

Industry Insights - pork production

Answer guide



www.dpi.nsw.gov.au

Author: Meg Dunford (Project Officer School programs, NSW DPIRD Orange).

Editors and Advisors: Michelle Fifield (Coordinator School programs, NSW DPIRD Orange), Jo Hathway (Project Officer School programs, NSW DPIRD Tocal College) and David Brouwer (NSW DPIRD Tocal College).

Disclaimer: This resource is produced for use by teachers and students. The information contained in this resource is based on knowledge and understanding at the time of writing (October 2021). However, because of advances in knowledge and technology, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information. To the extent permitted by law, the Department of Primary Industries within Regional NSW excludes all liability for any direct or indirect losses, damages, costs or expenses, incurred by, or arising by reason of, any person using or relying on this document (in part or in whole) and any information or material contained in it. Recognising that some of the information in this document is provided by third parties, the Crown in right of the State of New South Wales acting through the Department of Primary Industries within Regional NSW, the author and the publisher take no responsibility for the accuracy, currency, reliability and correctness of any information included in the document provided by third parties. Department of Primary Industries within Regional NSW expressly disclaims responsibility for any error in, or omission from, this report arising from, or in connection, with any of the assumptions being incorrect or otherwise.

Copyright

© The Crown in right of the State of New South Wales 2022, except where indicated otherwise. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0). Under this licence the material is available for free use and adaption. Educators may use, share, adapt, and republish material from the resource. You must give appropriate credit, provide a link to the licence, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.



Australian pork production – Answer Guide.....	4
Pig anatomy.....	4
Pig breeds.....	4
Pork processing, marketing and value adding.....	8
Specifications and markets	13
Pig diseases and biosecurity.....	16
Swine digestive anatomy and physiology (Monogastric digestion).....	16
Swine nutrition.....	17
Swine reproduction and reproductive technologies.....	19
Practical activity- detecting oestrous in sows	22
Current and emerging technologies in the pork industry.....	22

Australian pork production – Answer Guide

Sample answers have been provided for learning activities where applicable for this document. The following suggested answers should be used as a guide. It should be noted that these sample answers are suggested answers and not necessarily the very best answer, nor are they the only possible answers.

All resources found at [‘NSW DPIRD Industry insights- Pork production’](#).

Pig anatomy

Label the parts of the pig using the NSW DPIRD ‘Pork Production’ poster.

1. Snout	8. Chest	15. Loin	22. Pastern
2. Face	9. Elbow	16. Teats	23. Foot or trotter
3. Ear	10. Forearm	17. Navel (gilt/sow); sheath/pizzle (barrow/boar)	24. Base of ham
4. Jaw	11. Knee	18. Underline	25. Scrotum (boar); crotch (barrow)
5. Jowl	12. Dewclaw	19. Flank	26. Rump
6. Neck	13. Rib	20. Stifle	27. Ham
7. Shoulder or blade	14. Top or topline	21. Hock	28. Tail

Pig breeds

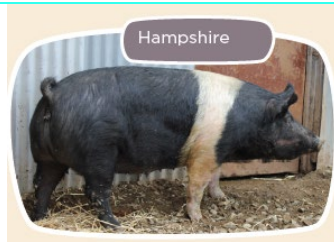
1. Use the NSW DPIRD ‘Pig Production’ poster to identify pig breeds important to Australian production. Research the origin and features of each breed pictured to complete the following table.

	Breed: Landrace
	Origin: Denmark
	What genetics (breeds) were used to develop this breed? Developed in Denmark using the Danish native pig and the Large White
Breed characteristics: (Skin colour, ears, frame size and length etc.) • white skin free from black hair. They are a lop-eared pig with a long middle, light forequarters, and excellent ham development • Early maturing breed with early, rapid growth, and high growth for age with heavy weaning weights. • Usually not as prolific a breeder as the Large White and tend to be slightly fatter than Large Whites	
Uses and performance/carcass characteristics: • Landrace became popular in Australia since intensive housing and production systems became popular. Landrace have traditionally been used in crossbred programs with Large Whites as they suit intensive production and meet market specifications. Today, most commercial crossbreds contain Landrace and Large White blood. • Carcass characteristics: long middle, light forequarters, and excellent ham development. • The Landrace breed improved carcase quality in the early years of its introduction into Australia, adding large frame size and increased eye muscle size. • Pure bred Landrace pigs are classed as vulnerable in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.	

	Breed: Large White Origin: England in the 1700's. The breed was first introduced into Australia in the last quarter of the 19th century What genetics (breeds) were used to develop this breed? Developed through crossing a small, fleshy type of pig from Canton in China with white pigs from Yorkshire and adjacent counties, producing the Small White, Middle White and Large White breeds
Breed characteristics: (Skin colour, ears, frame size and length etc.) • White skin free from black hair • Large-framed, late-maturing type which have a long middle and light shoulders. They have long, deep sides and flanks and are longer in the leg than other breeds but tend to have poor ham development. • Head- moderately long with a slightly dished face and pricked ears. • High fecundity (fertility). Sows are heavy milkers and have excellent maternal instincts. • Sound structure- good feet and legs	
Uses and performance/carcass characteristics: • Large White is now the most popular breed in Australia with most intensively housed herds containing a large proportion of Large White blood • The Large White is a rugged and hardy breed that can withstand a wide range of climatic conditions. • Commonly used in crossbreeding or hybrid programs, with the most popular cross being Large White x Landrace. This cross is often used as the maternal line in commercial herds. A third breed such as a Duroc or Hampshire is often used as a terminal sire. Breeding programs result in pigs produced for market that meets consumer's requirements of low amounts of fat and high levels of lean meat content. • Lower back fat measurements with high daily weight gains make the breed ideal for producing high growth lean meat- thus meeting market specifications. • Pure bred Large Whites are classed as vulnerable in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.	
 Figure 3: Duroc boar.	Breed: Duroc Origin: United States of America. Exact origin unknown. Imported into Australia 1922 and 1936 then 1981. What genetics (breeds) were used to develop this breed? Modern Duroc originated from crosses of the Jersey Red of New Jersey and the Duroc of New York.
Breed characteristics: (Skin colour, ears, frame size and length etc.) • Large-framed, late-maturing type, excellent for heavy-carcass production (baconer and backfatter markets). • Light forequarters, particularly the head and neck • Small, lop ears and slight dish of the face. • Skin is a solid reddish colour, varying from gold to a deep, brick red. • Medium body length	
Uses and performance/carcass characteristics: • The Duroc was imported into Australia to provide a third commercial breed to the Landrace and Large White breeds. Duroc are used in crossbreeding programs as a terminal sire when crossed with Large White x Landrace cross sows' This cross is very suitable for the bacon trade. • Duroc's have higher levels of intramuscular fat (IMF) than faster growing 'white' European breeds such as Large White, Landrace and Yorkshire. Higher IMF correlates with greater eating quality- juiciness and tenderness • Pure bred Large Durocs are classed as critical in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.	

