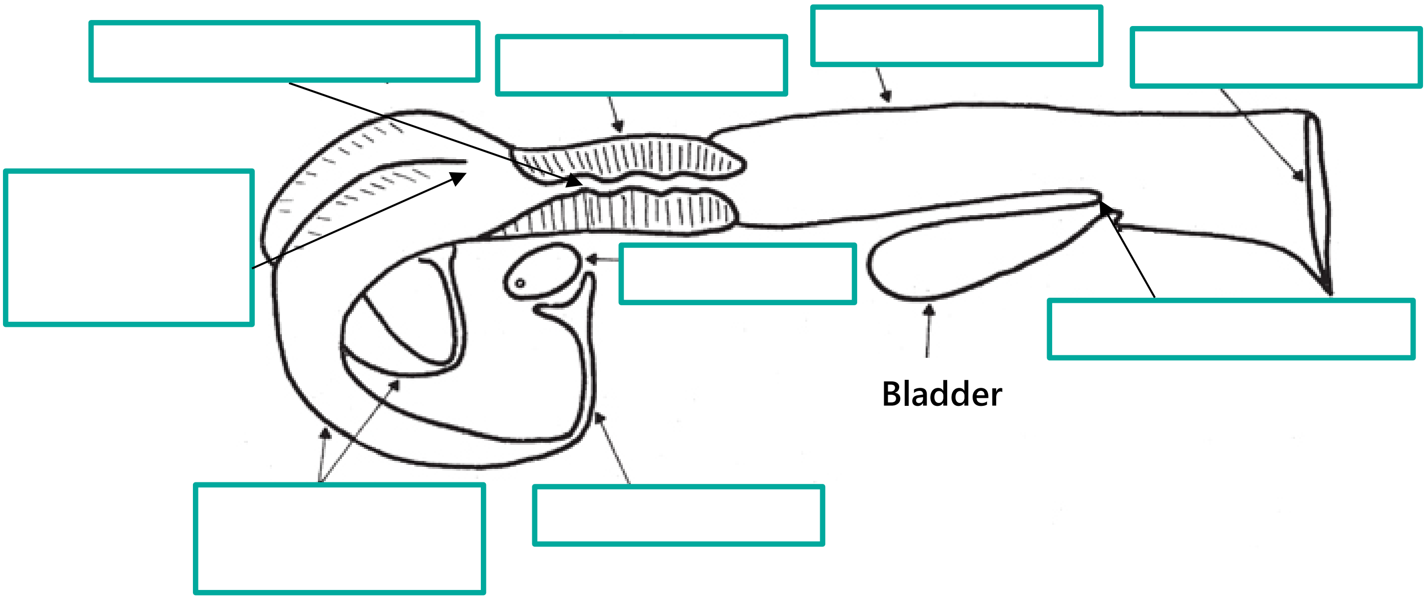


Figure 8 Anterior view of cow's reproductive tract (adapted from Department of Education and Training 'Reproduction, growth and development, 2006)

18. **Use Figure 8 to label the missing parts of the lateral view of a cows' reproductive tract.**



Reproductive physiology in females

- The external part of the female genitalia is called the vulva. The vulva seals the opening of the reproductive system to protect against contamination whilst providing the passage of urine.
- The vulva leads to the vagina, which is a smooth, tubular structure. In cattle, the bladder lies below the reproductive tract and is connected at the urethral opening located on the vaginal floor.
- The vagina, about six inches in length, extends from the urethral opening to the cervix. The vagina also serves as part of the birth canal at the time of calving. The opening into the cervix protrudes into the vagina.
- The cervix is a series of muscular ridges or folds forming a protective block between the uterus (place of development for the foetus) and the exterior. The cervix opens into the uterine body.
- About an inch long, the body of the uterus serves as a connection between the two uterine horns and the cervix. The uterine body is the site where semen is deposited during artificial insemination in cattle.
- The uterus is made up of the body of the uterus and uterine horns. The main function of the uterus is to provide a suitable environment for foetal development. The inner walls of the uterus have extensions called caruncles, which attach to cotyledons. These are the points of attachment of the placenta to the uterine wall.
- From the uterine body, the rest of the organs are in pairs. The uterine body separates into two uterine horns. When a cow is bred (naturally or via artificial insemination), the uterine muscles under the influence of the hormone oestrogen, rhythmically contract to aid in sperm transport to the oviducts.
- Oviducts carry ova (ovum=singular, ova=plural). The upper part of the oviducts (close to the infundibulum) is the site of fertilisation.
- The funnel-like structure on the open end of the oviduct, called the infundibulum, surround the ovaries, and catch ova, keeping them from falling into the body cavity.
- The ovaries are the primary organs in a cow's reproductive tract. They have two functions: to produce ova (eggs) and to produce hormones, namely oestrogen and progesterone, throughout the different stages of the oestrus cycle.
- The surface of the ovary contains two different types of structures: follicles and the corpus luteum (CL).
    - Follicles are fluid-filled, blister-like structures that contain developing ova. Numerous follicles are present on each ovary that vary in size from <1mm- 20mm in diameter. The largest follicle present on one of the ovaries is termed the 'dominant', 'primary' or Graafian follicle. At ovulation, the Graafian follicle ruptures, releasing the ovum.
    - The CL is the site where ovulation occurred during the previous cycle. Only one CL will be present on one of the two ovaries, unless there were multiple ovulations, such as twins or from multiple ovulation in an embryo transfer program. The plural of corpus luteum is corpus lutea.

