Department of Primary Industries

Industry insights- Poultry

Supporting document

NSW DPI Schools Program

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DPI in SCHOOLS

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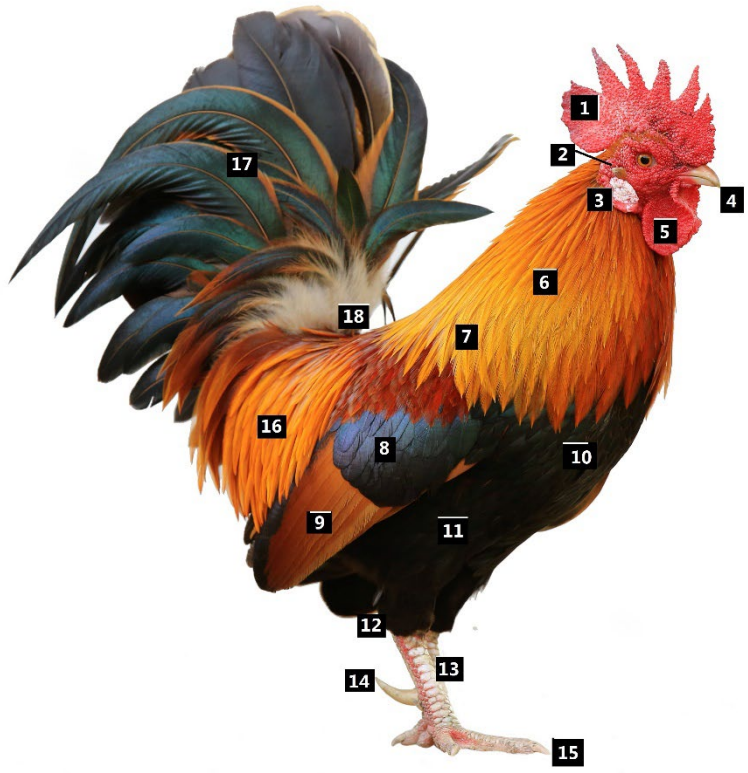
Industry insights - Poultry contents

Chicken anatomy

1. Label the parts of the chicken using the NSW DPI Schools Program 'Poultry' poster.



Chicken anatomy		
1	7	13
2	8	14
3	9	15
4	10	16
5	11	17
6	12	18

Poultry species and chicken breeds

Poultry are domesticated fowl (birds) farmed for meat, eggs and feathers. Niche products include hides and oil from ratites (emus and ostriches).

Poultry species reared for production are members of the orders Galliformes or domestic land fowl (species such as chickens and turkeys), and Anseriformes or domestic waterfowl (such as ducks and geese). Another order of poultry is Ratites (emu, ostrich and rhea).

The term poultry can be used to describe the different domesticated birds as well as the meat they produce.

1. Identify the poultry species in the following table. Where possible name the breed.

Poultry species			
			
			
			
			
			

Chicken is by far the most popular poultry species bred in Australia for both meat and egg production.

The first chickens (the species *Gallus gallus*- Red Jungle fowl) were lured or captured from the rain forests of India and Southern Asia over 3,000 years ago. Since that time, chickens have been domesticated and kept for meat and eggs by nearly every civilisation throughout the world. Over the years, these original chickens were selectively bred to produce the many breeds seen today.

Domesticated poultry were introduced into Australia on the First Fleet in 1788. Species included turkeys, geese, ducks and chickens. Since that time multiple poultry genetics and animals have been imported into Australia.

Historically chickens were kept in small 'backyard' flocks to sustainably provide eggs, with birds being used for meat if they were culls or had finished laying eggs. Urbanisation and population growth led to the development of commercial broiler (meat) and layer (egg) industries in the 1950s and 1960s.

Most Australian chickens are produced in large-scale commercial operations. Small scale chicken-keeping makes up a small amount of the national flock but is popular all over the nation. Small scale operators raise poultry for backyard production, niche markets or are chicken 'fanciers' raising birds for breeding and showing. Small scale growers tend to use purebreds, whereas commercial operators only use highly refined crossbreeds, developed specifically for either eggs or meat (not both).

Watch 'History through the eyes of a chicken- Chris A. Kniesly'- Ted-Ed, to learn more about domestication of poultry through the ages.

Find out more about species other than chicken raised for production by following these links:

- The Australian Poultry Industry, Poultry Hub
- Other poultry, Practical poultry raising

2. Are pure bred chickens used in commercial poultry production? Why or why not?

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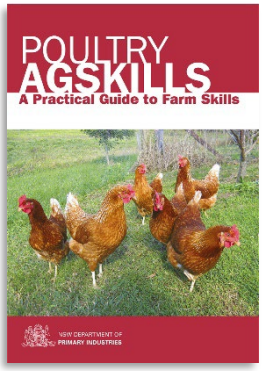
3. Label the chicken breeds using the NSW DPI Schools Program ‘Poultry’ poster.

Chicken breeds			
			
			
			
			
			
			
			
			

Practical activity- catch and handle chickens



Adapted from Poultry Agskills available in hardcopy or as an eBook. Find this activity, publication and more at the Tocal online bookshop.

Before carrying out this practical activity, make sure you read and follow the NSW Animals in Schools website.

Background: Performing regular health checks on poultry is essential for animal health and welfare, enterprise productivity and good management. Regular health checks have many benefits, including: making birds quiet through regular handling, preventing health and disease occurring rather than relying on treatment, creating accurate continuous records.

Aim: To catch and hold a bird

Materials:

- Housing or holding pen to assist catching
- Optional- catching equipment, shepherds crook for poultry.

Method:

1. Whenever handling livestock NEVER frighten them or cause stress unduly. Always move deliberately and slowly and handle animals with care and compassion. Keep voices calm with NO shouting. Never chase animals around causing undue stress. Regular handling with high levels of animal welfare will over time, result in quiet, happy, easy to handle animals.

Figure 1 Holding a hen in a comfortable position- two legs and wing secured.

2. Select the bird to catch- quiet birds are the easiest to catch.
3. First pen the bird in a confined space. Birds are more easily picked up when they are confined with multiple birds.
4. Approach the chosen bird quietly and make slow deliberate movements that block escape.
5. Gently grasp the wings to the body by moving your hands down over the top of the bird.
6. A shepherd's crook could be used to hook the animals' legs in places of step 5.
7. Gently grasp the legs in one hand while continuing to secure a wing to the body with the other hand.
8. Support the bird's body with the hand holding the legs. Hold the bird close to your abdomen to quickly settle it and make it feel calm and secure. See Figure
9. Once the bird has settled, inspect as required.

Figure 2 alternative method of picking up and carrying poultry.

*An alternative to catching, picking up and carrying the bird using step 7- is letting it hang upside down as seen in Figure 2. The bird is gently and securely held by its legs and can be turned right side up (Step 8) as soon as it has settled.

Poultry digestive anatomy

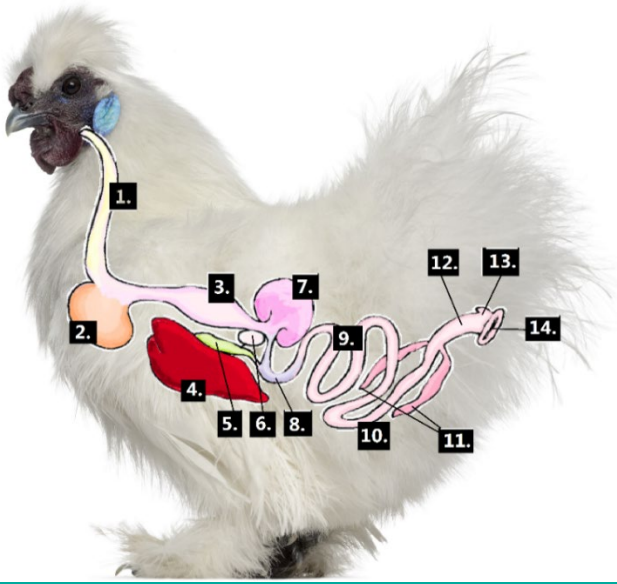
The digestive system in the domestic fowl is very simple, yet efficient compared to ruminant animals.

It includes the digestive tract and accessory organs which all work to carry out physical, chemical and some microbial digestion as well as absorption of nutrients from food. The digestive system has evolved to allow birds to efficiently digest grains and starchy diets.

Parts of the avian digestive system include:

- Beak (mouth)
- Oesophagus
- Crop
- Proventriculus
- Gizzard (ventriculus)
- Small intestine
- Duodenum
- Caeca
- Large intestine
- Cloaca
- Vent
- Accessory organs- salivary glands, liver, gall bladder and pancreas.

1. Label the hen's digestive tract using the NSW DPI Schools Program 'Poultry' poster.



1	8
2	9
3	10
4	11
5	12
6	13
7	14

Poultry digestive physiology

The digestive tract breaks down food the animal has eaten so it can be absorbed into the body. Large food molecules are broken down at different stages throughout the digestive system. Food is broken down into small, soluble molecules (nutrients) that pass through the wall of the intestine into the bloodstream and then travel to all cells around the body.

Chicken's digestive tract functions include:

- Beak: chickens have no teeth, lips or cheeks for physical breakdown of food. The beak or mouth has two major functions:
    - To pick up food particles
    - To direct the food into the oesophagus

  Salivary glands are connected in the mouth cavity and secrete saliva which aids lubrication and begins chemical breakdown of ingested food. Saliva contains the enzyme amylase which starts breaking down carbohydrates.
- Oesophagus: a muscular tube connecting the beak to the crop. The oesophagus secretes mucous which helps lubricate and aid the passage of food through the digestive system.
- Crop: the crop is a pear-shaped sac which stores food before further digestion begins. The crop continuously releases food particles, allowing for continuous digestion. Poultry have a high metabolic rate and high energy requirements, so require continuous digestion to meet those energy needs.
- Proventriculus (glandular stomach): this is a small, muscular tube. Glands connect to the proventriculus which secrete enzymes that chemically digest and break down food into available nutrients. Its main function is to carryout chemical digestion and transfer food from the crop to the gizzard.

  Chemicals secreted in the proventriculus include
    - Hydrochloric acid which lowers the pH of the food and digestive tract,
    - Pepsin that breaks down protein,
    - Hormone gastrin that stimulates the production and release of gastric juices.
- Gizzard (ventriculus): this is a flat, round, muscular organ which grinds food. Water is added to create a smooth paste. The gizzard mimics the physical breakdown of food

which is carried out by teeth in monogastric and ruminant animals. To increase the grinding process, birds consume grit and gravel which is stored in the gizzard. Shell grit can be supplemented in poultry diets to assist the grinding process. The grinding action reduces the size of food particles, which increases chemical digestion of food into available nutrients.

- Small intestine: is a thin but long tube connecting the gizzard to the caeca and large intestine. The pancreatic and bile ducts open into the small intestine at the end of the duodenum. These provide enzymes responsible for chemical digestion of fats, carbohydrates and protein. Most digestion and absorption of nutrients takes place in the small intestine.
- Duodenum (part of the small intestine): a long loop starting at the gizzard. The duodenum is closely surrounded by blood vessels and lymphatic tissue which help absorb nutrients and fluid.
- Caeca: these are two, large 'blind sacs' at the point where the small intestine joins the large intestine. Caeca are absorptive organs. They contain bacteria and microflora which have a limited capacity to break down some fibre from plants, through fermentation. The bacteria and microflora help maintain bird 'gut health'. Fibre breakdown in poultry is low compared to other monogastric animals.
- Large intestine: this is a short tube connecting the small intestine to the cloaca and vent. Its main function is to absorb water.
- Cloaca: this opening connects the urinary, digestive and reproductive tracts to the vent. The urine, faeces as well as eggs or sperm from the reproductive system all exit through the cloaca.
- Vent: is the exit point for the digestive system, urinary system and reproductive system. Waste and undigested food are mixed with urine in the cloaca and eliminated from the body as faeces through the vent.

