

London and District Science Olympics

Annual Competition

"...AND THIS LITTLE PIG..."

Senior Biology

"...AND THIS LITTLE PIG..."

RULES

Biology

Grades 9-12

Changes to the rules are marked by a vertical line

In this event teams of 3 to 6 will be expected to develop careful dissection techniques and become familiar with the name and location of the major structures of the circulatory, respiratory, digestive, and urogenital systems as described in the dissection guide to be provided. Students should be able to enter the thoracic and abdominal cavities quickly. A basic knowledge of the function of major organs will also be assumed.

Non-dissected male and female specimens will be provided on the day of competition. Students must bring to the competition their own dissecting kit and gloves, and a pen or pencil for answering the question sheets.. Each kit may include 1 scalpel, 1 spare scalpel blade, 1 probe, 1 pair of tweezers, 1 pair of dissecting scissors, and 1 box of T-pins. Students will be allowed to open up the thoracic and abdominal cavities, identify structures (approximately 15) and complete a dissection questionnaire regarding structure, function and physiology of organs.

Sample Directions

1. Insert a green pin into the gall bladder.
2. Insert a red pin in the organ which is the site of sperm production.

3. Clear the tissue from the region anterior to the heart and insert a black pin in the right subclavian artery.

4. Name the tube that drains the bladder.

Each year, a particular system will be designed for special study, and this will be announced on the web page.

Scoring

- i) Each dissection will be marked out of 100%. Structures must be clearly displayed.
- ii) Written answers to questions will be marked out of 100%
- iii) The final mark will be calculated using the following weighting: 65% dissection (i above) and 35% questions (ii above) to give a total mark out of 100%.

Questions

- | If there are any questions, please contact Elizabeth Heinicke at 473-5695.

1. INTRODUCTION

In 1680 Edward Tyson published *Anatomy of a Porpoise* after dissecting a specimen which had found its way up the Thames River and into a fisherman's net. He found this animal to be much more like a four-legged mammal than fish. Similarly, the dissection of a Malaysian "orang-outang" by Tyson and William Cowper in 1699 clearly showed the kinship of man and the Great Apes.

Over the following 300 years, careful dissection of diverse animals and plants has revealed many marvels of biological engineering and helped us to further understand how organisms develop from embryos into adults, how they sense and react to their environments, how they are affected by disease and aging, how their internal organ systems function and how they are evolutionarily related to one another.

The foetal pig is a particularly interesting animal for dissection since it more closely resembles human anatomy than other readily available laboratory animals and it provides the additional advantage of showing foetal modifications of the circulatory system. (These animals are not sacrificed for use in the laboratory but are otherwise discarded by the meat packing industry).

The Dissection of the Foetal Pig, which follows, was prepared by Mrs. Jeanne King, UWO. It is intended that this Guide be used as the primary, but not necessarily exclusive, reference for this event.

The diagrams have been prepared using WordPerfect Presentations by Patrick Whippey, and are less clear than Mrs King's

originals, due to the difficulty of representing subtle structures. You will need to supplement them in some cases with better quality drawings.

DISSECTION OF THE FOETAL PIG

GENERAL RULES FOR THE DISSECTION OF ANIMALS

1. **READ** the directions carefully before you begin to dissect.
2. **IDENTIFY** the structures to be cut before cutting them.
3. **LIFT** structures to be cut with forceps or probe.
4. **CUT** only what is absolutely necessary.
5. **EXPOSE** structures completely and cleanly to view

Glossary of anatomical terms:

dorsal:	near or toward the back
ventral:	near or toward the belly
anterior:	near or toward the head end
posterior:	near or toward the hind end
pectoral:	relating to the chest and shoulder region
pelvic:	relating to the hip region

Instructions for dissection:

Care in dissection is essential. You must be attentive and patient as you work. You should know where you are cutting and why you are cutting. If you are not sure of your ground, go slowly, inspecting each step.

Your dissecting kit contains a number of different instruments. Perhaps scissors are the most useful of your tools. They can be used to cut, or to spread or separate, but remember that when you are cutting into something, keep the round or blunt arm of the scissors inside, and the hidden point turned up as much as possible to avoid chopping through internal structures. Your scalpel should only be used occasionally to cut through firm, thick tissue. The difficulty with a scalpel is that you never know how deep you are cutting, or what is being sliced beneath the layer in which you are

interested. Forceps are handy for holding things aside, or as a probe when closed. A probe is used to push things aside, to penetrate into chambers, to trace out blood vessels, etc., and to scrape away connective tissue. This is probably your most frequently used tool. Dissecting needles can be used cautiously as probes, or to hold things down, or as fine scalpels to cut through very delicate tissues.