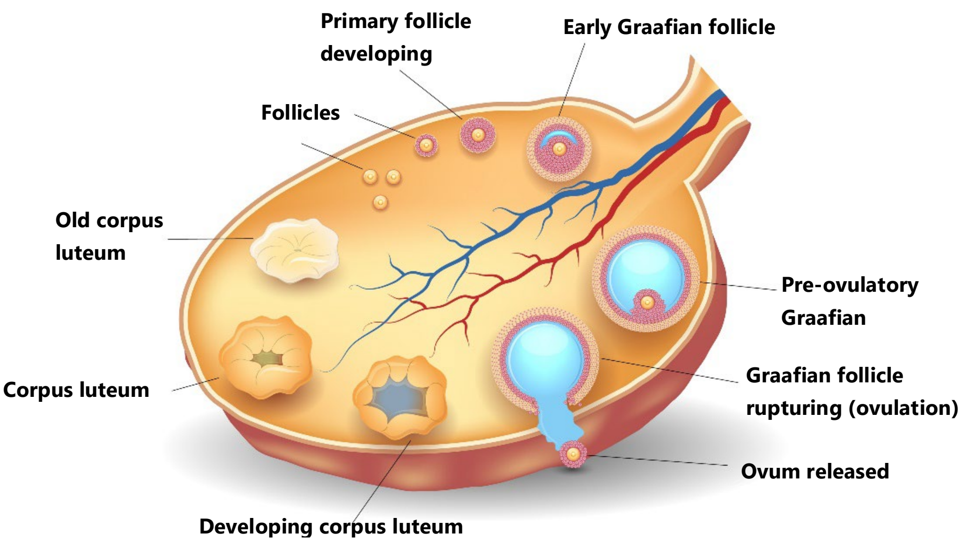
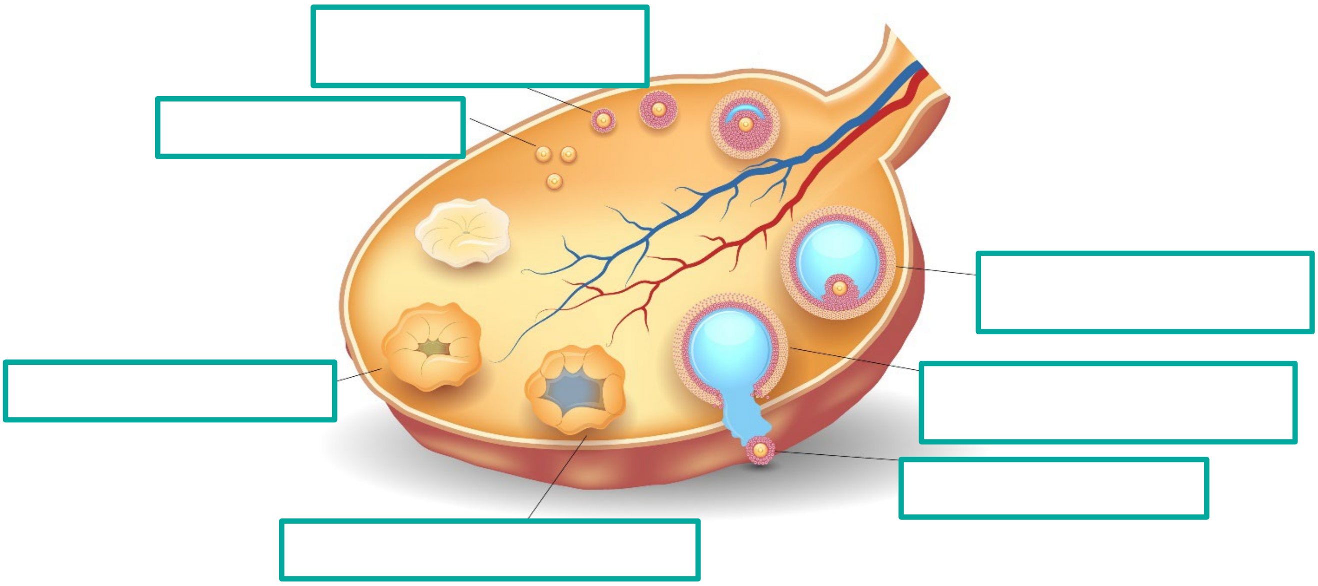


Figure 9 Follicle development in the ovary

19. Use figure 9 to label the steps in follicle development in the ovary.



20. Complete the table by matching the organ to the function

Organ	Function
	Carry ova. The upper part of this is the site of fertilisation.
	Made up of two parts. Provides a suitable environment for foetal development.
	Primary organs in a cow's reproductive tract. They have two functions: to produce ova (eggs) and to produce hormones.
	Connect the body of the uterus to the oviducts.
	The external opening of the reproductive system. Protects against contamination and provides the passage of urine.
	Funnel-like structure which surrounds the ovary and catches ova.
	About six inches in length, extends from the urethral opening to the cervix. During natural mating, semen is deposited here. Also serves as part of the birth canal at the time of calving.
	The site where semen is deposited during artificial insemination in cattle.
	Made up of a series of muscular ridges or folds forming a protective block between the uterus (and the developing foetus) and the exterior.

21. Distinguish between the corpus luteum and Graafian follicle.

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22. When would you find multiple corpus lutea on ovaries?

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Hormones and the cow's oestrous cycle

The cow and heifer's reproductive cycle consists of a series of events that occur in a definite order over a period of days in response to changing hormone levels. These changes naturally repeat every 21 days. This repetitive cycle is called the oestrous cycle. Heifers start ovulating and following the oestrous cycle at puberty which is when they become sexually mature. Time of puberty is influenced by genetics, nutrition and other environmental influences. Puberty is generally reached when the heifer is between 40-50% of her mature body weight.

Throughout the oestrous cycle, the reproductive tract prepares for oestrus (heat) and ovulation.

- Day 0: One ovary has a dominant follicle (Graafian follicle) with a mature ovum ready to be released. The cells lining the follicle produce the hormone oestrogen which is transported to all parts of the body via the bloodstream. Oestrogen controls:
    - The cow coming into oestrus (standing heat).
    - Increased blood flow to the genital organs (a sign of oestrous).
    - The cervix being sensitive to insemination and secreting mucous lubrication (a sign of oestrous).
    - The muscles in the uterus to contract to aid in the transport of sperm cells to the oviducts.
    - Behaviour of the female when she is coming into oestrous such as bellowing, pacing, standing to be mounted and mounting others (signs of oestrous).

  As oestrogen reaches a certain level, a surge of Luteinising hormone (LH) is released by the pituitary gland. Near the end of standing heat, the mature Graafian follicle ovulates (ruptures) in response to the LH surge.

- Days 1—2: After ovulation, new types of cells called luteal cells grow in the ruptured Graafian follicle. This change in cells is caused by hormonal action, primarily the action of LH.
- Days 2—5: The corpus luteum grows rapidly in both size and function. At this stage, numerous follicles may be seen on the ovary, by day 5 they have begun to degenerate.
- Days 5—16: The corpus luteum continues to develop and typically reaches its maximum growth and function by day 15 or 16. It secretes the hormone progesterone, which inhibits (blocks) LH produced in the pituitary gland. During this period, the ovaries are relatively inactive except for the functional corpus luteum. No follicles reach maturity or ovulate because of high concentrations of progesterone.

  The pituitary gland is found in the brain. It releases two important hormones (gonadotrophins) which control parts of the oestrous cycle:

    - Follicle stimulating hormone (FSH): stimulates the growth of follicles in the ovary and stimulates luteal cells to grow to produce the corpus luteum.
    - Luteinising hormone (LH): stimulates oestrogen production in the Graafian follicle causing it to rupture.

  Progesterone:
    - Prepares the uterus for pregnancy
    - Prevents the animal from returning to oestrous by regulating the release of hormones from the pituitary gland.
    - Regulates FSH and LH throughout pregnancy, stopping the animal coming back into oestrous.