	Breed: Tamworth Origin: Ireland. Descended from the wild hog residing in the Midland Counties of England. Domesticated around 300 years ago Imported into Australia in the 1890's What genetics (breeds) were used to develop this breed? They are not a composite breed and are thought to be one of the oldest and purest breeds in Britain.
Breed characteristics: (Skin colour, ears, frame size and length etc.) - Narrow head with erect ears, very long straight snout suited to turning over hard and rocky ground - Very good length, but lack eye muscle of modern breeds. - Tamworth's almost have a 'feral' pig appearance and an abundance of hair which makes them very hardy and ideal for outdoor production in a range of climates. - Their coat varies in colour from light gold to red, with red skin. - Tamworth sows make excellent mothers and are very maternal, but litter sizes are small (5-7) piglets and the piglets are slow growing compared to other breeds	
Uses and performance/carcass characteristics: - Compared with modern breeds they are slow growing, slow weight gain, have a small eye muscle and tend to lay down fat quickly as they grow and mature, so don't meet current market specifications. In past consumer trends, when consumers preferred more fat on their bacon the Tamworth was highly regarded for high quality bacon. - Carcass taste and eating quality is ranked very high, but unfortunately eye muscle area and backfat measurements do not meet commercial market specifications. - This breed has had the least genetic improvement of any of the British origin pigs since their introduction into Australia. - Pure bred Tamworth's are classed as critical in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.	
	Breed: Wessex Saddleback Origin: England – Wiltshire and New Forest (Hampshire area) in the West counties of England. Imported into Australia in the 1930's. What genetics (breeds) were used to develop this breed? A cross between two indigenous old English bacon pigs the Essex and the Wessex.
Breed characteristics: (Skin colour, ears, frame size and length etc.) - Small lop ears and slight dishy face. Pigs have a black head and neck, as well as a clearly defined continuous belt of white extending over the forelegs and shoulder. - This breed was very popular in Australia for many years because of their docile nature, excellent mothering ability and their ability to forage. - The breed has been traditionally used in commercial crossbreeding systems, especially with Large White. - These animals are regarded as excellent eating pigs. They are traditionally used as a 'baconer' and raised for bacon and hams. - Medium-framed, late-maturing type, slow growing breed with medium carcass length, unsuitable to intensive production.	
Uses and performance/carcass characteristics: - Wessex Saddleback meat is characterised by its slightly darker colour and heavier marbling which produces a sweet tasting pork. - Saddle backs tend to be hard to finish to heavier weights with acceptable fat scores (they produce too much backfat for market specifications). They can also have pigmentation on the skin and carcass showing the stripe. Black skinned pigs and sometimes have 'seedy belly' which is pigmentation in the glands in the black belly, these factors contribute to challenges for carcass production. Although pigmentation does not have any effect on eating quality it is undesirable to consumers.	

- Purebred saddle back pork is suited to niche markets.
- The Wessex Saddleback is now recognised as an endangered species by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.



Breed: **Hampshire**

Origin: United States of America. The Hampshire breed was developed in the United States from the Wessex Saddleback and other varieties first imported from England around 1825. Hampshire pigs were only introduced into Australia in the 1980's, from Canadian and New Zealand bloodlines

What genetics (breeds) were used to develop this breed?

The breed derives directly from the English Wessex Saddleback.

Breed characteristics: (Skin colour, ears, frame size and length etc.)

- Small erect ears and slight dishy face. Pigs are black and white skinned (black with a continuous white saddle around the shoulder and forelegs).
- Quiet, placid temperament. Sows are very maternal with high fecundity (fertility) with average litter sizes of 14 piglets.
- Hampshire boars are often used in crossbreeding programs to add the lean quality to the meat
- Early maturing with rapid growth. Large, heavily muscled carcass.

Uses, performance and carcass characteristics:

- Carcass is thin-skinned and lean
- Hampshire's have a lean and muscular carcass with minimal backfat. They have exceptional eye muscle area for high yielding bacon or loin cuts. They are excellent terminal sires over any breed, adding yield in the back (loin) and ham area.
- Used mainly in crossbreeding programs.
- Pure bred Hampshire's are now the most critically rare pure breed in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.



Breed: **Berkshire**

Origin: England. One of the oldest breeds of pigs in England from the county of Berkshire. Berkshire pigs were imported into Australia in the late 1800's.

What genetics (breeds) were used to develop this breed?

Berkshire pigs are indigenous to England for the shire of Berks area.

Breed characteristics: (Skin colour, ears, frame size and length etc.)

- Berkshire pigs are black with six specific white markings: four white socks, a white splash on the snout, and a white tip to the tail. Slightly dishy face and erect ears.
- The Berkshire is popular with outdoor production, as the animals are very hardy and good foragers.
- Good temperament. Sows are very maternal and fertile.
- Medium sized, slow maturing

Uses, performance and carcass characteristics:

- Berkshire's have higher levels of intramuscular fat (IMF) than faster growing 'white' European breeds such as Large White, Landrace and Yorkshire. Higher IMF correlates with greater eating quality- juiciness and tenderness
- Berkshire pork, prized for juiciness, flavour, and tenderness, is pink-hued and heavily marbled. Its high fat content makes it suitable for long cooking and high-temperature cooking. The meat also has a slightly higher pH, which makes the meat darker, firmer, and more flavourful.
- Berkshire pork is prized by the Japanese for its noticeably sweeter, marbled and more tender meat. It is used for the Japanese dish 'Kurobuta Pork' (literally black pork) and culturally referred to as the Kobe or Wagyu of Pork.

- The breed appears to be experiencing resurgence in popularity for small scale production for niche markets.
- They are not a pig suited to the general butcher trade, rather, they are more readily accepted in restaurants and sell well at Farmers Markets. They also have black hair which is an issue for the general consumer market. Like all other black breeds though, you can use a pure white boar over them to produce white piglets
- Pure bred Berkshires' are classed as vulnerable in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.