When dissecting make sure the structure you are seeking gets exposed as completely and cleanly as possible. Do not stop at the first glimpse of it; do not give up if it does not pop immediately into view. To dissect means "to cut away from". Do that. Be sure you see all the structures mentioned in this manual.

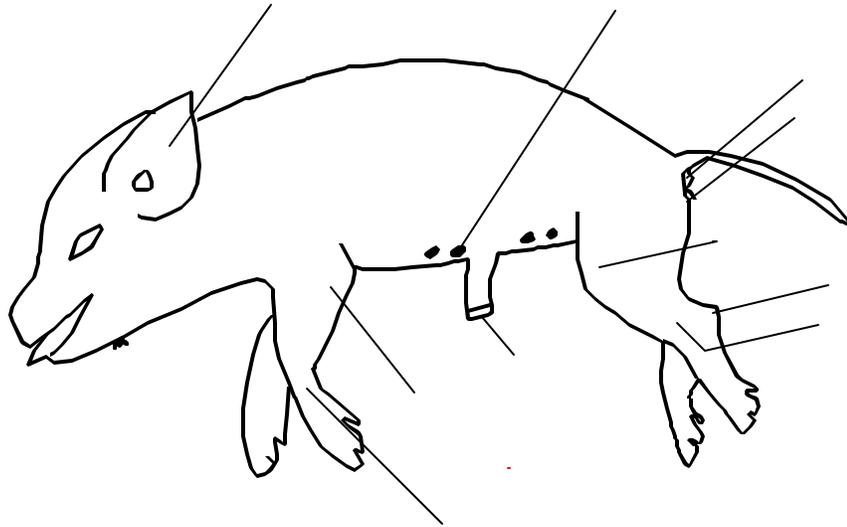


Figure 2 Female Pig, External Features

External Features

1. Distinguish *right* and *left*, *dorsal* and *ventral*, *anterior* and *posterior*. What kind of *symmetry* does the pig show?
2. The body of the pig (like other higher vertebrates) consists of a *head*, *neck*, *trunk* with *limbs*, and *tail*. Note that the eyes are closed and hair may be developing on different parts of the body including a tuft under the chin.
3. The flap of the external ear is called the *pinna*.
4. The more anterior part of the trunk is the *thorax* which contains the *ribs*, while the posterior portion is the *abdomen*. The *umbilical cord* may be seen mid-ventrally in the abdomen. Two lines of mammary glands will be seen running along the ventral surface.
5. Each limb ends in 4 *digits*, tips of which are

the *hooves*. The pig walks on the tips of its fingers and toes. Identify the *wrist joint*, *elbow joint*, *ankle joint* and *knee joint*. Note that the heel is located quite high up on the hind limbs.

6. Determine the sex of your pig. If you have a *male*, the opening of the *penis* may be found just posterior to the umbilical cord on the mid-ventral abdominal wall. You should be able to feel the penis just below the skin posterior to the opening. Below the tail, note the *anus* and the two *scrotal sacs*.

If you have a female you will find two openings immediately below the tail. The more dorsal is the anus. Right below this is the opening to the combined urinary and reproductive tracts. This opening is surrounded by folds of tissue called labia which come together to form the pointed *genital papilla*.

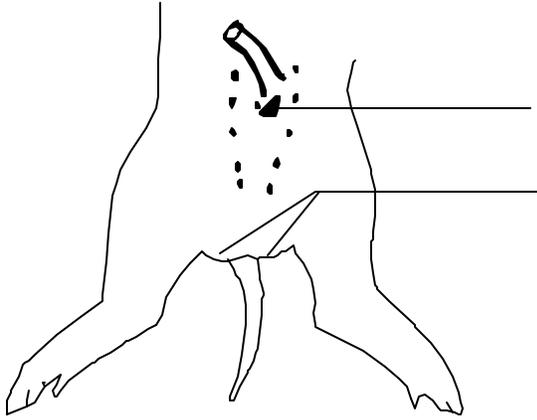


Figure 3 Male Pig Posterior Ventral Region

Umbilical Cord:

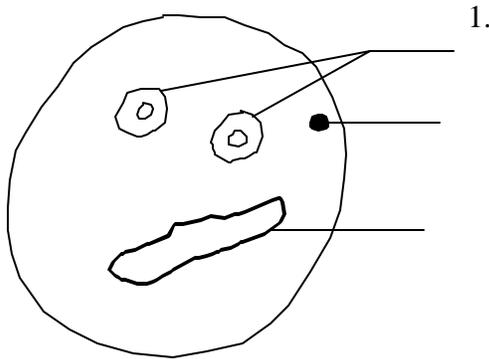


Figure 4 Cross section of Umbilical Cord

With scissors make a fresh cross section of the umbilical cord about 1 inch from the animal's body. In the cross-section there are two thick-walled *umbilical arteries* as well as one larger, thinner-walled *umbilical vein*. These blood vessels connect the foetus to the placenta. Near the arteries is a small hard core of tissue, the *allantoic stalk* which is a derivative of the allantois, one of the membranes which forms part of the placenta.