  Watch 'Virtual chicken: Full digestive system'

1. Complete the table to summarise information about the chicken's digestive tract. The first example has been given.

Organ	Description	Function	Identify the digestion type where applicable (physical, chemical, or microbial)
Beak	• Mouth with no teeth. • Salivary glands connect to the mouth. • Connects to oesophagus	• Picks up food particles and directs the food into the oesophagus • Saliva added here which contains the enzyme amylase which breaks down carbohydrates	Chemical
Oesophagus			
Crop			
Proventriculus			

Gizzard			
Small intestine			
Duodenum			
Caeca			

Large intestine			
Cloaca			
Vent			

Poultry nutrition

Poultry require nutrients for growth, development and maintenance of the body. The six nutrient categories are:

- Water: is an essential nutrient needed for all chemical processes in the body. Fresh, clean water must always be available.
- Carbohydrates: contain high amounts of energy. Energy is needed for normal body maintenance and activity. Foods high in carbohydrates are cereals such as wheat, barley, maize, oats and sorghum.
- Proteins: needed for growth, replacement of old cells and production of eggs, muscle and feathers. High protein feed sources include meat meal, fishmeal, oilseeds (such as soybean meal and sunflower seed meal), peas and lupins.
- Fats: are an important energy source. They improve palatability of food, are high in energy and contain fat soluble vitamins. They are needed for body maintenance as they are the basic unit of many hormones produced by the bird. They are very high in energy; therefore, added fats are usually used only in high-energy broiler (meat chicken) feeds. Feed sources high in fats include oils such as canola oil, linseed oil, sunflower oil as well or grains such as maize, sunflower, linseed and soybean.
- Vitamins: are only needed in very small amounts but are essential to chemical processes taking place in the body. Examples are vitamin A (required for normal growth); vitamin D (needed to prevent rickets) and vitamin E. Vitamin E deficiencies result in muscle wasting and poor co-ordination. Vitamins are either fat soluble or water soluble. Vitamin A is found in carotene in green plants. Vitamin D is provided by sunlight and from plant material which has dried in the sun. Vitamin E is found in green plants and grain.
- Minerals: are only needed in small amounts for a wide range of body functions, growth and development. Examples are calcium and phosphorus, which are needed for eggshell formation; correct bone growth and structure; and a range of other bodily functions. Calcium can be provided as limestone (calcium carbonate). Phosphorus is present in grains such as maize, barley and soybean.

1. **List the 6 nutrients essential for poultry.**

   _____

   _____

   _____

2. Complete the table to summarise information about poultry nutritional requirements. The first example has been given.

Nutrient	Why is the nutrient required?	Food sources the nutrient is found in.
Water	Water is required for all chemical processes in the body.	Water should be clean, fresh and always available. Small amounts can come from food.
Carbohydrates		
Proteins		
Fats		
Vitamins		
Minerals		

Go to the NSW DPI Poultry feeding and nutrition page to listen to the podcast 'Myth of hormones in chicken' and answer the following questions.

3. Are hormones used in the poultry meat industry?

   _____

4. When was the use of hormones banned in the chicken meat industry?

   _____

5. What percent of consumers have the misconception and think that hormones are still used in poultry production?

   _____

6. List and describe a reason why consumers still think hormones are used.

_____

_____

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_____

7. List the three factors which drive chicken growth.

- _____
- _____
- _____

8. Explain why short generation intervals have rapidly improved chicken genetics.

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9. Explain why a well formulated feed is important for growth and production?

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11. List environmental factors that are intensely monitored to optimise production.

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Factors affecting the nutrient requirements of poultry

The nutrient requirements of poultry are affected by:

- Genetics: (the species, breed or strain of bird). Different species, breeds or strains of birds have different average body sizes, growth rates and production levels and will absorb and utilise nutrients from feed with different levels of efficiency. Therefore, different species, breeds and strains require specific rations to meet their needs. The genetics of commercial poultry are constantly changing, and as a result, so are their nutrient requirements. Breeders of commercial poultry inform growers on the specific nutrient requirements for the birds they sell.
- Age: nutrient requirements are related to both body weight and the stage of maturity of the bird.
- Sex: before sexual maturity, the sexes have only small differences in their nutrient requirements and males and females can usually be fed the same diet to achieve acceptable growth rates. Following the onset of sexual maturity very different diet formulations are required for each sex.
- Reproductive state: the level of egg production in hens and sexual activity in males will affect nutrient requirements.
- Temperature: poultry use more energy to maintain normal body temperature in both cold temperatures and hot temperatures. The digestion process produces body heat; the amount of heat produced varies according to the nutrients in the diet. This is called the heat increment of the diet. In cold temperatures a diet with a higher heat increment (energy content) may be used, and the opposite in hot temperatures.
- Housing system: the type of housing system influences the level of activity of the birds and therefore their energy requirements. Australian commercial housing systems for layers are cage, barn or free range. For broilers they include either

barn or free range.

- Health status: birds with a pest or disease problem may benefit from an increase in some nutrients, most commonly vitamins.
- Production focus: the best nutrient composition of the diet varies according to production aims, for example, optimising weight gain or carcass composition, egg numbers or egg size. Poultry raised for breeding may need to have their energy intake restricted to ensure that they do not become obese.

12. List the eight factors which affect poultry nutritional requirements.

_____

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_____

Rations for birds at different growth stages

As all animals grow and develop, they have specific nutrition and energy requirements to meet their genetic and production potentials.

Layer chicken growth phases and protein requirements are:

Layer growth phase	Age	Protein requirement
Starter	0–6 weeks of age	minimum 20% protein
Grower	6–18 weeks	15–16% protein
Layer	18 weeks and onwards	16–17.6% protein

Table 1 Source: NSW DPI Small-scale poultry keeping- feeding, G. Poole.

The following table gives an example ration for starters, growers and layers.

Ingredient	Starter (0-6 weeks)	Grower (6-18 weeks)	Layer (18+ weeks)
Wheat (ground)	65kg	40kg	54.8kg
Barley or oats	5kg	15kg	10kg
Maize or sorghum	5kg	15kg	10kg
Meat meal (50% protein)	10kg	7kg	10kg
Sunflower meal	8kg	7kg	7kg

(38% protein)			
Soybean meal	6kg	-	-
Bran or pollard	-	15.25kg	-
Shell grit	-	-	Ad lib
Limestone (flour or chips)	-	-	7.0kg
Salt (fine)	250g	250g	500g
Vitamin premix	250g	250g	500g
Methionine	125g	-	75g
Lysine	125g	-	125g
Total weight	100kg	100kg	100kg
Crude Protein	20%	16%	17%

Table 2 Example rations for starter, grower and layer birds. Source: NSW DPI Small-scale poultry keeping- feeding, G. Poole.

13. Explain why starter chickens have a higher protein requirement than growers and layers?

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14. Explain why mature layers are provided ad lib shell grit and limestone, compared to growers and starter chicks which are not provided shell grit and limestone?

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15. The following table shows the feed analysis for three different poultry rations. Complete the table by identifying which layer growth stage each feed would be most appropriate for. Then explain why it is appropriate for that growth stage.

Feed name	Feed 1	Feed 2	Feed 3
Ingredients	Wheat, triticale, barley, oats, peas, lupins, lentils, beans, soybean, canola, sunflower and products derived from these ingredients. Meat meal, blood meal, fat, limestone, di-calcium phosphate, sodium bicarbonate, bentonite, salt, lysine, methionine, threonine, tryptophan, antioxidant, egg yolk pigments and enzymes. Shell grit. Vitamins and minerals premix.	Wheat, triticale, barley, oats, peas, lupins, lentils, beans, soybean, canola, sunflower and products derived from these ingredients. Meat meal, fish meal, blood meal, fat, limestone, di-calcium phosphate, potassium carbonate, sodium bicarbonate, salt, lysine, methionine, threonine, tryptophan, antioxidant, and enzymes. Vitamins and minerals premix.	Wheat, triticale, barley, oats, peas, lupins, lentils, beans, soybean, canola, sunflower and products derived from these ingredients. Meat meal, fish meal, blood meal, fat, molasses, limestone, di-calcium phosphate, salt, lysine, methionine, threonine, tryptophan, antioxidant and enzymes. Bran and pollard. Vitamins and minerals premix.
Feed analysis	Protein (min) 17% Fat (min) 3% Calcium (min) 4% Fibre (max) 8% Linoleic acid (min) 1.2% Salt (max added) 0.35%	Protein (min) 23% Fat (min) 5% Fibre (max) 6.5% Salt (max added) 0.35%	Protein (min) 16% Fat (min) 5% Fibre (max) 10% Linoleic acid (min) 1.3% Salt (max) 0.35% 0.35%
Which layer growth stage?			
Why is it appropriate?			

Watch '[Broiler brooding best management practices'](#)– Chicken farmers of Ontario to investigate nutritional management for broiler chicks further.

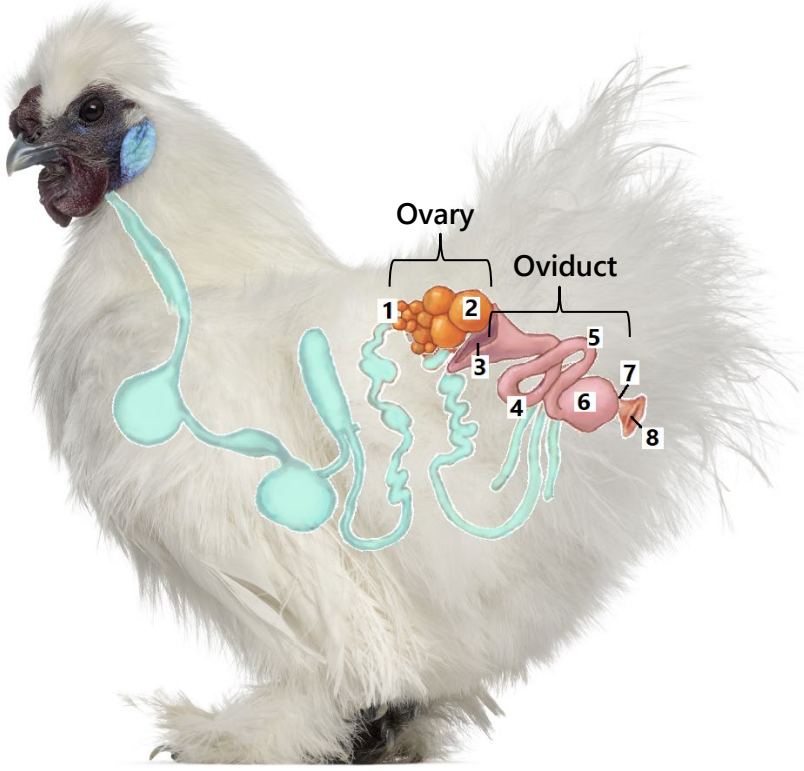
Poultry reproductive anatomy

Parts of the poultry reproductive system include:

- One ovary containing multiple ova
- Infundibulum (fimbria)
- Magnum
- Isthmus
- Shell gland (uterus)
- Cloaca
- Vent

(Infundibulum, Magnum, Isthmus, Shell gland = Oviduct)

1. Label the hen's reproductive tract using the NSW DPI Schools Program 'Poultry' poster.



Hen's reproductive tract	
1	5
2	6
3	7
4	8

Poultry reproductive physiology

Figure 3 chicken ovary showing ova

The reproductive system of the female chicken consists of two parts: the ovary and oviduct.