Breed: **Large Black**

Origin: England. Large Black is native to Cornwall, Devon, and Somerset in southwestern England. Large Black pigs were imported into Australia in the late 1900's.

What genetics (breeds) were used to develop this breed?

Large Black was developed using indigenous pig breeds from south west and eastern England.

Breed characteristics: (Skin colour, ears, frame size and length etc.)

- Large Blacks are a fully black pig with black skin and hair. They have very large, lop ears which impede their vision and hearing. Extra-large framed pig with long, thick, deep bodies. Slow maturing.
- Only British all-black pig breed.
- Large Blacks are well known for their hardiness and suitability for extensive farming, due to their strong foraging and grazing ability, which efficiently converts poor quality feed into meat.
- Sows are excellent milkers with a docile temperament. Sows stay highly fertile into old age and have a strong maternal instinct. Sows are very fertile giving birth to large litter of 10 plus piglets.
- Large Blacks are often crossed with Yorkshires or Landrace pigs for commercial production, which produces white skinned, hybrid piglets with good growth for age, and a lean carcass.

Uses, performance and carcass characteristics:

- Large Blacks are known for their lean, quality carcass and flavour without an excess of back fat.
- Pigs are used in crossbreeding programs for commercial production for the baconer trade or for niche markets using extensive, free-range production.
- Large Black meat is known for its succulent taste and eating quality; it is especially suitable for cured products: bacon, salami prosciutto & capocollo.
- Pure bred Berkshires' are classed as endangered in Australia by the Rare Breeds Trust of Australia, due to commercial production using hybrid pigs.

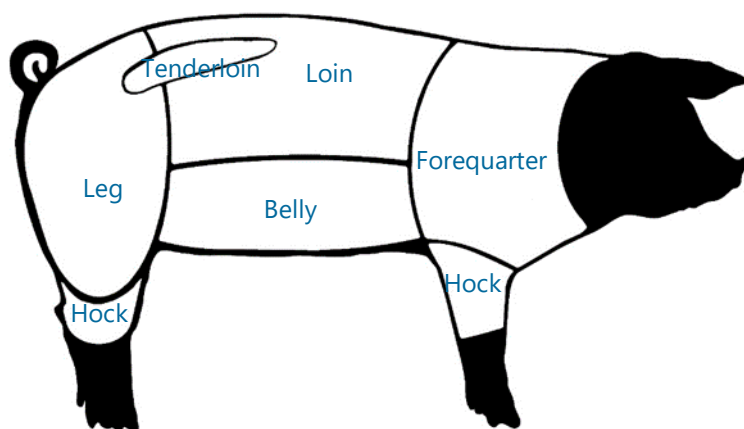
Pork processing, marketing and value adding

2. Define value-adding and include an example of a value-added pork product.

Value-adding involves processing a raw product to make it of greater value to the consumer. The price is determined by what customers are willing to pay based on their perceived added value. For example, ham, salami, stir fry pork strips, pork mince, bacon etc.

3. Watch "[Australian pork carcass breakdown](#)", Inspired by Australian Pork,

4. 2019. Use the NSW DPIRD 'Pork Production poster to label the six carcass locations



5. Use the NSW DPIRD 'Pork Production' poster to complete the table by listing pork cuts.

Carcass location	Pork cuts	Carcass location	Pork cuts
1. Leg	• Leg roast • Easy carve leg roast • Leg steaks • Mini roast	5. Belly	• Belly • Spare ribs • Rolled belly
2. Hock	• Pork hock or shank	6. Forequarter	• Forequarter roast • Easy carve shoulder • Scotch fillet roast • Forequarter chop • Scotch fillet steak
3. Loin	• Cutlet • Loin steak • Rolled loin • Butterfly steak • Loin chop • Loin rack	Miscellaneous	• Mince • Stir fry strips • Diced pork • Crackling
4. Tenderloin	• Pork fillet		

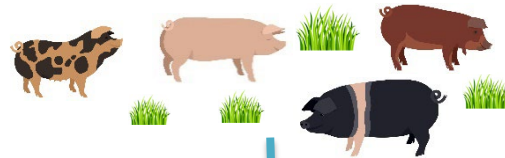
6. Common sale methods for market pigs include: Direct selling to butchers, via consignment to abattoirs, online auctions and saleyard auctions. Use research to find out more about each method and complete the following table.

Marketing method	Description of marketing method	Advantages of method	Disadvantages of method
Direct sales	Direct selling is a form of retail in which products and services are marketed directly to consumers e.g. market pigs are sold directly to retailers, butchers etc.	• Opportunity of receiving higher return (less costs) • Great opportunity for smaller or niche producers • Customer feedback is directly received and influences production • Greater transparency of products to consumer	• Demand can be seasonal • Skills required: producer takes on new responsibilities and roles being responsible for marketing, retailing, advertising and customer relations
Direct consignment or contract	Direct sale at an agreed price, based on depth of backfat (P2) and carcase weight. Approximately 90 percent of pigs are sold by direct consignment in Australia.	• Lower market costs. • Negotiated premiums based on weight and grade. • Payment based on objective measurements. • The producer is provided with carcase feedback (weight and fatness) and may also obtain information on carcase quality and carcase condemnations. • Reduced pre-slaughter handling and stress due to direct consignment to abattoirs.	• The market's unexpected highs cannot be exploited, although contract prices may be based on an agreed market indicator. • Producers should: – Stipulate the day of payment as part of the contract. – Confirm backfat readings by using another kill site, -Request feedback from the processor or inspect carcasses. – Regularly check weights and dressing percentage.
Online auction and saleyard auctions	Live auctions, account for sales of less than 1% of the country's pigs, promote competition and identify supply and demand. (Online auctions don't require animals to be brought to a saleyard.)	• Competitive environment. • No price penalties apply, although buyers may choose to discount on the basis of previous purchase • Online auctions reduce chances of stress, bruising and handling as animals are sold online.	• Price is based on subjective inspection of live animals which does not reveal carcase quality. • Selling costs are 5–7% higher than with direct selling because of agent commissions, saleyard online auction fees charges, and extra transport (saleyard). • Moving pigs between the farm gate and the abattoir triggers bruising, weight loss, carcass condemnations and stock losses. • Fewer options- few saleyards hold pig auctions.

7. Match the missing titles to the descriptions to explain what is happening at each step of the pork production and marketing chain. Use the “NSW DPIRD Pork production” poster for assistance.