NOTE that your pig is probably doubly injected with coloured latex, so that under ideal circumstances, the arteries should be red and

veins blue.

Mouth and Pharynx

The following cuts will allow the lower jaw to drop down, opening the mouth.

1. Insert the round end of the scissors inside of the mouth and cut into the angle of the jaw. You are cutting through cartilage and muscle, and the tissues are quite thick. Alternate cutting back a bit on one side and then on the other and as you do, pull the lower jaw down. Continue to cut back following the curvature of the tongue until the *epiglottis* pops into view. Make one more cut on either side so that the opening in which the epiglottis was inserted is visible. This region posterior to the tongue is generally called the *pharynx*.

2. The epiglottis is a flap which surrounds the opening to the respiratory pathway, the *glottis*. The epiglottis normally flattens over the glottis when swallowing to prevent food from entering the *larynx* or voice box.

The larynx will be visible in the neck dissection later.

3. Just dorsal to the glottis is the *oesophagus* which leads to the stomach.

4. The *epiglottis* was inserted into an opening in the roof of the pharynx which leads to the *nasal pharynx*. The nasal pharynx is covered by the smooth *soft palate*. Anterior to the soft palate is the ridged *hard palate* above which lie the nasal cavities.

5. Glandular tissue has a nodular or lumpy

texture, while muscle is fibrous. There are 3 pair of salivary glands, the parotid, sublingual, and *mandibular glands*. You should be able to see the mandibular glands in the jaw tissue on either side of the epiglottis.

Neck Region:

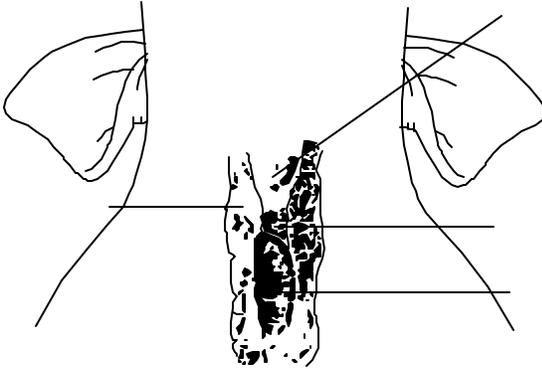


Figure 5 Structures in the neck region

Follow cut line #1 on Fig.5

1. With the pig lying on its back and mouth closed, locate the tuft of hair on the chin. Break through the skin with scissors just posterior to the hair, and make a midline incision through the skin to the level of the forelimbs. **Always keep the round end of the scissors inside so as to do minimal damage to underlying structures.**
2. Use your blunt probe to spread the incision open. Immediately below are long strips of muscle running down the neck. Deeper, you will find a large paired gland which runs down either side, the *thymus gland*. This gland is large in young vertebrates but regresses as they mature. It is involved in the establishment of the immune system.
3. Lying in the midline is the *larynx* (voice

box). Carefully clear the strips of muscle from the larynx. Extending posteriorly from it is the *trachea*, which leads to the lungs. The trachea is strengthened by rings of *cartilage*. Just below the larynx on the trachea is the darker coloured *thyroid gland*. Dorsal to the trachea is the more flattened, softer *oesophagus*.

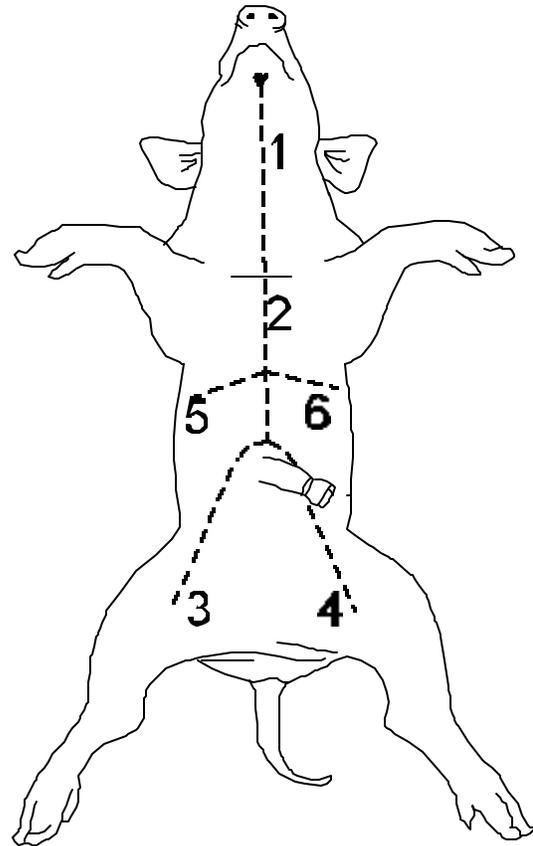


Figure 6 Lines followed when cutting

Opening the Body Cavity.