- Days 16—18: Determination of pregnancy or preparation for next oestrous. The uterus 'searches' for the presence of the attached and growing embryo. If the embryo is detected, the CL is retained and continues to produce progesterone which maintains the pregnancy.
  If fertilisation was unsuccessful, or the animal was not bred, the uterus begins to produce a hormone called prostaglandin. Prostaglandin begins to destroy the CL which stops the production of progesterone.
- Days 18—19: As the CL is destroyed, no more progesterone is produced, removing the blocking action of progesterone on LH and FSH. Of the several follicles that are present, one becomes dominant.
- Days 19—20: Increased oestrogen released by the Graafian follicle and a decrease in progesterone by the regressing corpus luteum, bring the animal back into oestrous (cycle has now returned to day 0). The high oestrogen concentration in the blood triggers a release of LH. Following this surge in LH blood concentrations, the mature follicle ruptures to release the ovum, and the cellular tissue left behind becomes luteinized and forms a new CL (cycle has now returned to days 1—2). Progesterone again becomes the dominant hormone.

Figure 10 shows the hormone interactions throughout the cow's oestrous cycle.

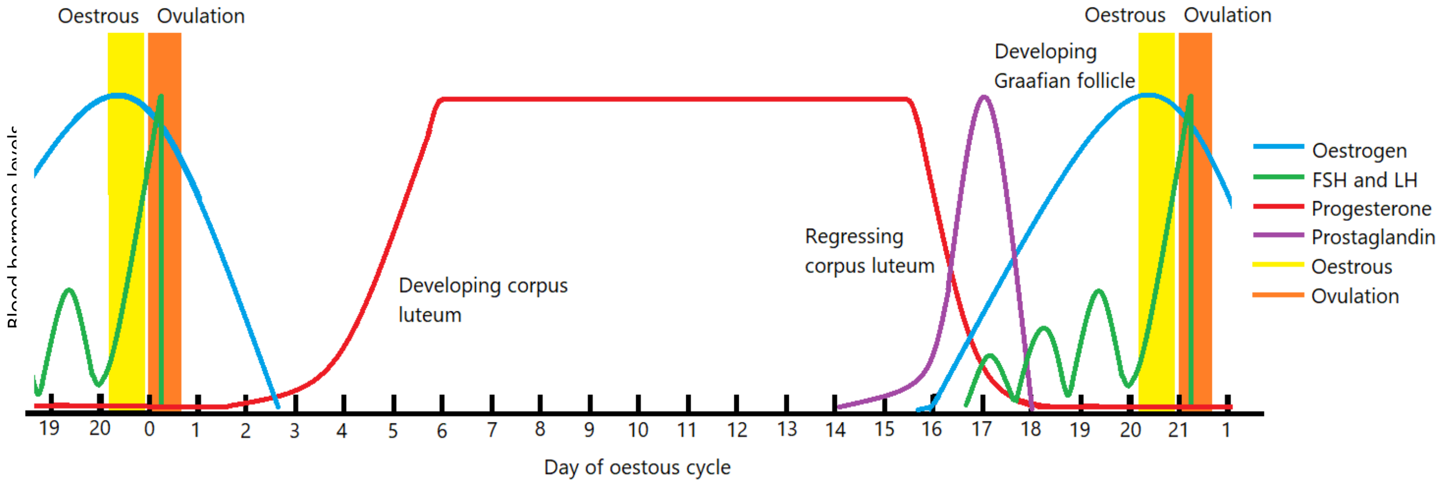


Figure 10 Schematic summarising hormone interactions throughout the cow's oestrous cycle

23. Complete the table describing the hormones controlling the oestrous cycle.

Hormone	Where is it produced?	What does it control?
Oestrogen		
Progesterone		
Luteinising hormone (LH)		
Follicle stimulating hormone (FSH)		
Prostaglandin		

Reproductive anatomy in males

Understanding the anatomy and physiology of the bull's reproductive system is fundamental to cattle management. Basic knowledge in this area helps producers understanding of breeding and bull break down.

The bull's reproductive tract consists of:

- Two testicles
- Epididymis
- Vas deferens
- Penis
- Seminal vesicles (accessory gland)
- Prostate (accessory gland)
- Cowper's gland (accessory gland)

Figure 11 shows a lateral view of a bulls' reproductive tract.