Title		Description
Pig production on farm		Farms range from small family owned to large scale corporate owned operations. Operation types include specialist breeding farms (farrow -to-wean), specialist finishing farms (Grow out facilities) or integrations of both. (Farrow-to-finish) Managers precisely manage pigs in terms of nutrition, genetics, reproduction, welfare and health and disease to increase quantity and quality of product and to meet market specifications. Sale methods of market pigs include: Direct selling to butchers, retailers or via consignment to abattoirs, online auctions or via saleyard auction
Transportation		Market pigs and pork products are transported from farm to a processing facility, to retailers and consumer, all throughout the production chain.
Processors	Primary processing	First stage in pork processing e.g. Abattoir. Carcasses are classified according to market specifications. Carcasses can be broken down to fresh pork cuts, frozen or vacuum sealed and delivered to sellers. It can also be sold to butchers and smallgoods producers, as a whole carcass, so individual retailers can develop their own cuts and food styles to suit their customers. It can be directly sold to the consumer.
	Secondary processing (manufacturing)	Second stage in pork processing. Secondary processing involves the further processing of pig meat cuts into value added products bacon, ham and smallgoods through curing, cooking and smoking.
Wholesale/ retail	Exporter	Products are distributed to specific overseas consumers and markets.
	Wholesaler	Sells/ supplies pork product to resellers who in turn sell directly to the end consumer.
	Retailer	e.g. butcher or supermarket, restaurant
	Company owned food enterprise or food service	These businesses may be vertically integrated - production to processing facility to retail outlet or export market or the processor can be linked to a chain of retail outlets and sources pig within strict specifications for these outlets.
	Direct marketing	Farmers/producers have great involvement in the marketing of their pork via farmers markets or community supported agriculture schemes - usually the domain of small scale or niche production systems.
Final consumer		Final consumer purchases pork product for consumption Branding, marketing and campaigns affect sales to final consumers and creation of markets. Consumer requirements affect all stages of production and processing.

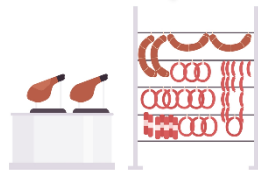
8. Use the following images and the 'Pork Production' poster to create a pork production and marketing chain



Pig production on Farm- Operation types include specialist breeding farms (farrow -to-wean), specialist finishing farms (Grow out facilities) or integrations of both. (Farrow-to-finish)



Primary processing. First stage in pork processing e.g. Abattoir. Carcasses are classified according to market specifications. Carcasses can be broken down to fresh pork cuts, frozen or vacuum sealed and delivered to sellers. It can also be sold to butchers and smallgoods producers or directly sold to the consumer.



Secondary processing. Second stage in pork processing. Secondary processing involves the further processing of pig meat cuts into value added products bacon, ham and smallgoods through curing, cooking and smoking.



Exporter- Products are distributed to specific overseas consumers and markets.



Retailer e.g. butcher, restaurant or supermarket

Wholesaler- Sells/ supplies pork product to resellers who in turn sell directly to the end consumer



Food services/ enterprise- These businesses may be vertically integrated - production to processing facility to retail outlet or export market or the processor can be linked to a chain of retail outlets and sources pig within strict specifications for these outlets.



Transport- Market pigs and pork products are transported from farm to a processing facility, to retailers and consumer.

Direct marketing



Final consumer- Final consumer purchases pork product for consumption.

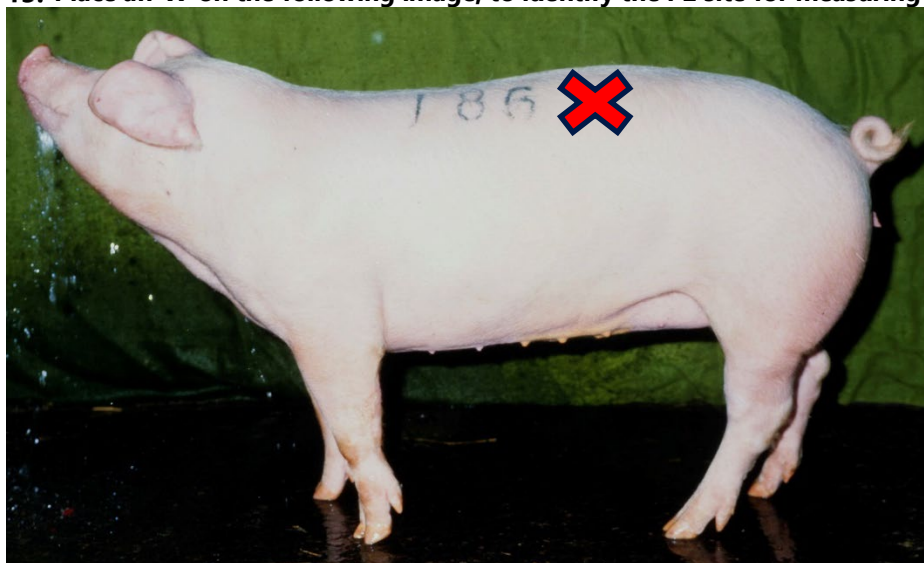


Branding, marketing and campaigns affect sales to final consumers and creation of markets.

Consumer requirements affect all stages of production and processing.

Specifications and markets

9. **List the major market specifications for Australian pork.**
Fat depth at P2 site, weight, lean muscle percentage, age
10. **Pick 2 major pork specifications and describe how a producer could manipulate their management to meet the specifications.**
Answers will vary. Two answers required. Example, fat depth at P2 site. Feed pigs a specific ration that meets growth, weight gain and fat requirements for specific market. Regularly weigh and assess pigs fat depth to determine animal development. Alter ration as required if pigs require more fat or need to slow down to meet market specifications.
11. **List the minor market specifications for Australian pork.**
Breed, genetics, meat and skin colour, sex, intramuscular fat, fat quality.
12. **Pick 2 minor pork specifications and describe how a producer could manipulate their management to meet the market requirements.**
Answers will vary. Two answers required. Example, Breed and meat/skin colour- producer selects large white, landrace genetics to meet fast growth rate for age and have produce white skin pork, thus meeting commercial market specifications.
13. **Place an 'X' on the following image, to identify the P2 site for measuring fat depth.**