Follow cut lines 2 to 6 in Fig.5

1. Continue the incision from the neck straight down the midline to the umbilical cord. In the region between the forelimbs you will be cutting the rib cage and sternum. **Keep lifting the body wall up with your scissors as you cut to prevent damaging the internal organs**

below. As you approach the cord, lift it up and watch for the umbilical vein, which runs from the inside of the cord across to the liver.

2. Extend the cut diagonally on either side of the umbilical cord until you reach the thick tissue of the legs. Now cut the umbilical vein in the middle so that this structure may be identified later.

3. Locate the *diaphragm*, a sheet of muscle which runs right across the *coelom* (body cavity) above the liver. Make lateral incisions through the body wall just posterior to the diaphragm on each side and cut the edges of the diaphragm to free it from the body wall.

4. Finally, the abdominal cavity of your pig may be filled with preserved blood. In any case, wash out the cavity thoroughly at one of the lab sinks.

The Coelom

1. The diaphragm separates the coelom into the *abdominal cavity* and the *thoracic cavity*

2. The thoracic cavity is divided into the right and left *pleural cavities* which contain the *lungs* and the *pericardial sac* in the centre, which contains the *heart*. The wall of the sac is called the *pericardium* and a mass of thymus gland lies over the anterior end. **Carefully** remove the thymus and pericardium. Note the muscular *ventricles* and the small, thin-walled *atria*. Do not damage the blood vessels around the heart. You will identify these later.

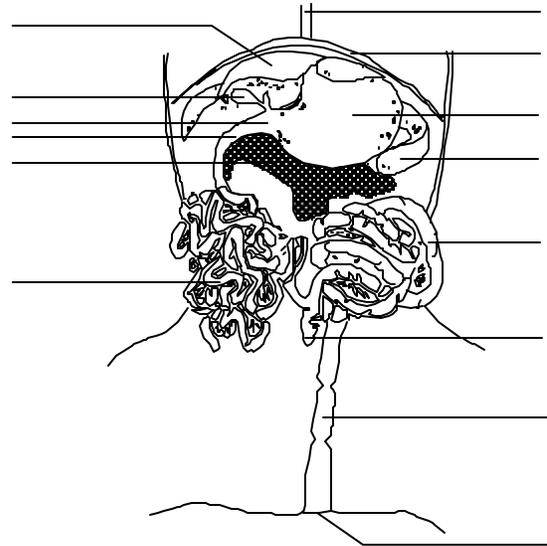


Figure 7 *Organs of the Abdominal Cavity - Ventral View*

Abdominal Cavity

1. The *liver* is the largest organ of the abdominal cavity. It is composed of a number of lobes. Locate the *gall bladder* on the underside of the liver, to the right of the midline. (Of course references to left and right always refer to the pig's left and right sides).

2. Lift up the liver to find the *stomach*. The thin strap-like *spleen* is connected to the outer curvature of the stomach.

3. At the end of the stomach you can feel the thick muscular *pyloric sphincter*. The *small intestine* which follows is more loosely coiled, while most of the *large intestine* or *colon* is tightly bound together in one unit.

4. The first part of the small intestine is the *duodenum*. This is followed by the rest of the small intestine called the *jejunum-ileum*. The *pancreas* extends across the body under the stomach, and down the side of the anterior

portion of the duodenum.

5. Find the end of the small intestine where it enters the large intestine. The blind end of the large intestine, the *caecum*, projects out. (In human beings the appendix is a finger-like projection on the end of the caecum.) The last part of the colon runs posteriorly down the dorsal abdominal wall. The very end is the *rectum* which is not visible at this time.

6. On either side of the descending colon, note the large *kidneys* which are covered by the *peritoneum*, the shiny lining of the abdominal cavity.

7. Running down the inside of the flap made by cutting on either side of the umbilical cord, note the continuation of the *umbilical arteries*, and in between these, the urinary *bladder*.

Thoracic Cavity

1. With scissors cut the connections between the pig's **left** lung and the heart. Remove and examine the left lung. You can see the left *bronchus*, leading into the lung and also cut sections of the left *pulmonary artery* and *pulmonary vein*.

2. Running down the mid-dorsal wall of the thoracic cavity is the *dorsal aorta*. Because the aorta is thick-walled it appears white, but if you nick it with your scalpel you will find that it is usually filled with red latex.