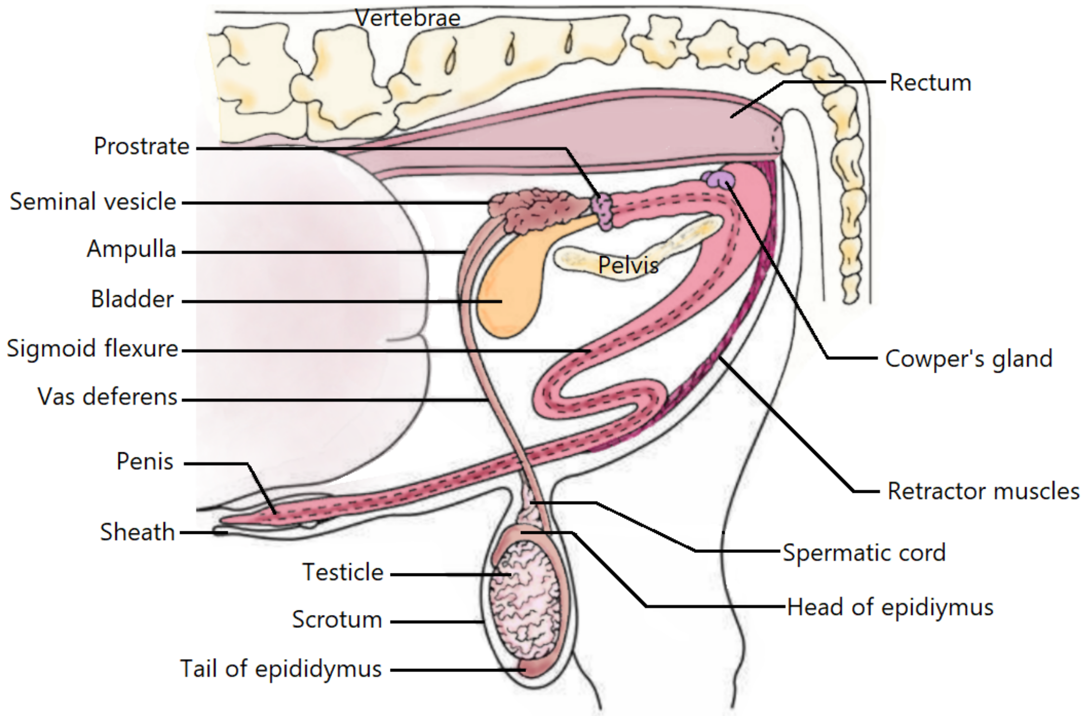
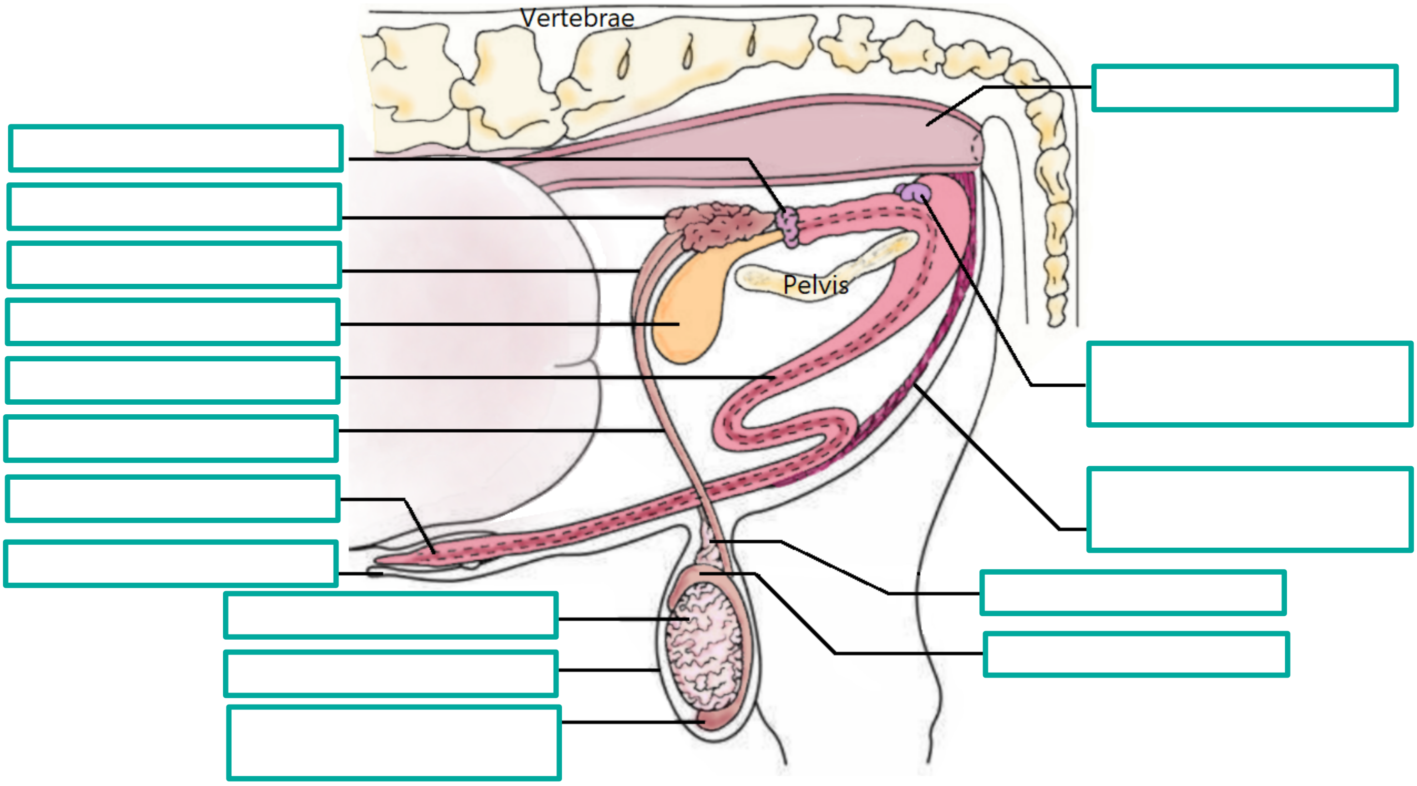


Figure 11 Reproductive tract of the bull

24. **Use Figure 11 to label the missing parts of the lateral view of a bulls' reproductive tract.**



Reproductive physiology in bulls

- The scrotum is a supportive and protective pouch of skin located outside the body cavity between the hind legs of the bull. The testicles are encased in the scrotum. This is essential for normal sperm formation since it can only happen at a temperature range several degrees below normal body temperature (37 °C). Cold or hot temperatures damage sperm production and reduce bull fertility. Heat stress is the most damaging to sperm production. As a result, a temperature sensitive layer of muscle located in the walls of the scrotum relaxes when hot, and contracts when cold. Relaxation causes the scrotum to lengthen thus moving the testicles away from body heat. In cold weather, the reverse happens, the scrotum shortens, and the testicles are tucked toward the body. Occasionally testicles fail to descend from the body cavity, such males are referred to as cryptorchids and have reduced fertility.
- The testicles are the primary reproductive organs. They have two vital functions:
    - To produce spermatozoa (sperm)
    - To produce the hormone testosterone
- The testicle contains many long tiny, coiled tubules, the seminiferous tubules, in which the sperm are formed and mature. The hormone testosterone is produced in specialised cells called the cells of Leydig. These are found scatted around the seminiferous tubules.
- There are many hundreds of individual seminiferous tubules in the testicle, which join up into larger tubules that pass out of the testicle into the head of the epididymis.
- The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle. The different parts of the epididymis are the head, the body and the tail. The epididymis has four major functions:
    - To transport developing sperm cells from the testicle to the vas deferens
    - To concentrate sperm by absorbing surplus fluids
    - They allow developing sperm to mature
    - They store mature and viable sperm cells in the epididymis tail. Millions of sperm can be stored in the tail of the epididymis prior to ejaculation. If sexual activity is slowed, the tail of the epididymis reabsorbs sperm cells.

  It takes 45 to 50 days for sperm to be formed in the seminiferous tubules in the testis and move through the epididymis where they mature for ejaculation. Heat stress can reduce fertility by killing sperm. This causes a delay between the heat event and time of reduced fertility in semen.
- The spermatic cord supplies, supporting muscles, connective tissue, blood and nerves to the testicle. Males may be castrated with a surgical vasectomy. This is where the vas deferens are cut, preventing the passage of sperm. If only the vas deferens are cut, the testicle continues to function normally producing both sperm and testosterone. However, if the blood vessels of the spermatic cord are cut, shutting off the blood supply, the testicle will stop functioning and degenerate.
- The two Vas deferens widen into the two ampulla tubes near the seminal vesicles. These combine into a single tube (the urethra), the channel passing through the penis. The urethra serves as the common passageway for urine and semen. The ampulla collects fluid from the seminal vesicles and empties it into the urethra to mix with sperm.
- The seminal vesicles (accessory glands) consist of two lobes found at the top part of the vas deferens. They provide the ejaculate liquid portion which combines with sperm to make semen. The liquid contains nutrients which activate the sperm, making them become motile (moving).
- The prostate gland (accessory gland) is located on the neck of the bladder, where it empties into the urethra. The prostate gland has the same function as the seminal vesicles, secreting fluid to produce semen at ejaculation. However, it’s small size results with small volumes of fluid secretion.