The ovary is a cluster of ova found beneath the hen's spine, midway between the neck and the tail. See Figure 3. It is fully formed when the pullet chick hatches and contains several thousand tiny ova, each ovum within its own follicle. As the female reaches maturity, these ova develop and mature into yolks. Multiple ova continuously mature to become yolks, allowing for eggs to be laid daily.

Figure 4 Ovary and oviduct with a formed egg in the shell gland

The yolk is formed in the ovary. When a yolk is fully developed, its follicle ruptures, releasing it from the ovary. It then enters the infundibulum, the entrance of the oviduct

The oviduct consists of the infundibulum, magnum, isthmus, shell gland, cloaca and vent. It is a tube-like organ lying along the backbone between the ovary and the tail. In a mature hen it is approximately 65cm long. See Figure 4.

All parts of the egg (chalazae, albumen, shell membranes, and shell) are added to the yolk to form an egg, as it passes through the oviduct, before being laid.

Watch 'Virtual Chicken- Chicken egg production'

1. **Complete the table by matching the avian reproductive organs to their function. Use the NSW DPI Schools Program 'Poultry' poster.**

Reproductive organ	Function
	Egg passes through as it is laid
	10% albumen laid down; shell membrane laid downs; shape of egg determined
	Remaining 40% of albumen added; shell formed; pigment of cuticle laid down
	Picks up yolk. Site of fertilisation.
	40-50% of albumen laid down (egg white)

Chicken reproduction facts

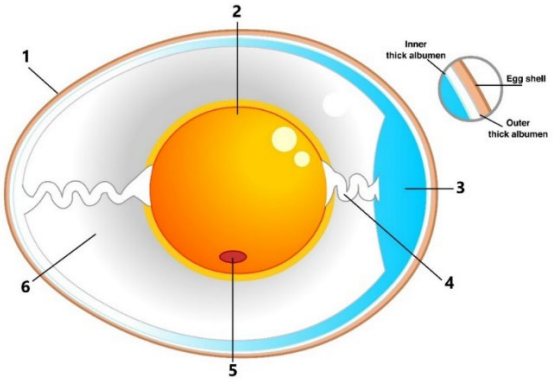
- Hens, like most other adult female birds, only develop a single oviduct and functioning left ovary. The right ovary regresses during development and is non-functional in an adult bird.
- Like the males of 97 percent of all bird species, a rooster does not have a penis, but instead has genital papillae (a small bump on the back of the cloaca). As hens do not have external genitalia either, poultry breed using an external opening: the cloaca. When the hen and rooster's cloaca's touch together, sperm is transferred into the female reproductive tract. This process is mimicked in artificial insemination of chickens.
- When a hen is inseminated, her eggs can be fertilised for up to four weeks. Rooster sperm remains viable for up to 30 days and is stored in the hen's oviduct.
- The total time a hen's body takes to transform a yolk (ovum) into a fully developed and lay an egg is approximately 25 - 26 hours. Typically, about 30 to 75 minutes after a hen lays an egg, the ovary releases the next ovum.
- Hens reach sexual maturity and can start laying eggs at about 18-21 weeks of age.
- Domestic chickens rely on changes in photoperiod (hours of light) to time reproduction. An increase in light to a point (14-16 hours) increases reproduction, whereas a decrease in hours of light will stop hens laying. For example, under natural daylight conditions, a hen almost never lays after 3:00 p.m. If a hen lays an egg too late in the day, the next ovulation occurs the following day, and the hen has a day when it does not lay an egg (rest period between clutches). Photoperiod affects chickens' clutch length, moult and sexual maturity.

Figure 5 Double yolk egg

- Every time a hen lays an egg, she has carried out ovulation.
- Chickens can't have 'twins'. Twins only occur if the ovary releases two yolks at the same time. The yolks are processed together, and the shell gland forms a single shell around both yolks. If the eggs were fertilised, two chicken embryos are encapsulated in the same egg. If the foetuses develop, when the chicks are ready to hatch, they encounter a problem. To get out of their egg, they must peck at the

air cell at the top of the egg. There in not enough space for two chicks to turn their heads around and peck, so both twins usually die. It is rare for both foetuses to fully develop throughout the entire incubation period.

2. Label the parts of the egg using the NSW DPI Schools Program 'Poultry' poster.



Parts of the egg	
1	4
2	5
3	6

3. Describe how the hen's environment can be managed and altered to increase laying.

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4. The layer industry produces eggs for human consumption. All eggs for human consumption from commercial layer farms are unfertilised. Roosters are not run with layer hens.
Explain why roosters are not run with hens in commercial layer enterprises in terms of consumer preferences? Use the internet to help with your answer.

---

5. Chickens are seasonal Polyestrous breeders. Use the internet to create a definition for a seasonal Polyestrous breeder.

   _____

   _____

6. What is the incubation period for a chicken?

   _____

   _____

   - Watch 'Day by day chicken embryonic development' on YouTube to see the time lapse footage, showing foetal development of a chicken without a shell from day 3-19.
   - Go to Poultry Hub's 'Incubation' webpage to answer the following.

7. What is an incubator and what does it do?

   _____

   _____

   _____

   _____

8. List and describe the four essential environmental conditions which must be managed throughout artificial incubation.
   - _____

     _____
   - _____

     _____
   - _____

     _____
   - _____

     _____

9. Complete the table to identify the incubation requirements for chickens.

Incubation requirements for chickens	
Incubation period (days)	
Incubation temperature (°C)	
Relative humidity (%)	
Day number to stop turning eggs	
Incubation temperature (last 3 days)	
Relative humidity (last 3 days)	

10. What is candling? When and why is it carried out?

_____

_____

_____

_____

11. Figure 6 shows an egg being candled.
    A) Is this egg fertilised or unfertilised?

    _____

    B) Approximately what day of gestation/ incubation is the egg at?

    _____

Figure 6 Egg candling

Watch 'Egg candling from day 1 to 21/egg hatching' to observe candling using a smartphone for the light source.

12. Complete the table to identify the effects of incubation failure on hatching

Incubator problem	Hatching characteristics
	Early hatched, weak chicks, unhealed navels, unabsorbed yolk sacs, crooked toes, crossed beaks and a high proportion late dead in the shell.
	Late hatching of large soft chicks which are slow starting, and chicks with wry (crooked) necks.
	Large numbers of unhatched, unpipped chicks, live trapped embryos and large chicks coated with albumen.
	Small weak chicks with large air cells, exhausted chicks in shells that have been chipped most of the way around, and chicks glued to the shell.

Go to Poultry Hub's 'The avian egg' webpage to answer the following.

13. How can eggs for consumption be enriched to be higher in minerals, antioxidants or omega-3 fatty acids and vitamins?

_____

_____

_____

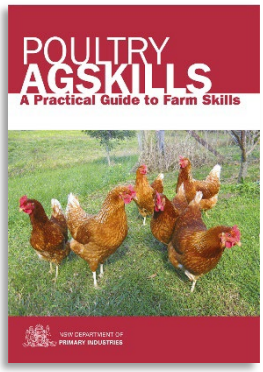
_____

14. Add the missing words to complete the passage.
    The egg contains all the _____ that the developing _____ needs during the _____ weeks of incubation period and for the first couple of days after _____. Water vapour and gases such as _____ _____ are able to move across the egg shell through small openings called _____. The developing chick starts off as a single fertilised _____ on the surface of the yolk and progressively grows, using up the _____, some of the _____ and some _____ from the inside of the _____ _____. In the final stages of development, the chick takes up the last bits of _____ into its own _____ _____.

15. Complete the table to summarise the composition and function of different components of an egg.

Egg component	Composition	Function
Yolk	The yolk is comprised of 33% lipid, 17% protein, and small amounts of minerals, vitamins and carbohydrates.	The yolk provides lipids and proteins essential for embryonic growth.
Albumen		
Egg shell		

Practical activity- Incubating eggs



Adapted from Poultry Agskills available in hardcopy or as an eBook. Find this activity, publication and more at the Tocal online bookshop.

Background: Hatching eggs using an incubator is an efficient way to increase your flock. Before selecting eggs for incubation, add a vitamin supplement either in the laying ration or water for a minimum of two weeks before the fertile eggs will be collected for setting (placing in the incubator). Alternatively, a broiler ration could be fed to laying hens two weeks before egg collection, as it contains additional vitamins and minerals.
Carry out a health check on hens, to identify genetically and physically unsuitable breeding hens. For assistance go to Practical activity- conduct a general health check for chickens.
Selecting, handling and storage of the fertile eggs will have a major effect on how many chickens can be successfully hatched.
The model, type and price of the incubator will determine how many chickens you can hatch.

Incubators

Incubators are basically a box that holds eggs while maintaining an appropriate temperature, humidity, and oxygen level. Incubators have varying capacities and adapters for eggs from different species.

Popular incubator models often include automatic turners, humidifiers, and temperature controllers. Egg turners can usually be purchased separately for incubators that do not include them. Humidifiers can be the type that dispenses water vapor as needed or many smaller incubators use a simple water reservoir. Temperature is controlled by older wafer systems or the newer digital thermostats.

Incubators come in forced air or still air versions. The temperature and humidity in a forced air incubator is more consistent. They also return to desired temperature and humidity more quickly after being opened.

Still air incubators can give inaccurate humidity and temperature readings and the temperature in them can vary considerably. Whenever possible, use a forced air incubator. Regardless of incubator type, for a successful hatch you must ensure eggs are turned, as well as monitoring the temperature, humidity, and ventilation.

The incubator should be in a room that has no drafts or direct sunlight; the temperature and humidity should be controlled and stable.

The incubator and hatcher should be isolated from the growing facilities. Newly

hatched chicks can be contaminated by older birds and the dust created by growing birds. Take biosecurity measures to ensure the incubator area is not contaminated by older birds

Chicks may be hatched in the incubator or in a separate hatcher. Advantages:

- Hatching in a separate unit will keep dust and down from contaminating the incubator.
- Temperature and humidity be accurately controlled by using separate units for incubating and hatching.
- Hatching eggs should not be continuously turned. Therefore, a separate hatcher allows for multiple batches of eggs at different dates to be in the incubator.

Regardless of method, the incubator and hatcher must be cleaned and disinfected between batches of chickens.

Familiarise yourself with your incubator before using by reading the manufacture's manual.

Incubation duration

Different avian species all have differing incubation times, humidity and temperature requirements for successful hatching. See Table 3 to identify requirements for some common species.

Table 3- Incubation period to hatch time requirements for common birds.