3. Ventral to the aorta is the oesophagus. The fine strands of the *vagus nerves* may be seen on either side of the oesophagus.

4. Ventral to the oesophagus, locate the

posterior vena cava (blue) which runs into the liver.

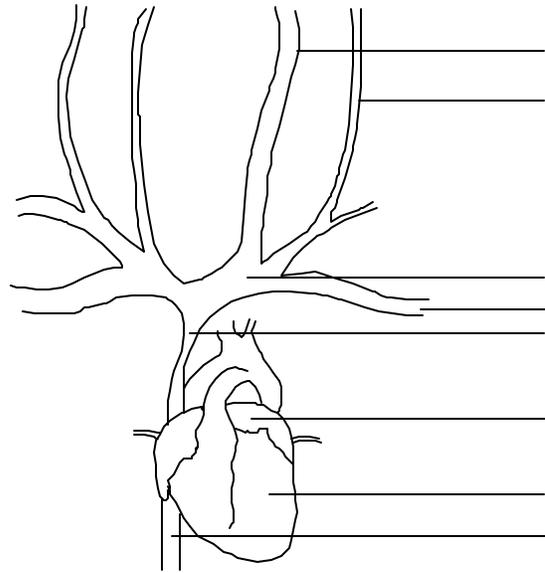


Figure 8 Veins anterior to the Heart

Veins Anterior to the Heart

1. The veins which drain the anterior part of the body lie just below the sternum (cartilage in the mid-line just anterior to the heart). Remove this cartilage carefully a bit at a time. Don't cut too deep or you will cut the veins.

2. The *anterior vena cava* along with the *posterior vena cava* enter the right atrium of the heart dorsally. Trace the anterior vena cava forward. It is formed by the union of the right and left *brachiocephalic veins*.

3. Trace one brachiocephalic vein anteriorly. Each is formed by the union of several veins including the *subclavian vein* which drains the arm (above the rib cage), and the *external and internal jugular veins* which run side by side along the trachea.

4. We will not identify most veins below the diaphragm in this exercise because they often fail to pick up blue latex but you will see the *renal veins* which drain the kidneys at a later time, and you have already identified the umbilical vein.

Arteries around the Foetal Heart

1. In order to preserve the veins anterior to the heart, cut the anterior vena cava just anterior to the heart and lift the venous system up. Don't cut too deeply. Important arteries lie immediately below.

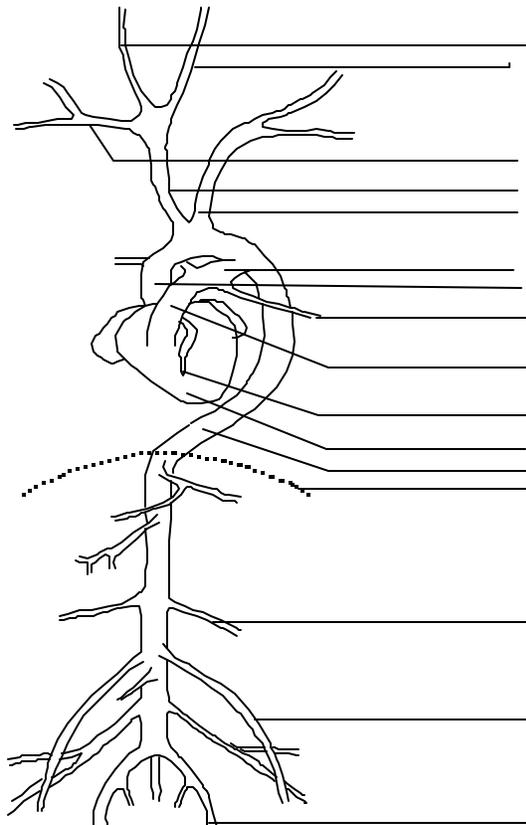


Figure 9 Ventral view of major arteries of foetal pig.

2. Examine the ventral surface of the heart. Running across the anterior end of the

ventricles towards the pig's left is the *pulmonary trunk*. Follow the pulmonary trunk out to the left using your blunt probe to clear connective tissue from around it until you can see the stub of the *left pulmonary artery*. (It leads to the left lung which you removed). The right pulmonary artery runs across the dorsal side of the heart to the right lung and probably won't be seen in this dissection. The extension of the pulmonary trunk between the pulmonary artery and the aorta is the *ductus arteriosus*.

3. Arising immediately behind (dorsal to)

the pulmonary trunk is the very first part of the aorta. It curves around in an arch (the *aortic arch*) and then runs down the mid-dorsal body wall.