- The Cowper's glands (accessory glands) are located on either side of the urethra. These glands produce pre-ejaculate fluid which provides lubrication when the bull mates. The fluid also neutralises the acidity of the urethra in preparation for the passage of sperm cells.
- The penis has an anatomical structure called the sigmoid flexure (an S-shaped structure). Strong retractor muscles hold the penis in the S shape, holding it inside the sheath except during mating. If the bull's penis protrudes all the time, this can be a result of weak retractor muscles and can make the bull more susceptible to penis injuries.
- The penis is the organ of insemination. Cells in the penis fill with blood during arousal, which results with an erect organ. The end of the penis is called the glans penis. It is supplied richly with nerves which are stimulated during mating to induce ejaculation of semen.

25. Complete the table by matching the organ to the function

Organ	Function
	Has four major functions: • Transport developing sperm cells from the testicle to the vas deferens • Concentrate sperm by absorbing surplus fluids • Allow for the maturation of the developing sperm • Stores mature and of viable sperm cells
	Widenings at the end of the vas deferens. They collect fluid from the seminal vesicles and empty it into the urethra to mix with sperm.
	Tubules in the testicles, which join up into larger tubules that pass out of the testicle into the head of the epididymis.
	Organ of insemination
	Accessory gland, which is located on the neck of the bladder, where it empties into the urethra. The liquid contains nutrients which activate the sperm, making them become motile (moving).
	Produce spermatozoa (sperm) and contains the cells of Leydig which produce testosterone
	Two cords which connect the epididymis to the urethra
	Accessory glands which are located on either side of the urethra. These glands produce pre-ejaculate fluid which provides lubrication when the bull mates. The fluid also neutralises the acidity of the urethra in preparation for the passage of sperm cells.
	Muscles which hold the S-shaped structure in the penis in place prior to mating
	Supplies blood and nerves to the testicle, supporting muscles and connective tissue.

	Accessory glands consisting of two lobes found at the top part of the vas deferens. They provide the ejaculate liquid portion which combines with sperm to make semen. The liquid contains nutrients which activate the sperm, making them become motile (moving).
	A supportive and protective pouch of skin located outside the body cavity between the hind legs of the bull.
	S-shaped structure in the penis

26. **What is a cryptorchid?**

27. **Describe the process of castration which makes an animal sterile.**

28. **Explain why a bull might have reduced fertility approximately 45 days after a summer heat wave event.**

Hormones and the bull

Bulls can continuously mate, unlike cows that are receptive when in oestrous. Even though bulls don't go through a specific breeding cycle, hormones still have a vital role in reproduction.

The normal functions of male reproduction are largely controlled by the hormone testosterone. Testosterone has several major functions:

- It is essential for normal sperm formation.
- It is a major factor in the normal sex drive (libido) and behaviour of the male
- It is largely responsible for the development and maintenance of the male reproductive tract
- It causes the development and maintenance of the secondary sex characteristics associated with masculinity, such as the crest and muscular shoulders of a bull
- It increases muscular and skeletal growth

The testicles are influenced by the same gonadotropic hormones that regulate ovarian functions in the cow Luteinising hormone (LH) and follicle stimulating hormone (FSH). In bulls they regulate testicular growth and function.

LH and FSH are released from the pituitary gland and control:

- FSH- stimulates the growth of the testis and spermatogenesis (sperm production).
- LH- stimulates sperm production and release. LH also stimulates the testis to produce testosterone.

29. Complete the table to describe what each hormone controls in bull's reproduction and identify where it is produced.

Hormone	Where is it produced?	What does it control?
Testosterone		
FSH		
LH		

Lactation anatomy and physiology

An important part of species survival and health, the mammary gland is a modified skin gland that produces nutrient-rich milk for growth and development of offspring. In dairy cows the milk is also sold for human consumption and used to make value-added dairy products.

Mammary system anatomy

The cow has four mammary glands (quarters) grouped into a structure called an udder. The general anatomy within the mammary gland is:

- Teat canal
- Teat
- Gland cistern
- Ducts
- Lobes
- Alveoli (alveolus= single, alveoli= plural)