Incubation period to hatch time and when to transfer to hatcher. Temperature and humidity levels for common birds.						
Common name	Incubation conditions			Hatcher conditions		
	Days	Temperature °C	Humidity %RH	Transfer day	Temperature °C	Humidity
Chicken	21	37.5	58	18	37	66–75
Dove	14	37.5	58	12	37	66–75
Duck	28	37.5	58–62	25	37	66–75
Muscovy duck	35–37	37.5	58–62	31–33	37	66–75
Domestic goose	30	37.5	62	27	37	66–75
Geese (various)	22–30	37.5	62	20–27	37	66–75
Grouse	24–25	37.5	54–58	22	37.2	66–74
Guinea fowl	28	37.5	54–58	22	37.2	66–74

Peafowl	28–29	37.5	58–62	25–26	37	66–75
Pheasant	22–28	37.5	58–62	20–25	37.2	66–74
Pigeon	17–19	38	58	14	37.2	66–74
Japanese quail	17–18	37.5	58–62	15	37.2	66–74
Swan	33–37	37.5	58–62	30–33	37.2	66–74
Turkey	28	37.5	54–58	25	37	66–75
Emu	49–50	36.4	32–40	47	36.4	69
Ostrich	42	36.4	32–40	39	36.4	69

Egg Selection and storage

Fertile eggs must be collected carefully and stored properly until they are incubated. Keeping the eggs at proper storage temperatures keeps the embryo from starting and stopping development, which increases embryo mortality. Collecting eggs frequently and storing them properly delays embryo development until you are ready to incubate them.

Tips:

- Do not store eggs to incubate longer than 10 days, as hatchability reduces. After 7 days, hatchability decreases 0.5 to 1.5 percent per day. Each day in storage adds one hour to the incubation time.
- Maintain temperature between 12.5 - 15°C.
- Keep relative humidity at 75%.
- Do not incubate cracked, soiled or uncharacteristically small or large eggs.
- Do not wash or wipe eggs with a damp cloth as this can remove the eggs natural protective layer (bloom).
- Wash hands before handling eggs to remove bacteria.
- Store eggs in a carton with the large end up (air sac). You do not need to turn eggs if they will be incubated within a week of being laid.
- If storing eggs more than 10 days, tilt them side to side over a 90-degree angle once- twice daily.
- The following method must be altered dependant on the species being hatched.

Aim: To hatch chicken eggs using an artificial incubator.

Materials:

- Incubator
- Brooder

- Hatcher
- Chick starter crumble
- Fertile eggs
- Electricity source (21 days un-interrupted)
- Tray of water
- Optional- dry bulb and wet-bulb thermometers

Method:

1. Always wash hands before handling eggs - this reduces disease and bacterial contamination of eggs
2. Two-three days before setting eggs- set up incubator: Sanitise incubator and set it up according to manufacturer's directions. Run the incubator for a minimum of 24 hours before date of use, to ensure the temperature, humidity and oxygen levels stabilise. If the incubator has an automatic turner, check this is operating properly. If required add a tray of water or fill the trough to provide humidity. Add the wet bulb and dry bulb thermometers to check the temp and humidity levels are correct and stable
3. Day 0- before setting stored eggs and before placing them in the incubator. Candle eggs to check for double yolkers, no yolks, cracks, missing air sac etc. Discard any malformed or damaged eggs (Practical activity- Candling eggs).
4. Day 1 of setting-
    a. Let the stored eggs warm to room temperature for 4-8 hours before placing into incubator. This reduces condensation and possible suffocation and contamination of eggs.
    b. Place eggs into incubator setting the large end of the egg (air cell) higher than the smaller end. This orients the developing chicks head close to the air cell.
    c. Once eggs are in the incubator, do not adjust the temperature or humidity, or open the incubator for up to 4 hours- unless the temperature exceeds 38.7°C (which will kill the embryo). Higher temperatures are more harmful to the embryo than cooler temperatures.
    d. After 4 hours make proper adjustments. The final temperature should only vary 0.5°C above or below the target temperature. See Table 3 for incubation requirements for common birds.
5. Start recording daily incubator checks and mortality records into Tables 4 and Table 5.
6. Throughout the setting stage, eggs must be turned at a minimum of 3-5 times per 24-hour period. Ideally eggs should be turned every hour, (hens move eggs hourly). Turning eggs prevents embryo death and unhealthy hatches. Record

results into Table 4.

7. Candle eggs on days 7, 14 and 20. Remove any malformed, damaged or dead eggs and keep a record. Always wash hands before handling eggs. For procedure on candling eggs- go to Practical activity- Candling eggs. Record results into Tables 4 and 5
8. Day 16- If using a separate hatcher, sterilise and set up hatcher at least 24 hours before egg transfer to allow humidity and temperature to stabilise.
9. Day 18- If using a separate hatcher, transfer chicken eggs into hatcher day 18. (If not using a separate hatcher- turn off automatic turner on Day 18 (chickens) and provide a cloth or rough paper for chicks to hatch onto. Check Table 3 for other species requirements.
10. Day 18- Candling is optional- Air sac will be large, embryo will appear dark, taking up most of the space of the egg. Potentially you will see embryo movement in light shell eggs. Any eggs that have died since day 14 should be discarded.
11. Day 20- sanitise and set up brooder. Check that Chick starter crumble is present as well as a shallow water tray in the brooder. The water tray must be shallow enough that chicks cannot drown. Check brooder lamp is working. Set up bedding in brooder for chicks- e.g., sawdust and newspaper.
12. Day 21- Check for chicks pipping (Figure 7).
    a. Process can take 10-20 hours. Hatching is very energy draining for chicks. Chicks will be very active for a while then have long rests (up to hours) before pipping again. Chicks will pip out of their shells using their egg tooth. Do not assist chicks hatching. Chicks that cannot hatch on their own usually die or are disease prone and weak.

Figure 7 Chick pipping

    b. Eggs that have not hatched after 20 hrs should be discarded.
    c. Weak chicks should never be used for breeding because these traits will be passed on.
13. Day 21/22- Once chicks successfully leave the shell:
    a. increase the ventilation in the incubator and leave them in it about 24 hours or until their feathers are dry.
    b. When more than 90 percent of the chicks are dry, remove them from the hatcher/incubator and place into a pre-set-up brooder.
    c. Move the chicks to a warm brooder and give them water and starter

crumble. Leaving chicks in the incubator too long can dehydrate them.

14. Record and calculate hatchability and mortality results into Table 5.

Results:

Complete Table 4 and 5

Discussion questions:

- List the two essential environmental conditions that must be managed throughout incubation and summarise why they are essential for a successful hatch.
- Identify the importance of turning eggs throughout artificial incubation. What is it mimicking? How often should eggs ideally be turned?
- Why is it important to discard any unviable eggs throughout incubation?
- Identify and list advantages and disadvantages of artificially incubating eggs.
- Discuss the implications of not assisting eggs hatch (pip) out of shells, in terms of production, resource use, and animal welfare and quality of life.

Table 4 Example Incubator recording sheet for chicken eggs

Day #	Date	Turner works (minimum of 3 turns/ 24hrs)	Temperature (°C)	Relative humidity %	Water checked	Candling	Comments
0	Candle Day 0- Before placing eggs in incubator. Check for double yolkers, no yolks, cracks, no air sac etc						
1							
2							
3							
4							
5							
6							
7						Day 7- remove cracked, damaged, unfertilised or early dead eggs	
8							
9							
10							
11							
12							
13							
14						Day 14- remove undeveloped or dead eggs	
15							
16							
17							
18		Do not turn eggs (chickens)				Day 18 - check air sacs and possible embryo movement.	
19							
20							
21							
Check eggs are turning at least 3 times every day except from days 19-21 for chickens.							

Table 5 Hatchability and mortality record

Hen ID#	Incubation set date	Eggs		Dead (candled)			Pips (Live / Dead)	Chicks		Hatchability and mortality percentages		
		Total eggs set	Total eggs removed	Early	Middle	Late		Cull	Retain	Fertility (%)[1]	Hatchability (%)[2]	Total eggs hatched (%)[3]
							/					
							/					
							/					
							/					
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Recording data will help identify problems with bird husbandry and incubation.

[1]Fertility (%) = (Fertile Eggs/Eggs Set) x 100%

[2]Hatchability (%) = (Good Chicks Hatched/Fertile Eggs) x 100%

[3]Total Eggs Hatched (%) = (Good Chicks Hatched/Eggs Set) x 100%

Practical activity- Candling eggs

Background: Candling is a method used to observe the growth and development of an embryo inside an egg which uses a bright light source behind the egg to show details through the shell. It is called candling because candles were originally used as the light source.

Commercial poultry producers use candling to learn which of their eggs are fertile and will hatch into healthy chicks. The process increases production efficiency. Candling can also be used to tell if a fertilised egg has stopped developing and allows dead or infertile eggs to be removed from incubation. Dead or infertile eggs can cause disease and bacterial contamination to the developing embryos, especially if they explode in the incubator.

Candling is a recommended husbandry practice for artificially incubated eggs, but not for naturally set eggs. Removing a broody hen from eggs can cause undue stress to the hen and even cause her to smash developing eggs.

When to candle?

The first candling should occur before putting fertile eggs into an incubator. Candling eggs before incubation can help show any abnormalities in the egg that would prevent it from hatching. Things to look for are missing yolks or double yolks, shell cracks and fractures and a damaged or missing air sac.

Candle eggs a maximum 3 times during incubation.

- Day 7- The embryo is very fragile during the first week, so should not be handled. Day 7-10 candle eggs to identify unfertilised or dead eggs. You will see an embryo developing- seen as a dark spot with fine blood vessels stretching from the embryo (Figure 8).
- Day 14- The embryo is fully formed and starting to take up most of the space inside the shell. Blood vessel system is extensive, pronounced and close to the shell. Air sac larger since Day 7 (Figure 9). Embryo movement possibly seen. Remove any early- quitter (dead) eggs.
- Day 18- candling not essential. If candling does occur, the chick should have filled the egg and the egg should be completely dark. The air sac should have further developed (Figure 9). Remove any late-quitter eggs.

Candling eggs more frequently than this will disturb the temperature and humidity and may contaminate or terminate embryos. It is particularly dangerous to the chick in the period the egg should not be turned or as chicks are pipping (days 18-21 chickens).

What to look for?

- Clear- If the inside of the egg is clear and free from visible structures or dark areas, the egg is infertile, or the embryo died very early. Remove this egg from the incubator.
- Blood ring- If a ring of red blood is visible within the egg, there was a viable embryo at some point, but it has died. Remove this egg from the incubator.
- Single dark spot- These embryos have died around the 8-day mark and should be removed.
- 'Spider's web' of blood vessels (see Figure 8)- indicates a viable embryo. Blood vessels in chicken eggs are observable from 3 to 10 days. By day 18 of incubation, the chick fills up most of the egg and appears as a dark area within the egg; blood vessels are not seen.
- Cracks- If you notice leaking eggs, eggs with cracks, or hairline fractures while candling remove and discard these eggs. The embryos will not develop, as cracks allow disease and bacteria to enter the egg.
- Air sac- should increase in size throughout embryo development in all poultry species. Figure 9 shows air sac development for chickens. If the air sack is too small, the incubation humidity is too high. If the air sack is too large, the incubator humidity is too low.

Figure 8 Viable embryo between days 5-10. Note the 'Spider's web' of

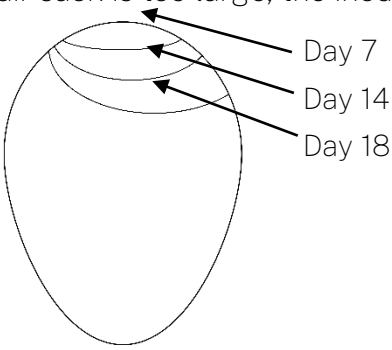


Figure 9 Guide for air sac development for a viable chicken embryo

Watch Egg candling from day 3 to 18 (Chicken eggs).

For further reading and advice go to 'How to candle eggs: Definitive day-by-day guide'.