4. The first branches off of the aorta arise at its very base under the pulmonary trunk and run down both dorsal and ventral surfaces of the ventricle. These are the *coronary arteries* which supply the heart muscle itself with blood. The one on the ventral surface of the heart, most visible to you, is the left coronary artery. It marks the line between the right and left ventricles.

5. At the top of the aortic arch where it curves, the brachiocephalic artery extends anteriorly. Note that there is only one *brachiocephalic artery* but a pair of brachiocephalic veins. Follow the brachiocephalic artery towards the head. It branches into the *right subclavian artery* to the right arm, and the right and left *carotid arteries* which run up either side of the trachea.

6. The *left subclavian artery* arises from the aortic arch just beside (to the pig's left of) the

brachiocephalic artery.

Adult Circulation of Blood through Heart

In the adult, blood from the anterior and posterior vena cava enters the right atrium, flows to the right ventricle, out the pulmonary trunk and down the pulmonary arteries to the lungs. From the lungs blood enters the left atrium via the pulmonary veins, flows to the left ventricle, and out the aorta to the body.

Foetal Circulation vs Adult

The pattern of foetal circulation differs in a number of ways from the adult. For example, blood rich in oxygen and nutrients enters the foetus by way of the umbilical vein, passes through the liver into the posterior vena cava, and from there into the right atrium. An opening between the right atrium and the left atrium called the *foramen ovale* allows some of the oxygen-rich blood to flow from the right to the left side of the pig's heart. From there it is distributed by the aorta and its branches to the head and body.

Do not try to locate the foramen ovale.

The heart and its surrounding arteries should be left in position in the pig.

Another foetal adaption, which you just identified is the *ductus arteriosus*. Blood leaving the right ventricle passes along the pulmonary trunk on its way to the lungs. While some blood flows into the lungs via the pulmonary arteries, most of it continues straight into the aorta via the *ductus arteriosus*, which is a foetal connection between the pulmonary trunk and the aorta. After birth, the foramen ovale closes and the ductus arteriosus constricts

so that the adult pattern of circulation is normally achieved. In addition, the umbilical vein and umbilical arteries atrophy.

Urogenital System - Female

1. Examine the pig's left kidney. It actually lies outside of the abdominal cavity behind the peritoneum. Leading from the kidney to the bladder is the *ureter* which may be seen through the peritoneum. The *adrenal glands* are narrow bands of tissue at the anterior end of each kidney facing the aorta. Break the peritoneum with your probe along the median (inner) edge of the kidney and locate the *renal artery and vein*.

2. The *ovaries* are a pair of small bean shaped organs in the posterior end of the abdominal cavity. They are supported by a mesentery (attaches organ to body wall) called the *broad ligament*. Running along the edge of the broad ligament are the wavy left and right *horns of the uterus* which meet in the midline to form the *body of the uterus*.