14. **Define hot carcass weight (HCW).**
The hot carcass weight (HCW) is the weight of the unchilled carcass in kg after the head, hide and internal organs have been removed
15. **Dressing percentage = (carcass weight ÷ liveweight) × 100**
Use this equation to calculate questions 16a)-c)
 - a) **An animal has a HCW 50kg and liveweight of 69kg. Calculate the dressing percentage.**

$$\text{Dressing percentage} = (\text{carcass weight} \div \text{liveweight}) \times 100$$

$$= (50\text{kg} \div 69\text{kg}) \times 100$$

$$= 72\%$$
 - b) **An animal has a dressing percentage of 70% and liveweight of 65kg. Calculate the HCW (kg) round answer to the nearest kg.**

$$\text{Dressing percentage} = (\text{carcass weight} \div \text{liveweight}) \times 100$$

$$70\% = (\text{carcass weight} \div 65\text{kg}) \times 100$$

$$\text{HCW} = (70\% \div 100) \times 65\text{kg}$$

$$= 46\text{kg}$$
 - c) **An animal has a dressing percentage of 75% and HCW 74kg. Calculate the liveweight.**

$$\text{Dressing percentage} = (\text{carcass weight} \div \text{liveweight}) \times 100$$

$$75\% = (74\text{kg} \div \text{liveweight}) \times 100$$

$$\text{Liveweight} = 74 \div (75\% \div 100)$$

$$= 99\text{kg}$$

16. Complete the table listing specific pig market weight specifications

Market	Liveweight	HCW
Oven pig	20-35kg	15-25kg
Porker	60-80kg	45-60kg
Baconer	80kg +	60-85kg
Backfatter	120kg +	90kg+

17. Explain why it is important to buy Australian made, grown and produced pork products.

Buying pork products that have been made or grown in Australia ensures that the products are safe, fresh and produced to Australia's high standards. It also helps to support Australian pork producers, local businesses and jobs. Buying the produce of Australian farmers helps them keep their jobs, just as you are helping factory workers keep their jobs when you buy the things they make. Food and products that are produced and sold locally use far less energy to reach their destination than imported products. This is better for the environment

18. Table 2 shows the influence feed grain and pork price have on production.**Explain the trend.**

When grain prices peak/increase, the following year sees a reduction in pork produced. This is due to pork producers relying on grain to feed/finish pigs. As supply of pigs (t/CW) decreases, the carcass price index (return) increases. Pig production has nearly halved from 2005-6 to 2019-21, with a noticeable reduction in t/CW produced in 2008-9 due to high grain prices in 2007-8. Since then there has been fluctuation, but it has remained rather stable. Pig production in Australia is heavily reliant on grain prices and \$ return to producers.

19. Tables 3 and 4 show NSW pork imports and Tables 5 and 6 show NSW exports in 2014-2020.**Complete parts a) – h) using the tables.****a) List the 5 main countries importing pork into Australia in 2020.**

United States, Denmark, Netherlands, Ireland, Canada

b) Where does the majority of imported pork in Australia come from in 2020?

United States, Denmark and the Netherlands.

c) Contrast the growth in import revenue and market share between 2014-2020 for:

- United States – import revenue has increased from \$51,893,898 (2014) to \$79,576,641 (2020) and market share has increased from 7% (2014) to 35% (2020).
- Denmark – import market has increased from \$50,934,448 (2014) to \$79,576,641 (2020) and market share has reduced from 35% (2014) to 86% (2020).
- Netherlands- import revenue has increased from \$41,657,776 (2014) to \$58,402,455 (2020) and market share has increased from 4% (2014) to 25% (2020).

d) List the 5 main export markets for Australian pork in 2020.

Singapore, New Zealand, Philippines, Papua New Guinea and Other

e) What was the main export market for Australian pork in 2020?

Singapore

f) Contrast the growth in import revenue and market growth between 2014-2020 for:

- Singapore – import revenue has increased from \$6,630,569 (2014) to \$7,361,517 (2020) and market growth has remained constant.
- New Zealand - import revenue has reduced from \$4,477,768 (2014) to \$3,383,820 (2020) and market share has also reduced from 21% (2014) to 15% (2020).
- Hong Kong – Market emerged/was developed in 2015-6 (\$758,285) and has grown over the four-year period to \$2,209,296 (2020) with market share of 9%.

g) Do you think there is opportunity for Australian pork producers to increase domestic supply of pork to meet or domestic demands and reduce pork imports? Why or why not?

Answers will vary.

- h) What are some of the external factors that might influence pork production in Australia and our import and export markets?

Answers will vary. Could include:

- Government international trade negotiations (political)
- Biosecurity issues – for example, African Swine fever in China 2018/19 resulted in culling of 200 million pigs in Chinese national herd
- World grain prices (effect Australian grain prices)
- Seasonal conditions for example, droughts in Australia effect grain prices (supply/demand)
- World pork prices (effect Australian domestic pork prices)
- Consumer demand and preferences for pork (domestic and export markets)
- Proximity of Australia to export markets
- Australian \$ value

20. Use the NSW DPIRD Pork Production poster to complete the table on production systems in Australia

System	Free range	Bred free range	Indoor housing
			
Description	All sows, boars and their progeny live outdoors but have fulltime access to movable shelters.	Raised indoors on straw - Sows and boars and their progeny are free range until weaning. The progeny are raised indoors on a deep litter system (e.g. straw or rice hull bedding) until sale.	All sows, boars and their progeny are raised in an indoor controlled climate.

Carry out research to answer questions 21-24. A great site to start your research is Australian Pork factsheet [‘Get the Facts on your pork industry’](#)

21. Describe the features of Australian pig, indoor housing production systems.

Indoor housing systems are used for pigs from birth through to finisher animals (for sale or slaughter) as well as lactating and weaned sows. This type of housing protects the animals from climate variations, predators, sunburn and can accommodate pigs of similar ages and sizes to be housed together in small, medium and large groups.

22. Describe the features of Australian deep litter pig production systems.

Deep litter housing systems are usually large open-sided sheds or hoop-like structures with deep litter flooring (rice hulls, straw, sawdust). These systems are used extensively for growing pigs and for group housing of dry sows.

23. Describe the features of Australian free-range pig production systems.

APIQ free range means that pigs are kept permanently outdoors for their entire lives with shelter provided from the elements, and suitable bedding available. All paddocks should include areas for grazing, as well as areas for wallows. All free-range pigs should have unlimited access to paddocks to free range at all times of their lives.

24. Describe the features of Australian outdoor bred pig production systems.

APIQ outdoor bred means that adult breeding sows live in open spaces with unlimited access to paddocks for their entire adult life. Bedded shelter, adequate feed, grazing paddocks, wallowing areas and water are provided. The piglets from these sows are born and raised under these conditions until weaning. At weaning the piglets can be moved to indoor grow-out housing until sale or slaughter; usually these are deep litter systems.