Dark shelled eggs

Dark shelled eggs are hard to see through. To successfully candle these, you will need to candle in a dark room with the brightest light source available. A good practice is to set a batch of dark shelled eggs along with light shelled eggs at the same time. Air sac development can be measured and compared between both dark and light shelled

eggs, giving an indication on embryo development.

Embryo death

Eggs fail to hatch because they are infertile or because the embryo dies. Humidity control can sometimes contribute to these problems.

Embryos usually die during the first 3 days of incubation (early quitters) or the 3 days immediately before a hatch (late quitters). Early embryo death happens when embryonic organs are forming. Eggs that are fertile one third of the way through incubation have a 90 percent chance of continuing to develop.

Death at the end of the incubation process can occur because the chick:

- Has difficulty positioning for pipping
- Cannot absorb the yolk sac
- Cannot transition to breathing air

Good practice involves recording when embryos die which can allow for correction of incubation management for future batches. A sample record form for hatch and fertility failure is in Table 5.

Examine eggs that fail to hatch (Day 23) by removing the top of the egg at the large end. A chick that has developed correctly will have its head tucked under the right wing. The air cell will be large enough to allow the chick to position correctly for hatching. The shell membranes should not dry onto the chick during hatching. Note any dryness. Note the condition of the beak, wings, and legs for proper formation.

All abnormalities, dead embryos, or unsuccessful hatchings should be recorded and analysed to determine if hatch failure was caused by fertility or environmental problems that can be corrected.

Use Table 5 to calculate the percentage fertility, percentage hatchability, and percentage of total eggs hatched. These numbers will help in evaluating hatch efficiency. Any changes in the mortality records data are early warnings to correct small problems before they become serious.

Aim: To determine fertile eggs and viable embryos for incubated chicken eggs.

Materials:

- Bright light source e.g. smartphone torch. (Proper candling light or other light source may be substituted here)
- Batch of fertilised eggs to be artificially incubated
- Dark room
- Flat surface - for example a table
- Incubator

Method:

Tips:

- Always wash hands before handling fertile eggs to reduce the possibility of disease and bacterial contamination.
- Always handle eggs carefully to prevent embryo damage and breakage of shells.
- Do not candle chicken eggs after day 18.
- Only candle eggs once before setting eggs (Day 0) then only 3 times during incubation- Day 7, Day 14 and Day 18 (optional).
- Do not candle eggs naturally being incubated by a broody hen.
- Do not leave an egg on a hot lamp too long or it can cook the embryo.
- Keep individual eggs out of the incubator for the least amount of time possible so they do not cool. Excessive heat is more harmful to a developing embryo than moderate drops in temperature.
- Replace eggs into the incubator with the large end up (air sac).

1. Turn smartphone torch on and place phone flat on a sturdy surface, in a dark room.
2. Carefully select and hold an egg over the phone lamp with the larger end (air sac) closest to the lamp. This works best with a smartphone with phone cover- which makes a cradle for the egg on the torch groove.
3. Gently turn the egg to observe for:
    - clear eggs (day 7),
    - blood rings or a single dark spot (days 7 and 14),
    - developing air cell (days 0, 7, 14 and 18),
    - Shell cracks and fractures (days 0, 7, 14 and 18),
    - Network of blood cells (days 7 and 14)
    - Possible embryo movement (days 14 and 18).
4. Discard any damaged or non-viable eggs.
5. Carefully return the egg to the incubator, large end (air sac) up.
6. Repeat steps 1-5 for each egg individually.
7. Record all results into Tables 4 and 5.
8. After candling all eggs check the incubator for turning, temp, humidity and ventilation requirements for eggs depending on time of development. For more information see Practical activity- Incubating eggs.

Results:

Complete Table 4 and 5 where applicable.

Discussion questions:

- List how often should eggs be candled?

- Identify and list advantages and disadvantages of candling and discarding eggs.
- Discuss the implications of candling eggs, in terms of production, resource use, and animal welfare.
- Identify advantages of completing a hatchability and mortality record (Table 5). Predict its effect in terms of fertility, bird health and offspring production in a poultry flock over time.

Practical activity- Brood and rear chicks

Background: Buying in day-old chicks from a commercial hatchery, or incubating chicks from your own stock are great ways to establish and quickly grow your poultry flock.

If you are purchasing commercial day-old chicks, check they have been vaccinated at the hatchery for Marek's disease. Always quarantine new birds from the existing flock for at least a month.

This activity gives guidance on how to raise (brood) chickens from day-old, whether they were purchased, hatched from an incubator or have been rejected by a broody hen.

The brooding period will be 3-6 weeks, dependant on seasonal temperatures and genetics. Throughout the brooding period chickens will rapidly grow and develop and have specific environmental, health and dietary needs to grow to their potential.

Additional ideas: measure weight of chickens over time for a breed comparison or a feed vs. growth related investigation.

Aim: To brood and rear a batch of day-old chickens.

Materials:

- Infra-red heat lamps
- Electricity source
- Draught excluder and insulation material
- Plastic sheeting
- Litter – examples include sawdust, wood shavings, straw or shredded paper.
- Feeders
- Waterer
- Day-old chickens
- Detergent, antimicrobial agent and cleaning gear
- Thermometer

Figure 10 Example brooder set up.

Method:

1. Preparation- set up the brooder well in advance to the chicks hatching or arriving.
    - Remove all manure and litter from previous batches of chicks
    - Scrub the brooding area, floor, plastic sheeting, waterers and feeders with detergent, then sanitise with an antimicrobial agent

2. Set up brooding area with plastic sheeting beneath litter and brooder frame.
3. Set down brooder frame and fill the base with a thick layer of litter. (See Figure 10 for ideas for brooder set up).
4. Surround the brooding area with an insulative material. For example, Styrofoam, cardboard, metal sheeting, hay, cardboard etc to a height of 50cm to exclude draughts.
5. Install infra-red heat lamp. Make sure nothing can touch the lamp to minimise fire or burning risk.
6. Set up the heat lamp. Adjust the height of the heat lamp over time so it provides temperatures of:
    - 33-35°C at chick level for the first week
    - Gradually reduce the temperature by approximately 0.5°C per day to about 24°C by week five.
7. Suspend the lamp from about 350-400mm above the litter and check the temperature by laying a thermometer on the litter. Reduce temperature by raising the heat lamp and increasing the temperature by lowering the heat lamp.
8. When chicks arrive transfer them immediately into the brooder. Observe they are eating and drinking and encourage them to do so by gently placing them near water and feed. They will instinctively peck food and water.
9. Observe chick behaviour to confirm temperature in the brooder. If chicks are too cold, they will huddle under the lamp. If they are too hot, they will move away from it and each other. See Figure 11.
10. Check and replace/top up feed daily. Chicks must be provided a constant, clean, fresh food source. Keep feed away from direct heat.
    - Provide fresh chicken starter crumble in shallow pans for the first fortnight. Chicken crumble is very important as it contains an anti-coccidial compound protecting chicks from coccidiosis. Gradually introduce increasing amounts of brooder ration from mid-week 2 onward throughout brooding. Slowly transition the chick's diet from starter crumble to a brooder ration. Do not change feed overnight.
11. Check and replace/top up the water source for chicks with clean, fresh water daily. Chicks must be provided a constant, clean, fresh water source. Keep water away from direct heat.
    - In the first week provide water in a shallow container. Day old chicks are prone to drowning. So, make sure the water level is very shallow. If not fill a deeper water bowl with sanitised marbles or pebbles etc which will stop the chicks from drowning in the first fortnight. As time goes on,

they can transition to waterers with a large well or dripper systems.

12. Check litter cleanliness daily. Remove any wet, or spent litter immediately and replace with clean, fresh litter. This is essential to optimise chick health and welfare and minimises unpleasant odours.
13. Keep chicks clean, warm, dry, and draught free at all times.
14. Perform daily health checks on all chicks throughout the brooding period. See Practical activity- conduct a general health check for chickens and Practical activity- catch and handle chickens
15. Determine the sex of the chickens. See Practical activity- determining the sex of chickens through wing observation
16. At approximately 4 weeks of age, food should have transition from a Starter crumble to:
    - a broiler finisher ration for meat birds or
    - a grower ration for layers.
17. Move chicks from brooder to chook house.
18. Broilers can be harvested at about 7-8 weeks dependant on market specifications. Layers will start laying at approximately 4 months onward dependant on season, nutrition and genetics.

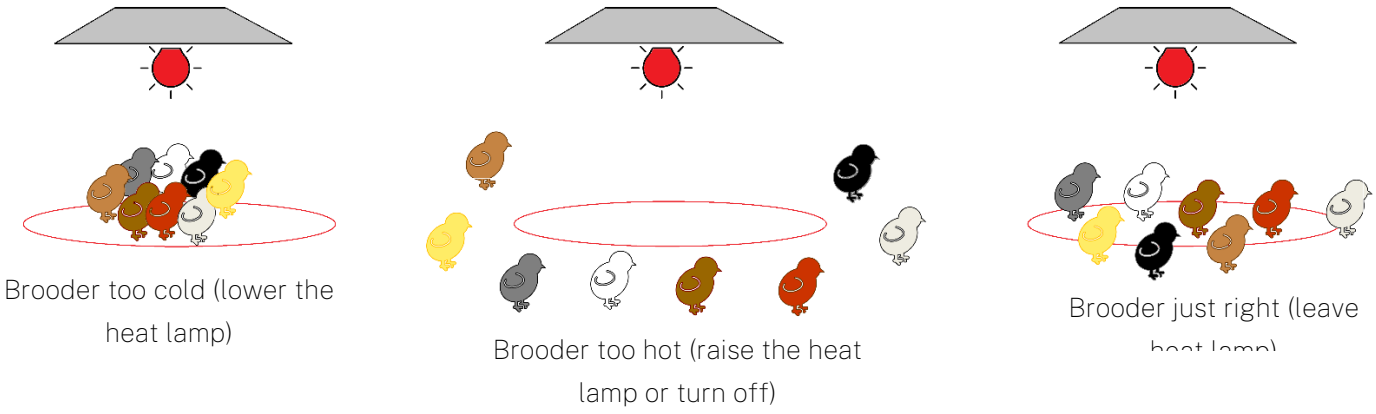


Figure 11 Chick behaviour due to brooder temperature

Results: record results into Table 6 Poultry health checklist (p 60).

Determining the sex of chickens

Determining the sex of chickens is an important management practice.

The poultry industry routinely determines the sex of chickens for various reasons. In layer enterprises males are unwanted and separated. In the broiler industry, males and females are separated and run for breeding and feeding. Chicks of the wrong sex in a management group are unneeded and increases the price of production due to excess feeding.

It is difficult to distinguish between day old pullets and broilers. It is easier and more accurate to distinguish between the sexes at 6 weeks of age onward as physical attributes such as the comb, tail feathers, saddle feathers, and crow (vocalisation) have developed.

Despite this, in industry, chicken sexing is routinely carried out on day old chicks to reduce cost of production. Sex determination is carried out using a technique called venting. Venting is the most accurate way to sex chickens, however, it is difficult and requires skilled operators, as it can cause harm to the chicken if not carried out properly.

To find out more about the venting technique go to:

- 'How to sex chickens: 6 ways to determine a hen or rooster' or watch
- 'How to tell the difference between rooster and hen chicks- vent sexing'.

Note- vent sexing cannot be carried out as a practical activity in schools. For a full list of poultry practicals check out NSW Animals in Schools, Fowls.