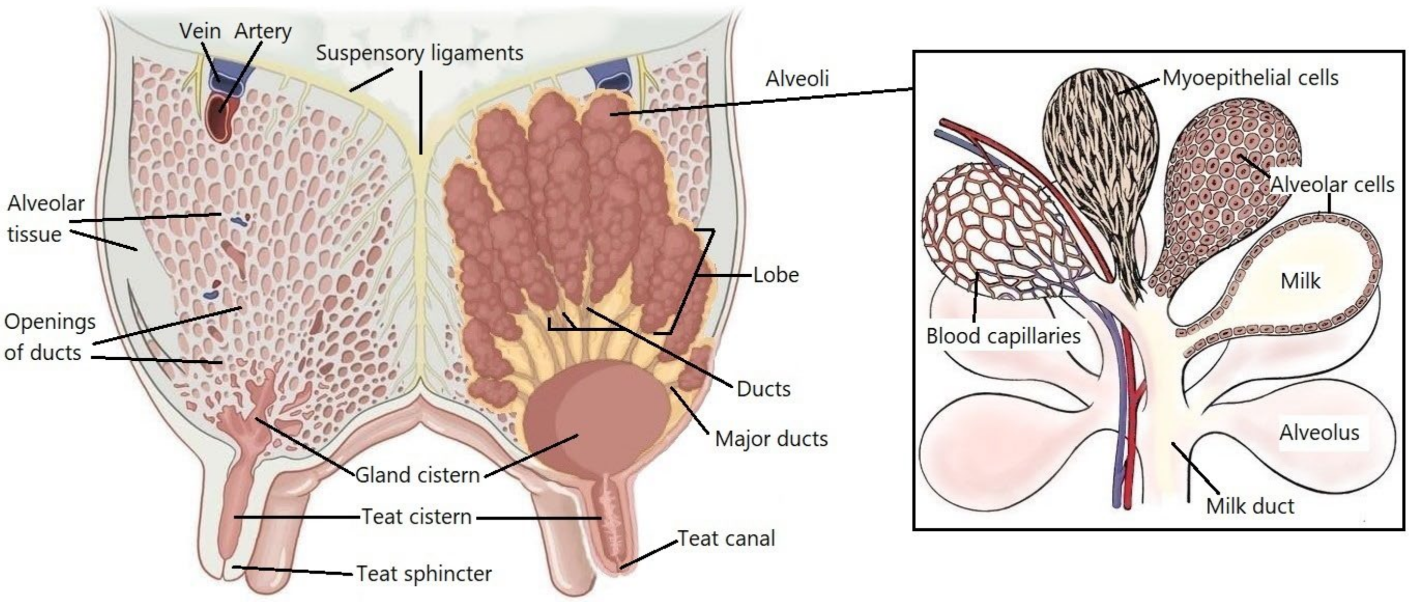
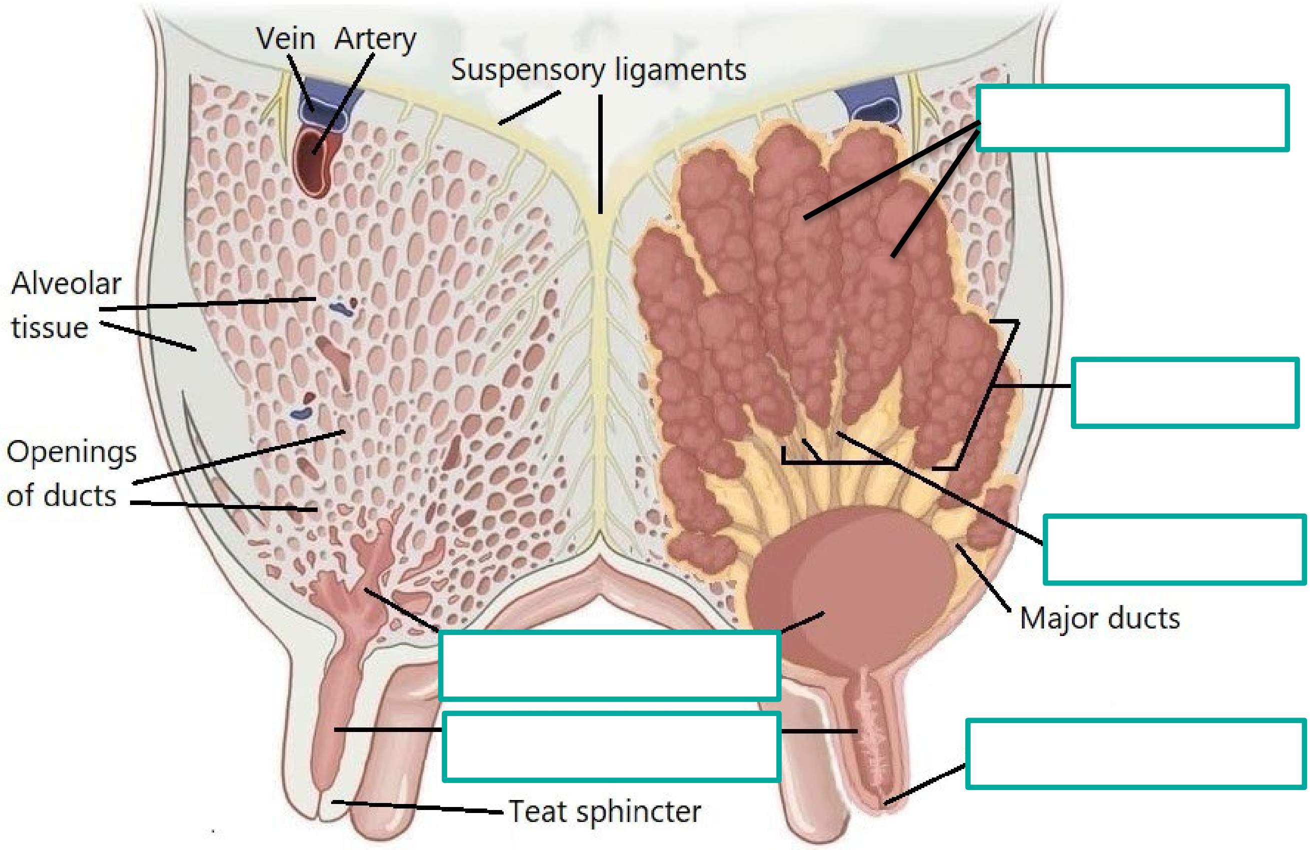


Figure 12 Schematic of cow's mammary system

30. Use Figure 12 to label the missing parts of the cow's mammary system.



31. Use the internet to find definitions for the following dairy terms

A. Lactation period

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B. Colostrum

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C. Parturition

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Mammary system physiology

- The teat canal acts as an exit point for milk but can also be an entry point for bacteria which can cause mastitis.
- The teat cistern holds milk before it leaves the teat.
- The teat sphincter is located at the bottom of the teat cistern just above the teat (streak) canal. The teat sphincter is a muscle that constricts to prevent milk from leaking out when the udder is full. Milk is released upon suckling or from machine milking.
- The gland cistern holds milk until it exits through the teat canal.
- The ducts are the tubes which milk travels though. The secondary or interlobular (between lobules) ducts lead milk from the alveoli (milk-creating cells) of the lobules to the major ducts, then gland cistern.
- The lobe is the milk-producing area of the gland. The lobe has many alveoli that are in groups called lobules.
- The alveolar cells have a single layer of cells called epithelial cells. These cells create milk in the alveolar cell. Each alveolar cell also has a layer of cells on the outside that contract to squeeze milk out into the duct. These are called myoepithelial cells.
- The alveoli are also are surrounded by capillaries that transport nutrients and blood to the cells to create milk. Mammary gland blood flow rate is highly correlated to milk production. To produce 1 litre of milk, approximately 500 litres of blood must pass through the capillary system in the udder. This means that when a cow is producing 60 litres of milk per day, 30,000 litres of blood are circulating through the mammary gland (Gorewitt, R.C., 1988)

32. Complete the table by matching the organ to the function

Organ	Function
	The milk-producing area of the gland. The lobe has many alveoli that are in groups called lobules.
	A layer of cells on the outside of alveolar cells that contract to squeeze milk out into the duct.
	Storage area which holds milk before it leaves the teat.
	Acts as an exit point for milk but can also be an entry point for bacteria which can cause mastitis.
	Located at the bottom of the teat cistern just above the teat (streak) canal. This muscle constricts to prevent milk from leaking out when the udder is full. Milk is released upon suckling or machine milking.
	Transport nutrients and blood to the alveoli cells to create milk.
	Tubes through which milk travels. Connect lobes to the gland cistern.
	Large storage area which holds milk until it exits through the teat canal.

Udder development and lactation

The foundations of udder development are completed within the first 15 months of life.