25. Select an animal welfare issue for Australian pork production systems.

In this activity, you will conduct research to: *Evaluate one management practice in Australian pork production, in terms of animal welfare outcomes.*

Answers will vary

Pig diseases and biosecurity

26. Define 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 accessing Australia; controlling outbreaks when they do occur and controlling spread and incursion of pests, diseases, weeds and contaminants already present in Australia.

27. Why is biosecurity a shared responsibility?

While robust response plans are in place to combat outbreaks, preventing pest, disease and weed incursions in the first place, is a shared priority 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. Biosecurity is a shared responsibility as high levels of biosecurity must be a holistic approach-everyone has a role in surveillance, prevention, protection, preparation, recovery and response to possible biosecurity threats.

28. List the 9 ways pig producers can manage pigs to sustain high levels of farm biosecurity.

- NO swill feeding or feeding pigs prohibited matter will feeding
- Reduce contact with neighbouring properties
- Keep pigs separate from other animals
- Quarantine and limit
- Controlled access of visitors, staff, vehicles, equipment and records
- Disease identification and reporting
- Pig identification and movement documentation
- Identification of pigs for sale or slaughter
- National vendor declaration- PigPASS NVD

29. Choose an endemic or exotic pig disease to further research. For your chosen disease conduct research to create a disease awareness brochure of fact sheet that could be provided to pig producers.

In your report include the following:

- Disease common name
- Disease scientific name
- Description of the disease (include animal/s affected)
- Description of how it spreads
- List symptoms (include images where appropriate)
- Describe how the disease can be treated
- List where the disease is found around the world (include a map if possible)
- Describe how the disease affects production, the environment or the economy.
- Summarise the biosecurity duty regarding this disease (How can you prevent the spread of this disease in pork production)

Helpful websites:

- [NSW DPIRD Pig Health and Disease](#)
- [African swine fever](#)
- [Foot and Mouth Disease \(FMD\)](#)
- [Classical swine fever](#)
- [Porcine reproductive and respiratory syndrome](#)
- [\(PRRS\) Postweaning multisystemic wasting syndrome](#)
- [\(PMWS\)](#)

Answers will vary

Swine digestive anatomy and physiology (Monogastric digestion)

30. Use Figure 3 to complete the table by labelling the parts of the monogastric pig digestive tract.

Digestive organ name	
1. Oesophagus	5. Caecum

2. Stomach	6. Large intestine
3. Duodenum	7. Rectum
4. Small intestine	8. Anus

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

Organ		Function	Identify the digestion type where applicable (physical, chemical, both or none)
Mouth		- Mouth consumes and physically breakdowns food through the grinding action of teeth. - Chemical – saliva contains enzyme amylase begins breaking down carbohydrates (starch) into maltose.	Both
Oesophagus		Muscular tube moves digesta to stomach from the mouth	None
Stomach		- Stomach is a muscular organ responsible for storage, initial breakdown of nutrients, and the passage of digesta into the small intestine. - The stomach churns food, mixing it with chemicals: Hydrochloric acid (kills the bacteria in food) and pepsinogen /pepsin (breaks down protein)	Both
Small intestine	Duodenum	- First section of the small intestine. Contains ducts which link secretions from the pancreas (insulin, glucagon, digestive enzymes and sodium bicarbonate) and liver (bile). - High levels of digestion of proteins, fats and carbohydrates occurs in the duodenum.	Chemical
	Jejunum	- Jejunum- (middle section of the small intestine), links the duodenum to the ileum. - This portion allows for the further breakdown of nutrients as well as the beginning of absorption of nutrients via the villi.	Chemical
	Ileum	- Final section of the small intestine - Continues nutrient absorption via villi	Chemical
Large intestine		- Large Intestine- main function is the absorption of water. - Limited chemical digestion occurs in the large intestine.	Limited chemical
Caecum		Caecum- connects to colon/rectum. Has little function	None
Rectum/Anus		Digesta is condensed into a semi-solid material (water absorbed) in large intestine and passed out of the rectum and anus.	None

Swine nutrition

32. List the 6 nutrients essential for swine.

Water, carbohydrates, proteins, fats, vitamins and minerals.

33. What is the importance of essential amino acids and essential vitamins and minerals to a pig's diet?

Essential amino acids and essential vitamins and minerals cannot be synthesised by the body. Even though they are required in small amounts – if they are not included in the diet the pig cannot carry out normal bodily function, growth and development.

34. A batch of piglets in a commercial piggery all present symptoms over a 3-week period after changing ration. They are all increasingly getting sick and are wastey with poor muscle

development and growth for age. All animals are on the same ration. What could be the possible problem/deficiency?

The new ration may not have adequate levels of Lysine for the pigs needs.

35. Define swill feeding and give examples of prohibited matter.

Swill feeding is the feeding of any mammalian or avian meat material, meat products, offal, hide feathers or any food that has come into contact with pigs, mammals and avians. Prohibited material include:

- food scraps and wastes from:
 - kitchen scraps
 - processors and manufacturers
 - food retailers including supermarkets and bakeries
 - hotels, restaurants, cafés, fast food outlets, delicatessens, lunch bars
 - rubbish dumps
- used cooking oil, unless it has been treated to the required standard
- offal
- blood, bones, carcasses from mammals.

36. Why is swill feeding illegal in Australia?

Swill feeding of prohibited matter is a significant biosecurity risk for the introduction of Emergency animal diseases (EAD's) and the emergence of zoonotic diseases, particularly those from certain viruses, including Foot-and-mouth disease (FMD) and African swine fever.

37. Identify and list 6 different production/growth stages of pigs

Weaner, grower, finisher, dry sow or boar, lactating gilt, lactating sow.