In non-commercial poultry production it is a useful skill to identify and separate pullets and cockerels from each other. This can be achieved by non-invasive approaches such as:

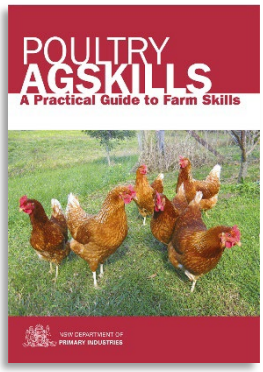
- Feather sexing- Sex determination can be carried out by observing the primary feathers of day-old chicks. See practical activity below.
- Observing comb/wattle colours and size- chicks start to develop their combs and wattles at two weeks of age onward. A large, fuller and brighter coloured comb and set of wattles indicates the bird could be male. Be aware this method of sex determination is not 100% accurate.
- Observing chicks for male or female behaviours- as chicks grow older, they begin to exhibit behaviours characteristic of their sex. Cockerel chicks often show signs of fighting including flying directly at other male chicks and slamming

chests, continuous pecking or kicking at other chicks. Be aware these methods of sex determination are not 100% accurate, as sometimes pullets can be aggressive, however it is rare.

- Colour of down feathers- Chickens have a genetic link between sex and colour. In cases where the parents of chicks came from two different breeds (crossbred), the colour of the down feathers indicates the sex of the chickens. If the parents of a chick are both from the same breed chicken (purebred), this will not work. There is no rule for the colours seen. Use the internet to search colours along with the two breeds being crossed.

  For example, Rhode Island red (♂) × White Wyandotte (♀) = day old cockerels are white; and day old pullets are reddish.

For more information on sex determination techniques go to: 'How to sex chickens: 6 ways to determine a hen or rooster'.



Practical activity- determining the sex of chickens using wing observation

Adapted from Poultry Agskills available in hardcopy or as an eBook. Find this activity, publication and more at the Tocal online bookshop.

Before carrying out this practical activity or any activity in schools using animals, make sure to read and adhere to the conditions in the NSW Animals in Schools website.

Aim: To identify and draft poultry

Materials:

- Day old chickens
- Identification tags e.g. poultry leg bands
- Housing or holding pen for individuals

Method:

1. Carefully capture the day old chick following the NSW Animals in Schools, Fowls, Handling procedures. The chick must be held firmly, but gently. Secure the bird by holding it around its body with wings and legs tucked in. Do not squeeze or drop the chick.
2. Tilt the chick on its side and observe a wing.
3. Using two fingers, gently secure the wing and extend it away from the chick's body to observe the primary feathers. The primary feathers are the outer feathers.

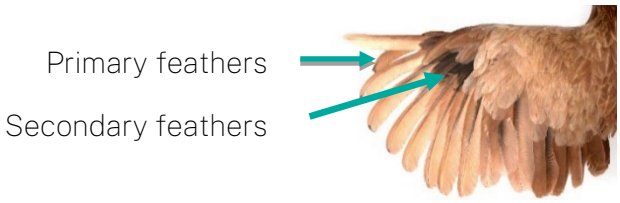
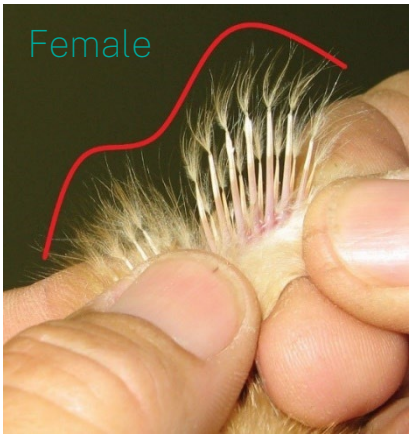
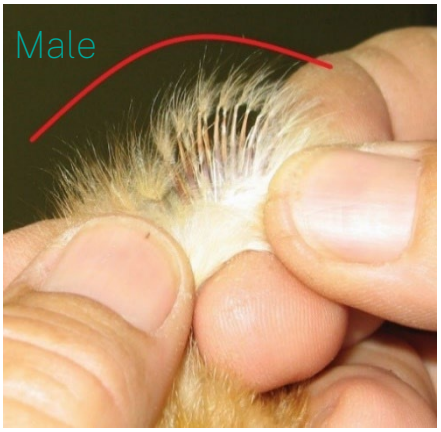


Figure 62 Primary and secondary feathers on an adult hen

4. Observe the wing feathers to determine if the chick is a pullet=female or cockerel=male.



Pullet: Primary feathers observed as a two-step curve shaped pattern. Primary feathers are thick and well developed



Cockerel: Primary feathers observed as a single-curve shaped pattern. Primary feathers are relatively all the same size and smaller and thinner than females.

5. Repeat steps 2-4 to observe the chick's feathers on the other wing to support your determination of the sex of the chick.
6. Place a temporary identification e.g., leg band gently around the chick's leg using a key. For example, pink band– pullet; blue band- cockerel.
7. Gently place the chick into a holding pen.
8. Repeat steps 1-7 for each day-old chick

Results:

Complete the table to identify and record the sex of all chickens in each batch.

Animal ID#	Hatch date	Date sexed- Primary feather observation	Male/ Female	Actual sex- determined at 6 weeks+	Male/Female	Day old chick sexing accuracy

Discussion questions:

- Describe the physical differences observed between day old male and female chicks.
- Discuss the implications of sexing day old chicks, in terms of production, management, resource use, and animal welfare.

Poultry pests, diseases and biosecurity

Biosecurity is the protection of the economy, environment and community from the negative impacts of pests and diseases, weeds and contaminants.

Biosecurity involves preventing new threats from entering Australia; controlling outbreaks when they do occur and controlling spread of pests, diseases, weeds and contaminants already present in our country.

Globalisation, urbanisation and climate change are increasing the risk of biosecurity events in Australia at national, state, district and individual property levels. The Australian Government has regulatory responsibility for biosecurity before they reach our borders, as well as when they reach our shores, while state and territory governments are responsible for activities such as surveillance and response once materials arrive here.

While robust response plans are in place to combat outbreaks, preventing pest, disease and weed incursions in the first place is a shared responsibility from the national level all the way to the state, regional and personal level.

Everyone has a role in biosecurity, and it is a shared responsibility!

Australia's geographic isolation allows Australia to be free from many diseases, pests, weeds and contaminants of serious global significance. Freedom from these exotic pests and diseases is a vital part of the future profitability and sustainability of Australian agriculture. Biosecurity allows us to preserve and access unique and essential international and domestic markets.

Biosecurity and the poultry industry

DO NOT enter a poultry farm if you have recently handled poultry at home, school, or you've been overseas in a country with Avian diseases.

Poultry producers carry out production to high biosecurity standards according to national and state legislation. To find out more follow these links:

- National farm biosecurity manual- Poultry production
- Animal Biosecurity, NSW DPI
- Managing Biosecurity in NSW, NSW DPI
- Your role in Biosecurity

High levels of biosecurity are essential in the poultry industry to prevent or minimise diseases such as Newcastle Disease, Avian flu and Salmonella enteritidis among many other bacterial and viral contagions.

Watch "Poultry Meat Biosecurity, Chicken Meat Australia" to answer the following.

1. List the main ways contamination and pathogens can spread on poultry farms.

- _____
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- _____
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- _____
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2. Describe three management strategies which reduce or prevent biosecurity threats on the farm.
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Avian influenza
situation update
NSW
dpi.nsw.gov.au/ai
EMERGENCY ANIMAL DISEASE HOTLINE
1800 675 888

Poultry health and diseases investigation

Poultry can be infected with a variety of diseases and parasites. Some of these can be zoonotic diseases, which means they are transmitted from animals to humans and vice versa.

The two most serious diseases that must be kept out of poultry flocks are Newcastle disease and avian influenza. Although these two devastating diseases are not present in commercial poultry in Australia, the poultry industry is at risk from their introduction.

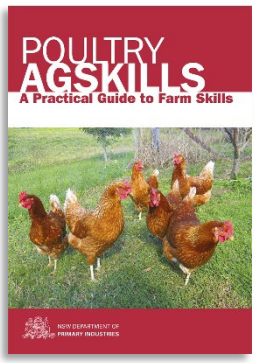
Other poultry diseases include coryza, chronic respiratory disease, infectious laryngotracheitis, lice and mite infestations, chlamydiosis, blackhead and internal parasites.

A strict hygiene program and high levels of biosecurity are required to keep diseases out of poultry.

Investigation

Instructions:

- ✓ Go to the NSW DPI, Poultry health and disease page
- ✓ Select a poultry disease to further research from the list (Avian influenza, Newcastle disease or Salmonella Enteritidis)
- ✓ For your chosen disease research and include the following:
    - Common name of disease
    - Identify the pathogen or causative agent. For example, bacteria, virus etc.
    - Explain how the disease spreads. List all vectors (spreading agents)
    - Explain the current situation in NSW and Australia (is the disease present or not)
    - Identify if the pathogen is zoonotic (spreads to humans)
    - Identify and describe ways the disease can be treated
    - Identify and describe ways the disease can be prevented
    - Explain how the disease could affect production in the poultry industry
- ✓ Compile your findings into a digital report; for example, a brochure or poultry disease fact sheet.



Practical activity- conduct a general health check for chickens

Adapted from Poultry Agskills available in hardcopy or as an eBook. Find this activity, publication and more at the Tocal online bookshop.

Background: Performing regular health checks on poultry is essential in terms of animal health and welfare, enterprise productivity let alone good management.

Regular health checks have many benefits including:

- preventing health and disease incursions rather than treatment
- quietening birds through regular handling,
- developing a greater understanding of poultry health, husbandry and welfare,
- creation of accurate records.

The following activity gives a list of general health checks for poultry. Birds should be sighted and checked daily when feeding and watering for basic health and welfare. A more in-depth check-up using the following method, should be conducting on every bird at least once a month, or immediately if any bird is behaving abnormally. Always consult a veterinarian if in doubt.

Other things to check and measure could include body weight, pulse, respiration rate, bird temperature etc. Modify this activity to suit individual requirements and equipment available at your school.

Before carrying out this or any practical activity involving animals, make sure to read and adhere to the NSW Animals in Schools website.

Aim: To conduct a general health check up on chickens

Materials:

- Chickens
- Chicken enclosure
- Groups of two students
- Checklist and writing/ recording materials

Method:

1. Students to work in pairs swapping roles between gently handling and checking the bird and recording notes
2. In your pair, catch and handle chickens keeping high levels of animal welfare. Refer to Practical activity- catch and handle chickens for guidelines
3. For each chicken, observe and make health checks using the checklist (Table 6).
4. Record results into Table 6.
5. Follow up any concerns immediately.
6. Contrast findings to previous records to track bird health over time.

Results:

Record results into Table 6.

Table 6 Poultry health checklist

Area	General health checklist - complete using a 'Yes' or 'No' for each bird	Bird identification	Bird identification	Bird identification	Bird identification	Bird identification
Comb and wattles	Combs and wattle are brightly coloured and full (not dry and dull)					
	Is the hen broody or moulting? (These affect comb appearance- comb and wattles can be pale)					
	Any pecks, scratches or dried blood?					
Beak	Upper and lower beak meet and align. If they don't, check to see bird can eat and drink.					
	Any fractures in the beak?					
	Any discharge from nostrils? Birds with nasal discharges should be isolated from the flock and only introduced when any discharge has cleared up. Consult veterinarian if required.					
Eyes	Eyes are clear, bright and alert (Cloudy eyes can indicate cataracts forming and blindness.)					
	Any discharge from eyes? Birds with discharges from eyes should be isolated from the flock and only introduced when any discharge has cleared up. Consult veterinarian if required.					