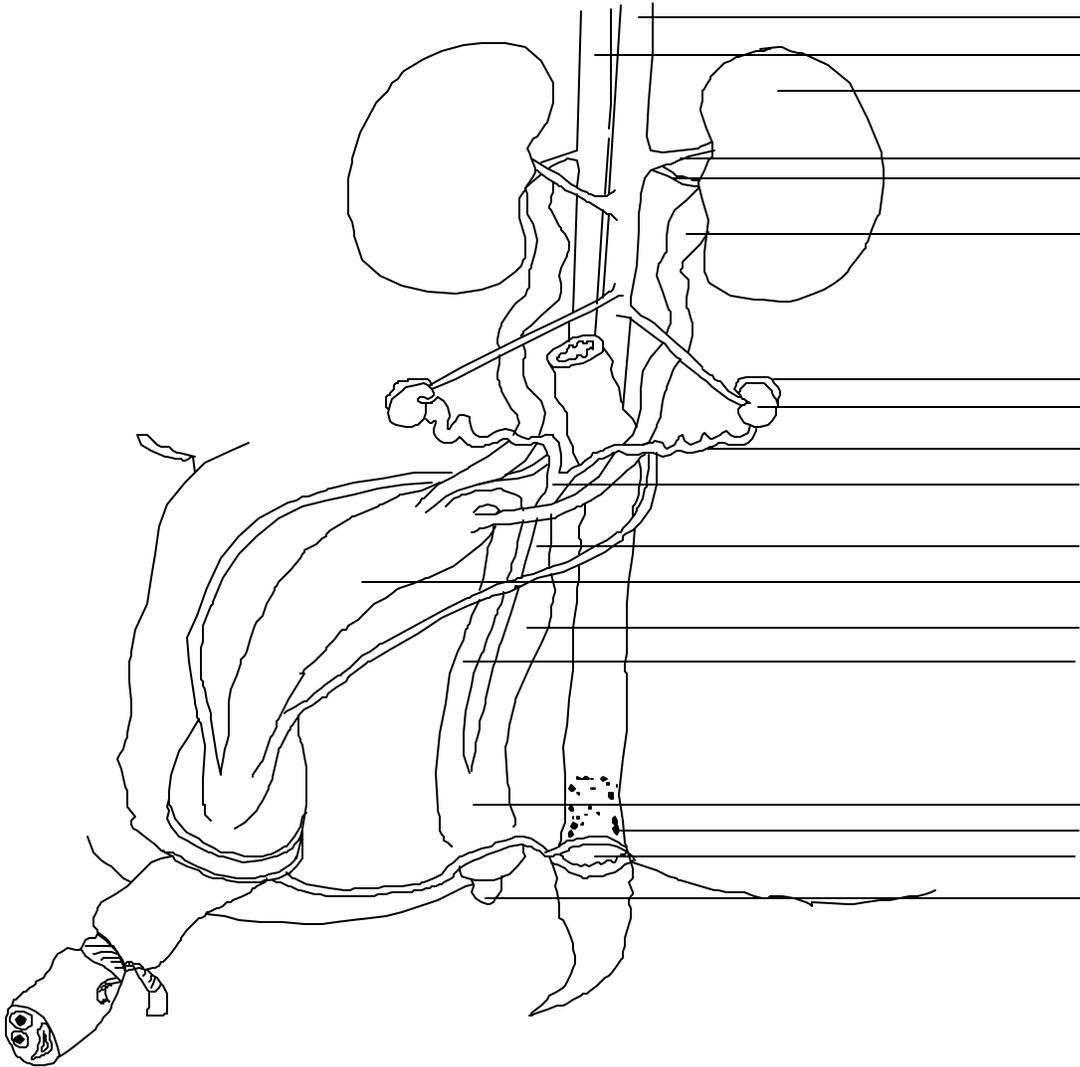


Figure 10 *Urogenital system of female foetal pig.*

Note that this shape of uterus is common among animals which produce several young at once. The developing piglets are strung out along the horns of the uterus. The body of the uterus is merely a passageway which leads to the vagina.

3. Examine the end of one horn of the uterus near an ovary. It narrows to form a convoluted *fallopian tube* which runs along the side of the ovary.

4. The body of the uterus disappears into the floor of the abdominal cavity. To expose the rest of the female urogenital system you must make a mid-ventral incision with your scalpel. Keep the flap containing the *bladder* pulled over to the pig's right and cut straight down the midline, pressing the legs out. Cut through the *pelvic girdle*. The incision should open right over the vagina and urethra.

5. Clear the connective tissue from the body of the uterus just posterior to the abdominal wall. As you follow the body of the uterus posteriorly you may be able to distinguish a slightly ridged region, the *cervix*, which leads to the *vagina*. The vagina is a fairly long smooth tube.

6. Leading from the bladder and running along beside the vagina is the *urethra*. Find the point where the vagina and urethra unite to form a common passageway, the *vestibule*. The opening of the vestibule along with the surrounding skin folds is the vulva.

7. Dorsal to the vagina observe the posterior portion of the descending colon which terminates in the lighter coloured *rectum*.

Urogenital System - Male

1. As noted in the female, the kidneys lie outside of the abdominal cavity dorsal to the peritoneum. The *ureters* may be seen behind the peritoneum leading to the posterior end of the bladder. Break the peritoneum along the median edge of the left kidney with your probe and identify the *renal artery and vein*.

2. Trace the *gonadal arteries* posteriorly from the aorta. Each one enters an *inguinal canal* which leads down to a scrotal sac. Emerging from the inguinal canals are slender white tubes, the *ductus deferens* which appear to join together in the midline and enter the *urethra* just posterior to the bladder. You should be able to insert your blunt probe into an inguinal canal from the abdominal cavity.

As the male foetus completes its development, the testes are gradually pulled (descend) down the inguinal canal into the scrotal sacs. If you have a small pig you may be able to see the testes still in the abdominal cavity near the inguinal canal openings.

3. Working from the body surface, open the left scrotal sac just below the tail. The inner wall of the sac is very tough, and to completely expose the *testis* you must slit this tough membrane with your scalpel and peel it off. The testis is a smooth bean shaped structure. Look closely for the tightly coiled *epididymis* which runs along one side of the testis and then straightens out to become the ductus deferens. At the posterior end of the testis is a rather gelatinous cord of tissue, the *gubernaculum*, which pulls the testis down into the scrotal sac.