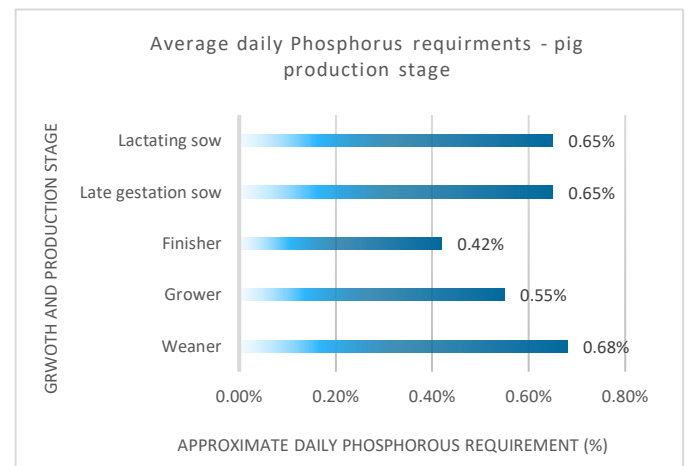
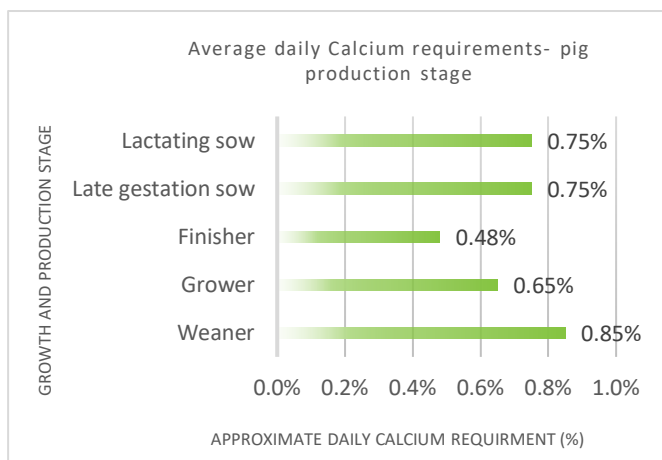
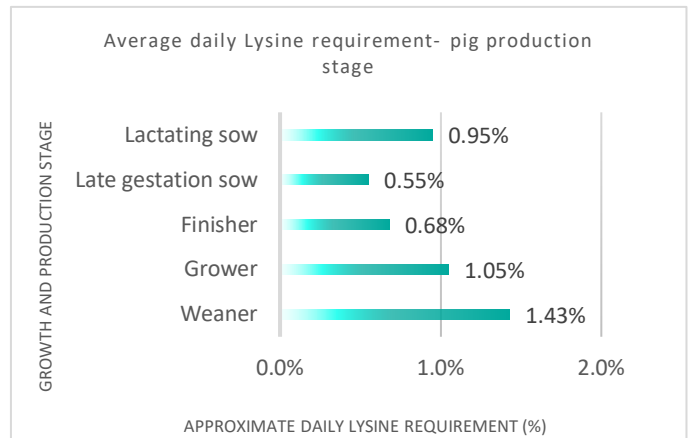
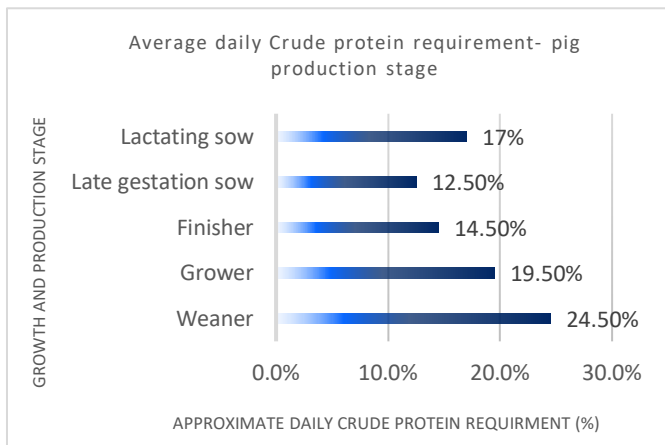
Selecting rations- worksheet

Part 1A)-G) Answers will vary dependant on individual justification for ration choice

Part 2 Answers will vary dependant on justification for ration choice. Possible solutions include.

Pig growth and production stage:	Possible ration/s:	Why did you choose this ration?
Weaner:	Ration 5 + supplementary addition of either Ration 10 (Soybean meal), Ration 11 (Cottonseed meal) or Ration 12 (oats) to meet weaner Crude protein % requirements	Justifications will vary.
Grower:	Ration 5 or possibly 2 – selection dependant on justification. Ration 5 is closest to Crude Protein requirements and has lower fibre content so more digestible and lower fat (so less energy wastage) than Ration 2 and meets energy requirements.	
Finisher:	Ration 4 meets all requirements however has high Crude fat which could negatively affect muscle: fat ratios and finisher market specs so not appropriate. Therefore Ration 6 is most appropriate in terms of CP, Ca and P; but does not meet Lysine and energy requirements. Supplementation of Lysine with Ration 9 (Lucerne hay) would meet nutritional L requirements without providing excess energy (crude fat) at crucial time to production and extra fibre would make animals feel full.	
Late gestation sow:	Ration 3- meets all requirements. High CP and energy than required. Would need to be monitored- could be fed with high fibre to fill gut and make animals feel full.	
Lactating sow:	Ration1 meets all Lactating sows daily nutritional requirements	

Part 3 graphs:



Swine reproduction and reproductive technologies

38. What is a sow?

A sow is a female who has had one or more litters of piglets.

39. What is a gilt?

A gilt is a young grower- finisher female, prior to her first litter.

40. What is a boar?

A boar is an entire male of any age.

41. What is a barrow?

A barrow is a castrated male of any age.

42. What is a piglet?

Piglet young suckling pig of either sex.

43. What is a sucker pig?

A sucker is a pig of either sex, between birth and weaning.

44. What is a weaner?

Weaners are weaned pigs of either sex between 4 to 8 weeks of age.

45. What is a grower pig?

Grower pigs are pigs of either sex post weaning. Grower pigs are usually kept in single sex groups.

46. What is a finisher pig?

A finisher pig is in the final stages of growth to market weight of around 90 to 100kg live weight. Their diet is less nutrient dense than younger growing pigs to reduce fat deposition.

47. Sows and gilts are nonseasonal and Polyestrous animals. What do the two terms mean?

- Nonseasonal breeder- Nonseasonal breeders or continuous breeders have the ability to breed and mate throughout the year irrespective to environmental factors such as season, daylength (photoperiod) and temperature.
- Polyestrous- Polyestrous refers to an animal's ability to have several oestrous cycles per year.

48. What does gestation period mean and what is the gestation length for pigs?

Gestation period is the time of foetal growth between conception and birth. The average gestation period for pigs is 115 days (three months, three weeks and three days).

49. What does oestrous mean and what is the oestrous length for pigs?

The oestrous period is the length of the cycle between ovulation of eggs (ova) in females (unless fertilisation has occurred). The average oestrous period of a sow is 21 days.