	Any changes in eye colour? Mareks' disease is a highly contagious viral disease in poultry and can be identified when a birds iris changes from its normal colour to grey colour. Consult veterinarian if required.					
Feathers	Feathers are glossy and tight (dependant on breed)					
	If feathers are not glossy, is bird about to moult or moulting?					
	Look for lice, fleas and mites (use magnifying glass or magnification on phone for mites) *Supply birds with a dust bathing area to keep parasite levels low. *Treat birds with approved poultry anti-parasitic powder if parasites present. Consult veterinarian if required.					
	Are there signs the hen is being hen-pecked* and bullied. *A bullied hen will have feathers pecked out and may have scratches and dried blood. If YES, hen should be isolated immediately, and efforts should be made to establish bird away from bullying bird.					
Crop	Locate and check crop by gently feeling for it in the hen's neck. Crop should feel full, rounded but not 'mushy' or 'rock hard'. (Crop will be empty in the morning and full at night.)					

	Does chicken have an enlarged and swollen crop? If YES, smell chickens breath- if it smells like rancid milk, the bird could have Sour crop. Sour crop is a common yeast and bacterial infection caused by food blockages in the crop. Consult your veterinarian if required.					
Legs and feet	Leg scales are smooth and uniformly coloured? In an older bird the scales are slightly rougher, but they should not be raised or uneven. If they are, she may have Scaly Leg Mites. Consult veterinarian if required.					
	Look for parasites- lice, fleas and mites-use magnifying glass or magnification on phone for mites. This is especially important for birds with feathered legs.					
	Are the toenails and spurs (in roosters) overgrown? If yes, and the overgrowth is affecting walking, lightly trim as required.					
	Check the bottom of the chickens feet for any impacted dirt, swellings or Bumblefoot. Bumblefoot will look like a black or dark swollen area which you cannot remove by rubbing or washing. Consult veterinarian if required.					
Vent	Vent is clean, healthy and pink (not pale and dry).					
	Does the hen have a prolapse, parasites or build-up of					

	faeces around the vent? Clean and/or remove soiled feathers and treat bird as required or consult veterinarian.					
Pubic bones	Pubic bones are flexible and wide apart in laying birds (at least two finger widths/ 4 cm apart) Pubic bones are the two small bones on either side of the vent. A non-laying hen will have stiff pubic bones that are close together.					
Abdomen	Deep and soft without an accumulation of body fat – Laying hen (A non-laying hen will have a smaller body with a shallow, firm abdomen)					
	Laying hens have a deep abdomen (three to four finger widths in length or 6-8cm) depending on breed (Depth of abdomen is measured between the depth of the keel or breast bone and the pubic bones.)					
Behaviour	Hen is behaving normally- laying, roosting, eating, drinking, defecating, walking, dust bathing, interacting with other birds etc.					
	Is the hen broody (sitting on eggs)?					

General comments List general comments about bird such as age-related concerns, production stage, any treatments, general findings and anything to follow up.					
Date					

For any suspicious animal sightings in your school in contact the National Emergency Animal Disease Hotline on 1800 675 888

Contrasting Broiler and Layer production and markets

Australian chickens are grown commercially for the major production markets of chicken meat and eggs. The chicken meat production industry is called the 'Broiler' industry and the egg-laying industry is called the 'Layer' industry.

The Australian Layer and Broiler industries support our domestic market as well supplying export markets.

In Australia, chicken meat has the highest consumption rate of all animal meats. The following table shows the average annual consumption of the major animal proteins in Australia.

	Beef and veal	Pork	Sheep meat	Chicken	Eggs	Seafood
Average annual consumption per person	34 kg	27kg	10kg	48kg	226 eggs/year	15 kg

In 2022 Australia produced 1.37 million tonnes of chicken meat. Of this amount produced, 39,700 tonnes (worth $78.9 million), were exported to major market in South Africa, South Pacific Islands, Hong Kong, Singapore, and the Philippines (ACMF, 2023). Whole eggs and egg products are exported to mainly Asian markets.

Export of both Australian chicken meat and eggs have increased over the past couple of years with the opening of new markets. This is because avian influenza (bird flu) has affected poultry production in Asia, Europe, and the United States, which are major poultry producers. Australia remains free of bird flu.

Commercial breeds used in both Australian broiler and layer industries have been developed for the specific purpose of either meat or egg production and are highly refined hybrid (crossbred) breeds.

The breeds used are developed by major international poultry breeding companies and have been selected for specific features such as robustness, disease resistance, growth and meat yield or egg production (depending on the industry). Conventional selective breeding techniques are used to improve breeds. These hybrid strains are usually named after the companies that developed them. The hybrid strains used in Australia are generally Ross and Cobb for the broiler industry and layer breeds Hisex, Hy-Line, and ISA.

Pure breeds are not usually bred for commercial production and efficiency and are not used for large scale commercial production. Popular Australian pure breeds for backyard production include Australorps (Australian developed dual-purpose breed); Leghorn (layers); ISA Brown (layers); Plymouth Rock (dual purpose breed); Silkie (layers and pets);

and Sussex (dual purpose breed).

Commercial layer and broiler production occurs close to processing plants and are situated close to larger cities and urban areas with readily available feed sources, electricity, labour, good quality water, processing plants and transport. Fresh eggs and poultry meat are perishable products so the proximity to consumers and reliable transport and feed sources reduces costs of freight and affect where production is carried out.

Poultry are commercially farmed for egg production in every state and territory in Australia except the Northern Territory. With a lack of grain production in the Northern Territory, the cost of transporting feed stops commercial poultry production for both industries.

Both broiler and layer production can be carried out under a range of systems, from intensive to semi-intensive. Types of systems for the broiler industry range between intensive litter-furbished sheds to extensive free-range systems. In the layer industry, management systems range from intensive cage and barn laying systems to semi-intensive free-range systems and organic for both.

As well as a range of production systems for Australian broiler and layer production, there are also specialised diets which add value to production, allowing the product to target niche markets, including: organic chicken meat or eggs, corn fed chicken meat and enriched eggs (for example Omega-3).

To learn more about the Australian broiler and layer industries and different production systems, watch:

Layer Industry

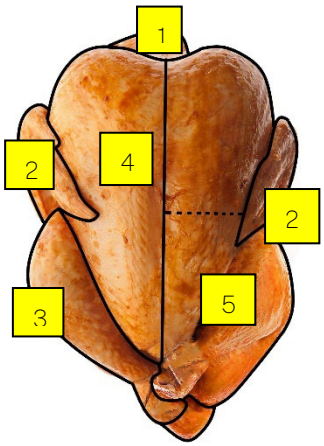
- 'Danyel Ahmed: an Australian cage egg farmer', - investigate cage egg production, Australian Eggs
- 'Rob Peffer: an Australian barn egg farmer' - investigate barn systems and watch egg grading and packaging, Australian Eggs
- 'Meet free-range egg farmer Lachlan Green': explore a free-range system, niche marketing, animal welfare and grading and packaging systems, Australian Eggs

Broiler Industry

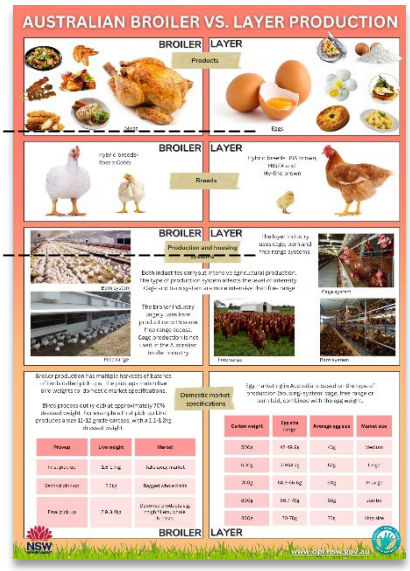
- 'A day in the life of a chicken meat farmer': explore daily activities on a barn and free-range broiler farm for a batch of chickens, Australian Chicken Meat Facts
- 'Visiting a meat chicken farm': investigate biosecurity, animal welfare and broiler production in a barn system with free range access, Australian Chicken Meat Facts

2. Use NSW DPI Schools Program 'Poultry' poster, to complete the table by naming the carcass location of the chicken and giving examples of poultry cuts.

Location	Carcass location	Poultry cuts
1		
2		
3		
4		
5		
Other		



Refer to the Australian broiler vs. layer production posters to complete the following questions



3. List the main raw product/s from the layer and industry.

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4. List the main raw product/s from the broiler industry.

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5. List 5 value added products from the layer industry.

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6. List 5 value added products from the broiler industry.

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7. List the breed/s used for the layer and industry.

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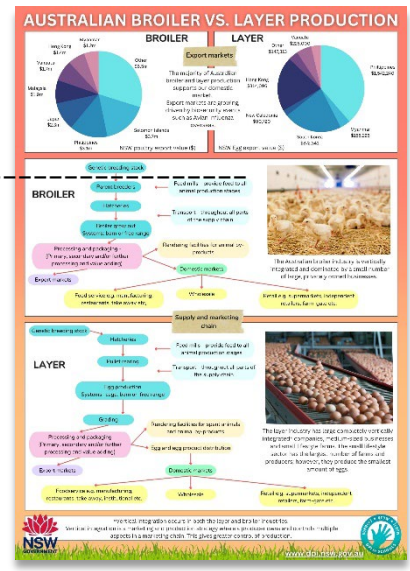
8. List the breed/s used for the broiler industry.



9. Compare commercial layer production systems

Cage_____

- Barn _____

  _____

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  _____

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- Free range_____

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10. Broilers process out (yield) at approximately 70% dressed weight.

    Dressing percentage = (carcass weight ÷ liveweight) × 100

    Use this equation to calculate answers and complete the table for the broiler domestic market specifications.

Market	Live weight (kg)	Carcass weight (kg)	Dressing percentage
Take-away market birds	1.6-1.7kg		70%
Bagged whole birds		1.54kg	70%
Deboned products	2.9-3.4kg		70%

12. Use ‘Export markets’ data to list export destination for both NSW layer and NSW broiler industry products.

_____

_____

13. Identify a global region or continent that is important to both the NSW broiler and layer industry export markets. Explain why you think that particular area consumes large amounts of NSW primary industries products.

_____

_____

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_____

14. Explain why Australian poultry meat and egg exports and new markets have grown over the last couple of years (Hint: think of biosecurity).

_____

_____

_____

_____

15. Define vertical integration

---

16. Evaluate free range production vs barn or cage production for either the broiler or layer industry. Evaluate each system in terms of:
    - Production efficiency
    - Management
    - Animal welfare

Measuring finances - poultry production

There are many features to a farm business that producers need to manage, including financial, physical, environmental, animal welfare, risk management, workplace health and safety and marketing. Agricultural productivity is measured as the ratio of agricultural outputs to agricultural inputs.

Identifying farm performance is essential for farm business monitoring. The types of performance indicators depend on the farm business plan.

Production performance indicators are specific to the enterprise. Livestock production performance indicators include yield measurements such as: calving or lambing percentage, weight gain for age, live weight, milk production/cow, milk composition, kg fleece, mortality rates, number of eggs. In plant production enterprises production indicators include: yield kg/ha, yield kg/megalitre water and other yield and quality measurements.