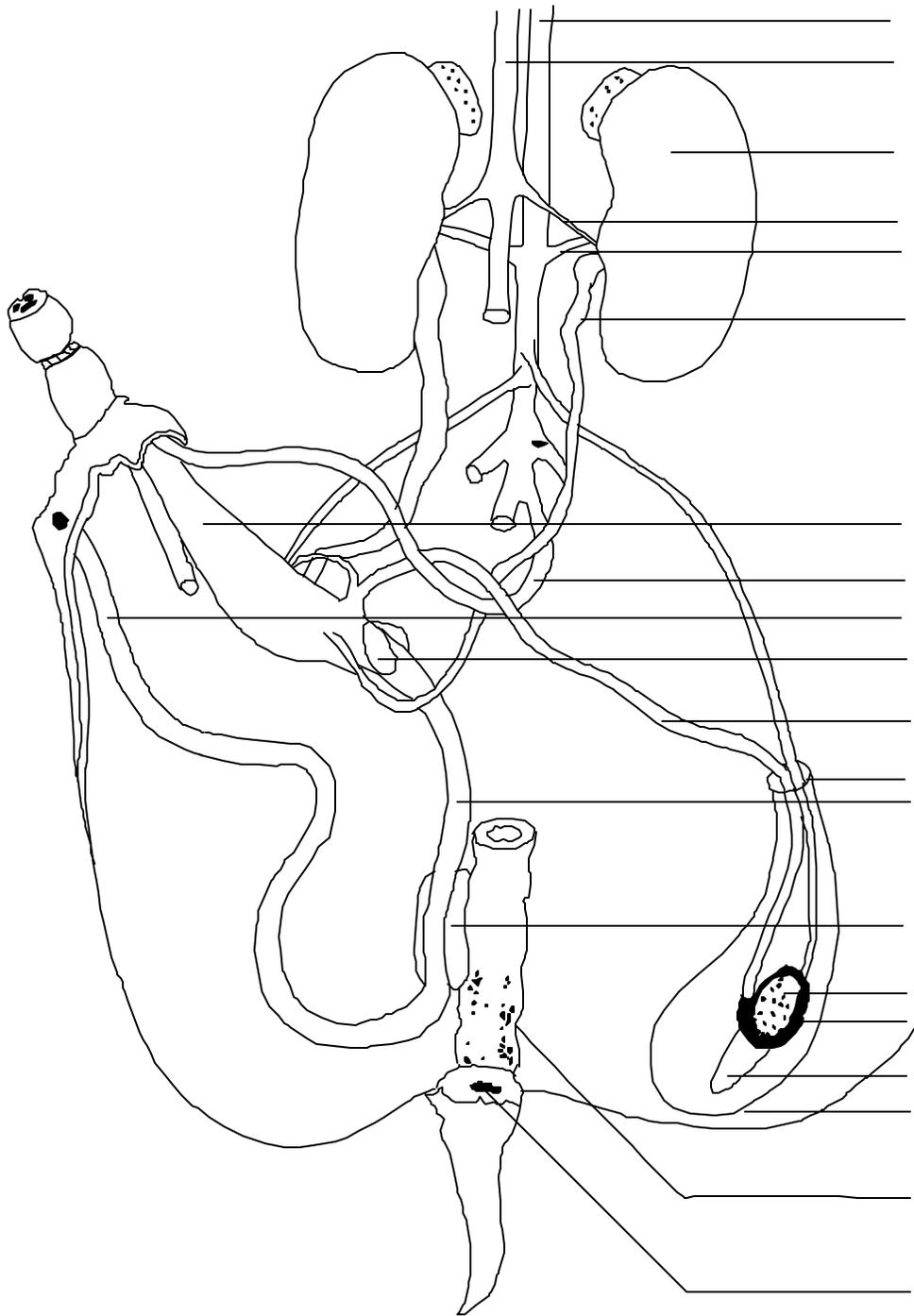


Figure 11 *Urogenital system of male foetal pig*

4. To expose the rest of the male system, pull the flap containing the bladder over to the pig's right and make a mid-ventral incision with your scalpel. Cut right down the midline, pressing the legs out. You will be cutting through the pelvic girdle, which should open up to expose the *urethra* underneath.
5. Clear the connective tissue with your blunt probe and trace the urethra posteriorly from the bladder. Just past the bladder on the *dorsal* side are the pair of *seminal vesicles* (at the point where the two ductus deferens enter the urethra).
6. Follow the urethra down under the pelvic girdle. On either side, identify the large *bulbourethral* glands.
7. As the urethra approaches the most posterior end of the pig it becomes very difficult to separate it from the surrounding connective tissue. In this region the urethra enters the *penis*. Locate the penis, which runs forward along the ventral abdominal wall, by cutting through the skin, and trace the penis to the opening just posterior to the umbilical cord.
8. Dorsal to the urethra and bulbourethral glands observe the posterior portion of the descending colon which terminates in the lighter coloured *rectum*.