50. What is standing heat and how long does it occur in gilts and sows?

Standing heat also described as when an animal is 'in oestrous' refers to the time period that a female animal is receptive to mate. Standing heat is linked to time of ovulation. The average standing heat length of a sow 48–72 hours and 24–36 hours in gilts.

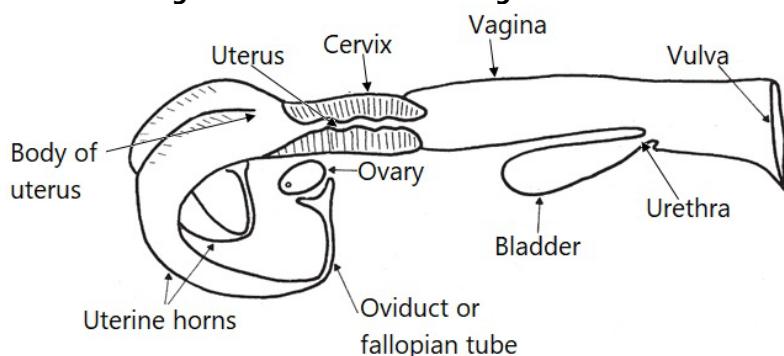
51. List the major structures of the female reproductive tract?

Ovaries, oviducts, uterine horns, uterus, cervix and vagina.

52. What is fertilisation?

Fertilisation is the process whereby a females' ova are fertilised by the male sex cell spermatozoa.

53. Use Figure 4 to label the following lateral view of the female pig's reproductive tract.



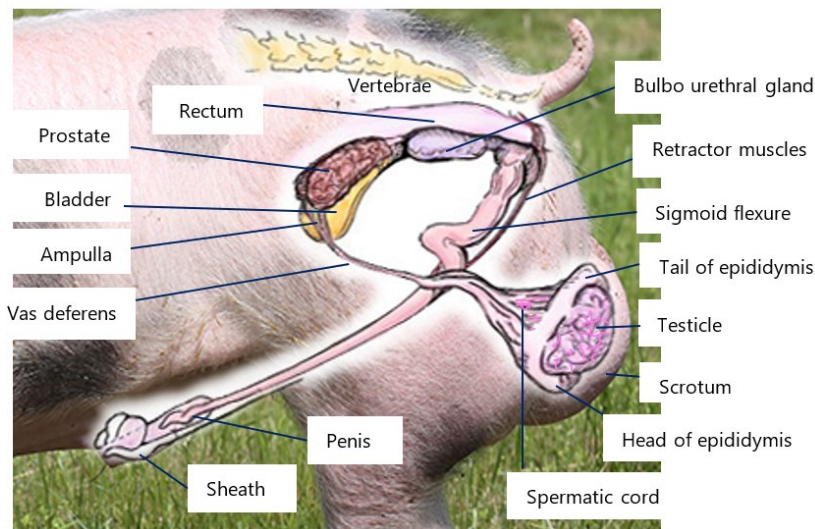
54. List the major structures of the male reproductive tract?

Spermatic cord, testes, epididymis, accessory sex glands (bulbo urethral gland and prostate), and the penis.

55. Why is temperature regulation important for males?

Temperature regulation is important because cold or hot temperatures damage sperm production and reduce boar fertility. Heat stress is the most damaging to sperm production and can make a boar temporarily sterile.

56. Use Figure 5 to label the boar's reproductive tract.



57. What is Artificial Insemination?

Artificial Insemination (AI) is a technique used in agriculture to artificially breed female livestock. In pigs, it involves placing semen directly into the body of the uterus, via the cervix.

58. Complete the table to contrast advantages and disadvantages of AI in pigs

Advantages of AI	Disadvantages of AI
• Semen from a range of top-performing tested boars of several breeds is available from AI centres. • The genetic influence of genetically superior boars can be widely accessed. • AI is a safe, cheap method of introducing new genes into pig herds, especially from those herds classified as specific pathogen-free, minimal disease or high health status, compared with bringing in live pigs. • AI overcomes size differences between boars and sows, thus improving animal welfare. • AI may be used during temporary shortages of boars from death, lameness or failure to work.	• Reduced farrowing rate (50%) with frozen semen. • Lower than average results with chilled semen stored longer than 72 hours. • Disappointing results where AI is poorly timed or done incorrectly.

59. List the four factors essential to successful Artificial Insemination results:

- Detecting oestrus in the sow
- Correctly timing the insemination
- Correct AI technique
- Correct semen handling and storage

60. When should AI be carried out after oestrous onset if?

- **Inseminating once**
24-32 hours after the sow stands to the Back Pressure Test
- **Inseminating twice**
8-12 hours after the handler first identifies the 'standing' reaction and again 8 to 16 hours later

61. Is the majority of boar semen in Australia fresh-chilled or frozen? And which has greater breeding success rates?

Majority of semen used in pork industry is fresh-chilled. It has been either directly collected from the boar on farm or has been shipped from a collection facility. Fresh-chilled has greater rates of success as the freezing and thawing process reduced the number of viable sperm.

62. Can semen be imported into Australia and why/why not?

No. It is illegal to import any genetics (semen, embryos or ova) or live pigs into Australia. These strict Biosecurity measures protect Australia's pork industry from many exotic diseases, such as African Swine Flu, and Foot and Mouth Disease which could destroy our pork industry.

63. Apply your understanding of sow's reproductive tract anatomy to label the missing parts of the sow's reproductive tract.

	Part		Part
A.	Fallopian tube	E.	Bladder
B.	Ovary	F.	Vagina
C.	Body of uterus	G.	Vulva
D.	Uterine horn		

Practical activity- detecting oestrous in sows

Activity: Complete the table to list physical and behavioural signs of oestrous in sows and gilts.

Physical	Behavioural
Rough hair and rub marks on ewes standing to be ridden while in oestrous	Standing reflex when pressure is applied to sow/gilts back
Reddening and swelling of vulva and clitoris	Standing to be ridden and riding
Sicky mucous discharge	Boar seeking
	Different vocalisations
	Increased activity
	Feed intake decrease

Current and emerging technologies in the pork industry**64. List the technology categories utilised in the pork industry**

- Record systems
- Genetics
- Reproduction
- Health and welfare
- Nutrition
- Meat production and processing
- Production and management systems
- Education systems
- Sustainability and environment management
- Marketing

Questions 65-68- answers will vary.