The development of the mammary gland starts early in foetal life. When the calf foetus is six months, the udder is almost fully developed with four separate glands and a median ligament, teat and gland cisterns. Little further development takes place before birth

A small amount of growth in secretory tissue occurs from birth to puberty, most of it is the deposition of fat tissue. It is important to manage young heifer's nutrition so that they are not over-conditioned which leads to fat deposits in the udder. Udder fat takes up space for milk duct and the milk secreting tissue development, which decreases lifetime milk production. The effect is irreversible.

Major milk duct and milk secreting tissue development takes place between puberty and parturition and is influenced by hormones from the oestrous cycle. With each recurring oestrous cycle after puberty, mammary gland development takes place. Oestrogen produced during each oestrous cycle is responsible for ductal growth and progesterone for development of the secretory tissue. When pregnancy occurs, a marked increase in mammary gland growth takes place. A slight amount of growth may occur until the peak of lactation. The udder continues to increase in cell size and cell numbers throughout the first five lactations, and the milk producing capacity increases correspondingly.

The composition of milk varies throughout the lactation cycle. Colostrum or first milk accumulates in the epithelial cells before parturition. It is concentrated with antibodies which passively immunise the young. After the colostrum is secreted the variations in milk composition and yield throughout the remaining lactation cycle generally increase to a peak early in the lactation (around days 40-80), then all gradually decline. Figure 13 shows the average milk composition and yield over time from a study of Holstein cows. Individual milk volume and composition varies between breeds and individuals and is influenced by nutrition; however, the trends in Figure 13 apply to all cattle.

Producing milk has large energy requirements, so cows' nutritional requirements must be closely managed to meet the production energy requirements specific to the stage of lactation.

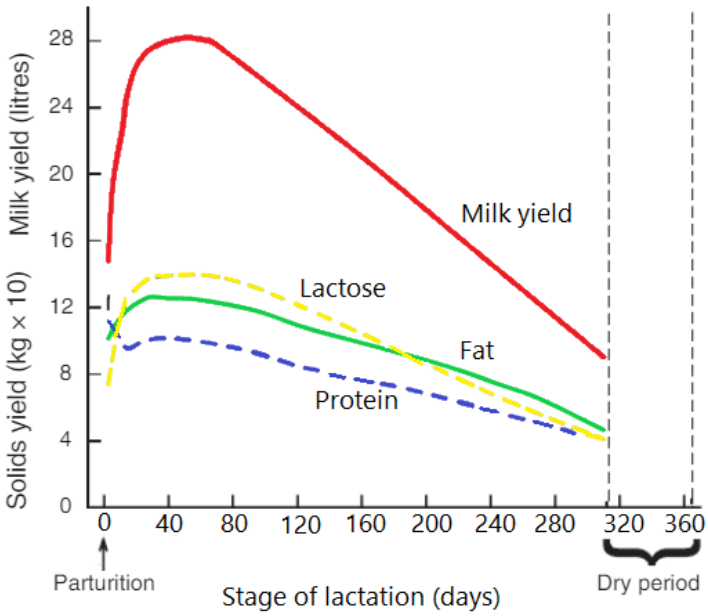

Figure 13 Average milk composition and yield throughout lactation in Holstein cows. Source: adapted from 'Effects of nutrition and management on the production and composition of milk fat and protein: A review' Walker, G., Dunshea, F. and Doyle, 2004.

33. Identify the hormone and cycle which influence milk duct and milk secreting tissue development after puberty.

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34. Why is it important to manage heifers to prevent them getting over-conditioned?

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35. Describe the trend of milk composition and yield throughout lactation in Figure 13.

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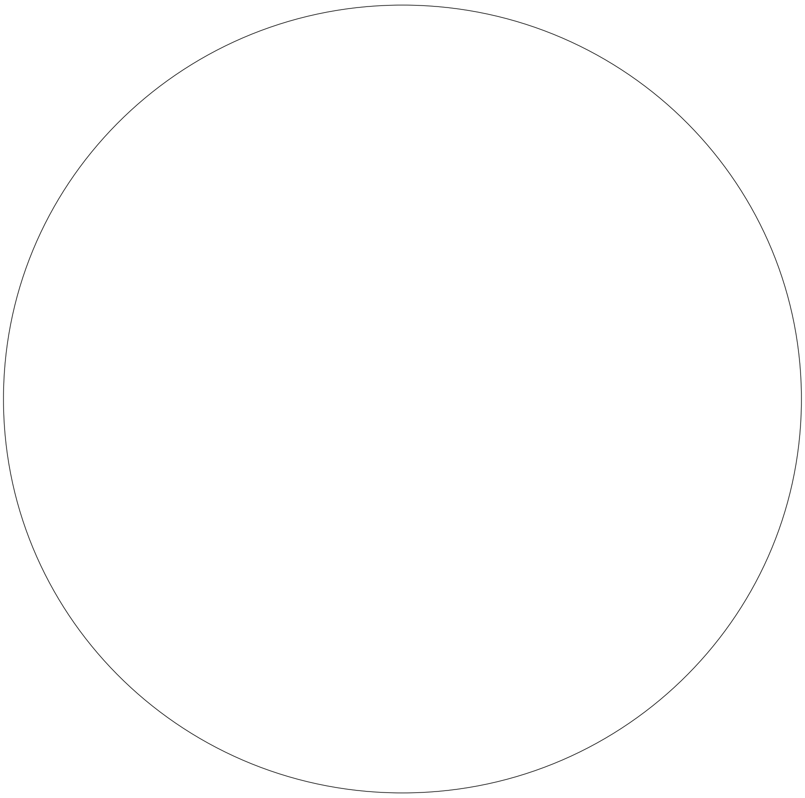
36. Use the NSW DPI 'Dairy production' poster to create a pie graph showing average components of milk.



Dairy Australia Interactivities- The business of dairy farming

Go to Dairy Australia's webpage to complete a range of interactive learning modules that summarise and extend learning from this resource.

Use the QR link below or go to: The Business of Dairy Farming

Stage 5

The learning modules are designed for Stage 5 Agricultural Technology students and allow for exploration of milk quality in a real working dairy farm business. Students then provide recommendations on how milk quality can be improved to increase revenue. The activities are divided into three interactive modules.

- Module 1: Overview of the Australian Dairy Industry. Students discover where Australian dairy farms are and explore the importance of milk quantity and quality for farmer income, and the main components of milk.
- Module 2: Breed, Milk Quantity and Milk Quality. Here, students explore the differences in milk quantity and quality between dairy breeds. Then complete a group activity where students become consultants and provide advice to a dairy farmer on breeds.
- Module 3: Advising the Farmer. Students meet Farmer Pat and his cows virtually through interactive videos, and learn about herd recording, and then help Farmer Pat select cows to keep in his herd.