Marketing performance indicators also depend on farm enterprises. Examples could include quality aspects such as micron, genetics, fat (mm), fleece tenderness, absence of weeds and contaminants, moisture content, protein percentage, customer satisfaction, minimisation of costs associated with transport, storage and selling.

Gross margins

Gross margins: (enterprise budgets) are used to measure and compare performance of individual enterprises, not whole farm performance.

Gross margin = Total income – Total variable costs

Benchmarks: Unproductive enterprises give a negative gross margin; productive enterprises show a positive gross margin

1. Calculate the gross margins for a small-scale layer enterprise and a small-scale broiler enterprise.

A)

Layer production sample gross margin (small- scale)			
Background: Birds are purchased at 18 weeks of age and sold at 70 weeks of age (52 weeks of production). Selling 95 spent hens sold. Marketing: Organic, free-range eggs sold to niche markets. Enterprise: Layers Enterprise unit: 100-layer hens Mortality: 5% Production system- Organic barn/free range Size- 2 ha			
Income			
	Quantity	Price	Total ($)
Jumbo and extra-large eggs	820 (dozen)	$7.80/dozen	
Large eggs	950 (dozen)	$8.00/dozen	
Medium eggs	400 (dozen)	$7.80/dozen	
Spent hens	95 hens	$1.00/head	
		(A) Total income	
Variable costs			
	Quantity	Price	Total ($)
Pullets	100 hens	$7.50/head	
Feed- layer pellets	600 kg	$4.95/kg	
Sawdust	6 bales	$105/bale	
Labour- broilers only	180 hours	$20/hour	
Advertising/marketing	1 flock	$250/flock	
Egg collecting and packaging	2170 dozen	$0.20/dozen	
Labour (collecting and packaging)	60 hrs	$18/hour	
		(B) Total variable costs	
		(C) Gross Margin = (A-B)	
		Gross margin/ bird	
		Gross margin/ unit area	

B)

Broiler production sample gross margin (small-scale)			
Background: 100 birds reared. Birds are housed as day old chicks and slaughtered and sold at 8 weeks of age. Slaughtering and selling 85 birds. Average 2.2kg dressed weight Enterprise: Broilers Enterprise unit: 100 broilers Marketing: Barn/free-range birds sold to niche markets. Mortality: 5% Production system- barn/free range Size 3ha			
Income			
	Quantity	Price	Total
Bird sales	272kg	$18.00/kg	
Manure/spent litter	1800kg	$80	
		(A) Total income	
Variable costs			
	Quantity	Price	Total
Chicks	100 chicks	$4.00/head	
Feed- Starter	220kg	$0.98/kg	
Feed- Finisher	280kg	$580/tonne	
Sawdust	3 bales	$105/bale	
Labour- broilers only	22 hours	$20/hour	
Marketing/advertising	1 flock	$180/flock	
Pasture maintenance	1 flock	$50/flock	
		(B) Total variable costs	
		(C) Gross Margin = (A-B)	
		Gross margin/ bird	
		Gross margin/ unit area	

2. Identify which production enterprise is more profitable in terms of the gross margin?

_____

_____

3. The broiler production system produces five batches of broilers each year. The layer system produces one batch each year. Calculate and contrast the annual gross margin/unit area, for each system. Which is the most profitable in terms of the gross margin/annum?

_____

_____

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_____

Current and emerging technologies

Current and emerging technologies in the poultry industry include:

- Animal technologies e.g., Artificial Incubation, Embryo Transfer, herd testing, electronic cow identification,
- Poultry shed technologies e.g., 3-D printing metal and plastic replacement parts; cleaning and sanitising robots, automated egg collection, remote controlled environment control (temperature, humidity, wind, light); Artificial Intelligence and sensor surveillance with detection of ill birds and predators; automated door openers for barns.
- Feeding technologies e.g., drones for flock surveillance; automated feeding and watering systems.
- Management technologies e.g., integrated electronic real-time marketing, finance; infrastructure, pasture and flock management software and applications; AI for sorting eggs and birds for packing and processing; use of solar to increase sustainability and profit.

1. Select a poultry 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

Animal welfare

Animal welfare and ethical treatment of animals is the human responsibility to provide and adopt standards of care and respect to the animals in their care.

Animal welfare guidelines, legislation and how animal welfare is measured and enforced differ between and within countries globally.

In Australia, the federal government has responsibility for trade and international agreements that involve animal welfare issues; including providing legislation that covers the import, export, processing and welfare of animals and animal products. Australian government animal welfare regulations require that farmers deliver an acceptable standard of care for their animals. State and territory animal welfare agencies manage and enforce these regulations.

Australian agriculture and farmers are world leaders in animal welfare. Australian farmers take pride in breeding and producing animals for various markets to a high-quality level and follow and adopt animal welfare practices for the following reasons:

- Farmers genuinely care and take pride in looking after the animals in their charge to the best of their abilities.
- Stressed animals are not productive. Other than genuinely caring for their animals, loss in production leads to loss of profit.
- To keep the good reputation of high-quality Australian livestock production.
- To meet consumer and community expectations and trust of Australian animals being farmed with high animal welfare standards.

Even though Australian agriculture boasts a good reputation of high animal welfare; there are unfortunately cases of poor animal welfare carried out by individuals. Developing an understanding and empathy toward farming and livestock production from the paddock to plate is important to consider when making a judgement on what we see in the media. We must realise that individual cases of poor animal welfare, while upsetting and unjust, do not reflect whole industry practices and all producers.

Examples of welfare practices in agriculture that involve debatable ethics include live animal export; caged egg production with chickens; using farrowing crates in piggeries; mulesing sheep and removing young calves from dairy cows to name a few.

Welfare in the poultry industry

The Australian poultry industry is focusing on improving its animal welfare standards and reversing the negative consumer perceptions of welfare surrounding production in the past.

The most significant changes to improve poultry welfare in the standards and guidelines include:

- A phase-out of conventional layer hen 'cages' over 10 to 15 years (at the latest by 2036), depending on the age of current infrastructure.
- A requirement to provide environmental enrichment for meat chicken breeders.
- Changes to the minimum light intensity and required periods of darkness, ventilation, and temperature parameters for all poultry species.

Find out more at: Australian Animal Welfare Standards and Guidelines for Poultry

Extension activity

- Use the internet to investigate a welfare issue for poultry production. Issues to investigate could include housing systems; poor ventilation and air quality; lack of mental stimulation and natural behaviours such as foraging and dustbathing; stocking rates in intensive systems.
- Brainstorm with your class/pair advantages and disadvantages surrounding the issue.
- Decide if the practice has overall positive or negative animal welfare impacts.

Poultry 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 in politics, to environmental engineering, careers in Agriculture are at the forefront of innovation.

Of course, farming remains at the heart of the industry, but even 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.

Australia's rural industries provide a fundamental contribution to the Australian economy and way of life. The Layer and Broiler industries both support employment and economic output from regional and rural communities to cities across the country. The industries have consistently grown over the past three decades.

Directly and indirectly, the Broiler industry contributes $7.9 billion to the Australian economy and employs 58,000 people (full-time equivalent). It accounts for 0.45% of Australian GDP. The industry is largest in NSW, where it accounts for $2.8 billion of gross state product and 20,000 jobs. In South Australia, the industry accounts for 1.1% of the economy.

Directly and indirectly, the Layer industry contributes $8.3 billion to the Australian economy). The three largest egg producing states are New South Wales, followed by Victoria then Queensland, which are followed by the other states and territories.

Employment opportunities

- Poultry development officer
- Intensive livestock industries manager
- Research scientists
- Animal Welfare officer
- Seasonal conditions officer
- Agricultural Land use officer
- Research officer
- Soil technician
- Nutrition research officer

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

1. Use the internet and other sources to investigate a poultry 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:

- Free range chicken farming- Yarra Farm New South Wales
- A day in the life of a chicken meat farmer
- Carers in Poultry- Poultry Hub Australia
- 14 Careers in the Poultry Industry With Duties and Wages

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 AG5-2 explains the interactions within and between agricultural enterprises and systems 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 AG5-7 explains and evaluates the impact of management decisions on animal production enterprises AG5-9 evaluates management practices in terms of profitability, technology, sustainability, social issues and ethics AG5-10 implements and justifies the application of animal welfare guidelines to agricultural practices AG5-11 designs, undertakes, analyses and evaluates experiments and investigates problems in agricultural contexts AG5-14 demonstrates plant and/or animal management practices safely and in collaboration with others	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 • Research a range of current and future employment opportunities in agriculture, • evaluate intensive and extensive production systems, for example: – intensive versus free-range meat bird production • identify and apply ethical and WHS practices, for example: (ACTDEP050) – demonstrate safe and ethical handling of animals • investigate procedures in the management of plants and animals within animal welfare guidelines (ACTDEP048, ACTDEP050) Core A: Animal Production 1 • Describe an animal enterprise • Investigate a range of important animal management skills, for example: – monitoring and recording production data, eg growth rates – drenching, drafting, mustering, yarding, catching and restraining • Investigate and implement a range of animal husbandry operations, following animal welfare guidelines, including Animals in Schools (ACTDEK044)

- Collect accurate evidence and record relevant data relating to the animal enterprise, for example: – weight gains – health treatments – feeding rations
- Research the markets available for chosen animal agricultural products, for example: – chilled export lamb market – domestic fresh milk market – free-range egg market
- Assess the market specifications required to market chosen animal agricultural products
- Examine the profitability of an agricultural animal enterprise
- Investigate the social and ethical issues that affect the chosen animal enterprises, for example: (ACTDEK040) – animal stocking rates – use of hormonal growth promotants (HGPs) – mulesing – the use of battery cages in egg production
- Research an agricultural issue relevant to the animal enterprise and propose possible solutions, for example: (ACTDEK044) – stock theft – shearer shortage – live exports – rising cost of feed
- Identify and apply ethical and WHS practices, for example: (ACTDEP050)
  – demonstrate the safe handling and treatment of animals
- plan and undertake procedures in the management of an animal enterprise within animal welfare guidelines (ACTDEP048, ACTDEP050)
- Work collaboratively to perform animal enterprise management activities (ACTDEP050, ACTDEP052)

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, e.g. grazing oats – Bos indicus cattle for tropical regions – fine wool Merinos for hot and dry regions
- Investigate the effect of beneficial and harmful microorganisms and invertebrates on plant and/or animal production
- 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
- Compare alternative production systems for a plant and animal enterprise, for example: (ACTDEK044) – glasshouse plant production – biodynamic and organic production – commercial worm farming
- Evaluate different production techniques for a chosen agricultural system or enterprise, for example:
  – caged layers versus free-range layers
- Design and conduct a controlled agricultural experiment, for example: (ACTDEP049)
  - compare growth rates
- investigate the role of value-adding in marketing agricultural products

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
- Analyse nutritional requirements for the production cycle of an animal, for example: – nutrition for growing animals – nutrition for pregnant animals

- Select and use technologies to assist effective animal management practices, for example: (ACTDEK047)
- identify emerging technologies that affect sustainability, for example: (ACTDEK041)
- Investigate profitability using financial tools, eg gross margins and budgets
- Implement and document practices in accordance with animal welfare codes
- Draw conclusions from evidence and analysis of data, for example: – determine the best feed for optimal growth rates – determine the suitable stocking rate
- Examine and analyse data from a range of sources, for example: – primary and secondary data, e.g. experiments, websites
- Communicate an understanding of trends, patterns and relationships in data to a specified audience, for example: – write a report – produce a presentation – create a website