Current and emerging technologies

Current and emerging technologies in the dairy industry include:

- **Animal technologies** e.g. Artificial Insemination, Embryo Transfer, herd testing, electronic cow identification, automated gates, heat detection and tracking devices, pregnancy diagnosis and walkover weigh systems.
- **Dairy shed technologies** e.g. robotic milking, automated cup removers and automated mastitis detection.
- **Pasture and feeding technologies** e.g. drones, automated feeding systems, soil moisture probes and variable rate irrigation.
- **Management technologies** e.g. integrated electronic real-time marketing, finance, infrastructure, pasture and herd management software and applications.

37. Select a dairy industry-specific technology from the list above. Use the internet to compile a 1- 2 page report on your selected technology.
Your report should include:
- **Name of the technology**
- **Images of the technology**
- **Thorough description of how the technology works**
- **Description of how the technology is used to improve production efficiency**
- **A table contrasting the advantages and disadvantages associated with using the technology**

Dairy careers

When you think about careers in Agriculture – the first job you probably think of is a farmer, right? Think again.

There are hundreds of jobs which – quite literally – could change the world in which we live.

From scientific breakthroughs to designing autonomous robots, campaigning for change within the walls of Westminster to environmental engineering, careers in Agriculture are at the forefront of innovation.

Of course, farming remains at the heart of the industry, but the job of a farmer is massively different today from the stereotypical image of an old man wearing dungarees, chewing straw.

Agriculture is in a time of exciting change. It is now one of the most fast-paced and dynamic industries to work in, giving young people plenty of options to pick from.

Tech development is enabling agriculture to lead the way in tackling many global challenges – such as feeding a growing world population, battling climate change and protecting the environment.

A career in Agriculture also offers great quality of life, the chance to help others, to make a difference, and it can pay generously.

There really is more to Agriculture than you think.

Think Careers? Think Agriculture.

Source: [This is agriculture]

Follow this link to find out more about careers in agriculture at "[This is agriculture – How agriculture is changing the world]"

The Australian dairy industry has changed significantly from the pastoral days of old. It is characterised as a highly efficient industry, full of advanced technologies and innovation, which produces high quality products while adhering to high animal welfare standards. The dairy industry offers some fantastic career paths. The diverse career pathways the industry offers surround 'Milk production' or 'Milk harvesting'.

The Australian dairy industry directly employs 43,000 Australians on farms and in factories, while more than 100,000 Australians are indirectly employed in related service industries (Rural skills Australia, 2019).

The following is a list of NSW Department of Primary Industries roles associated with the dairy industry to get you thinking.

- Dairy development officer
- Intensive livestock industries manager
- Research scientists
- Dairy technical specialists
- Robotic milking project officer
- Research officer
- Pasture production specialists
- Irrigation specialist
- Soil technician
- Nutrition research officer
- Ruminant efficiency research officer
- Geneticist
- Veterinarian
- Contracts manager
- Legal officer

- Biometrician
- Mechanical/trade engineer
- Biosecurity officer
- Farm manager
- Farm assistant
- International engagement officer
- Communications officer
- Stakeholder engagement
- IT technician
- Drone technician
- System developer
- Economist
- Business analyst
- Administration support officer

38. Use the internet and other sources to investigate a dairy industry-related career of your choosing. For this career find out the following:

- **Title of the career/job**
- **Role description**
- **Personal qualities**
- **Skills required (if formal courses or education is required, find out where you could train and the timeframe to complete the course)**
- **Salary or wage range**
- **Identify opportunities for job progression in the role**

Useful sites to help you with your research include:

- People in dairy, Dairy Australia
- Dairy Australia- Our people
- Career Harvest
- Stepping stone – Tasmania – The people in dairy
- Career pathways in dairy production, rural skills Australia
- Career pathways in dairy farming, rural skills Australia
- This is agriculture
- Agri labour Australia- Australian dairy jobs
- My Future
- Dairy NZ – Employee career pathways

Agricultural Technology Years 7-10 Syllabus, 2019

Outcomes	Content
AG5-1 explains why identified plant species and animal breeds have been used in agricultural enterprises and developed for the Australian environment and/or markets **AG5-3 explains the interactions within and between the agricultural sector and Australia's economy, culture and society** **AG5-4 investigates and implements responsible production systems for plant and animal enterprises** **AG5-5 investigates and applies responsible marketing principles and processes** **AG5-7 explains and evaluates the impact of management decisions on animal production enterprises**	**Core A: Introduction to Agriculture** • identify the characteristics of animal breeds and plant types specific to chosen enterprises, for example: – identify pasture types – associate plant growth patterns with local climate patterns • explain the significance of agricultural industries and products, and their intended markets, for example: (ACTDEK044) – create a market chain for a range of agricultural products – use the Australian Bureau of Statistics website to find data about agricultural industries • research a range of current and future employment opportunities in agriculture, for example: – agricultural practices employing Aboriginal knowledge – development of automation, eg irrigation, milking – operating unmanned aerial vehicles (UAV) – precision farming and Global Positioning Syst **Core A: Animal Production 1** • describe an animal enterprise, for example: – fresh cow's milk for the domestic market – fine wool from Merino sheep – bulls for the beef seedstock market • research the markets available for chosen animal agricultural products, for example: – chilled export lamb market – domestic fresh milk market – free-range egg market **Core B: Agricultural systems and management** • identify animal breeds and plant types specifically developed for a particular climate or market, for example: (ACTDEK044) – selection of pasture for the cold temperatures of winter, eg grazing oats – Bos indicus cattle for tropical regions – fine wool Merinos for hot and dry regions • identify opportunities provided by the agricultural sector, both as an employer and as a user of products • investigate information from secondary sources on agricultural production and Australian export trends in agricultural products, for example: – Australian Bureau of Statistics data regarding lamb and beef production and exports • investigate the role of value-adding in marketing agricultural products, for example: – potatoes, eg chips, potato bake, potato flour – milk products, eg cheese, butter, ice cream – bouquets of cut flowers for special occasions, eg Mother's Day **Core B: Animal Production 2** • identify some of the programs, techniques and tools used in animal breeding and analyse their impact on production, for example: (ACTDEK046) – crossbreeding, inbreeding, outbreeding, linebreeding – artificial insemination – embryo transfer – the use of estimated breed values for a particular enterprise • investigate timing and impact of relevant operations in an animal production cycle, for example: – shearing – breeding – drenching – culling • identify emerging technologies that affect sustainability, for example: (ACTDEK041) – genetic engineering, eg sex selection of embryos – electronic pasture meters – electronic monitoring of sheep