Investigation of a Mammal (A Rat)

Non-animal alternative to dissection

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- Questions and exercises throughout the DVD encourage student interaction
- Flexibility in how much information is used per lesson
- Close-up views help to overcome the limitations of dissecting such a small animal
- Colour photos and drawings provides additional teaching material
- Animated graphics help to explain the circulatory and respiratory systems
- May be used over and over saving animals, time and money
- Encourages a debate on ethical issues associated with dissection

Our grateful thanks to Dr. Wendy Van Dok, who has donated the right to distribute this teaching tool to the NORINA database project at the
Norwegian School of Veterinary Science (http://oslovet.veths.no/NORINA)

Introduction

The aim of this education package is to provide an alternative to laboratory dissections. The package includes a DVD, digitised photographs and a handout.

The DVD allows a flexible approach to teaching and encourages student interaction. The DVD is organised into sections, i.e. external organs and structures, the circulatory system, the respiratory system, the digestive system and the urogenital system. Thus, the whole dissection may be viewed in one lesson, or viewed section by section, when students have more time to assimilate the extensive amount of information generated from a dissection. A question is asked at the end of each section, and there are two exercises. One relates to the surface area to volume ratio of organs, and the second relates to reproduction in mammals. Educators may use their discretion to stop the DVD and allow for student participation as each question is raised, or use the questions as a basis for discussion after the DVD is finished. Similarly, students may do the exercises after they have been demonstrated on the DVD, or at the end of the DVD. The exercises require each student to have a calculator, ruler, toothpick, some plasticine about the size of a golf ball and a copy of Tables 1 and 2 included in the handout. Animated graphics in the DVD enable students to view the circulatory and respiratory systems in motion, a feature not possible in a conventional laboratory dissection. Furthermore, enlarging organs and structures on the screen helps to overcome the limitation of dissecting such a small animal.

The handout provides answers to the questions and exercises interspersed throughout the DVD, and includes further information and exercises about mammals and rats. Included also, are a number of ethical considerations with regard to dissection which might form the basis of a discussion on animals in teaching, in a separate class. The handout can be photocopied for individual students.

Colour photographs and overheads of different stages of the dissection assist students to understand how the organs are connected and organised. The drawings could be used in a number of ways. For example, labels of organs could be covered initially and progressively revealed as students identify the organs. Alternatively, photocopies could be made from the drawings and distributed to individual students to fill out and return for assessment.

This DVD and accompanying material will save both time and money.

Answers to Questions and Exercises

Q1: **What are the two external features mentioned so far which distinguish the rat as a mammal?**

A1: Teats which connect to the underlying mammary glands, and hair.

Q2: **A hiccup occurs when the diaphragm muscles contract suddenly. Do you think there is any scientific basis to the belief that a fright is a remedy for hiccups? Explain your reasons.**

A2: Breathing in mammals is controlled by the respiratory centre in the brain. Breathing is rhythmic and involuntary, like the beating of the heart. Although breathing can be voluntarily regulated to some extent, it is impossible to hold your breath to the point of death because involuntary controls take over. A hiccup is a spasm, or involuntary contraction of the diaphragm. If breathing can't be controlled voluntarily, then hiccups won't be either. A fright may cause a sudden change in the rate and depth of breathing, thus influencing the rhythm of the diaphragm, but is unlikely to control hiccups per se.

Q3: **What are the features of the rat's heart and blood vessels which make them suited for pumping and transporting blood around the body?**

A3: **Capillaries** are the site of exchange of materials between the blood and tissue fluids. Capillaries are thin and have a high surface area to volume ratio to facilitate rapid diffusion. **Veins** carry blood back to the heart from the body and are thin also. Muscular contractions of the body help to push blood through the veins. Veins have valves to maintain flow in one direction. **Arteries** carry blood away from the heart and maintain blood pressure in between contractions of the heart. Arteries have thick muscular walls which are elastic. The **heart** pumps blood around the body. It has thick muscular walls which contract to exert pressure on the blood and force it out through the arteries. Mammalian hearts have four chambers which make up two separate pumps. One for oxygenated blood and one for deoxygenated blood.

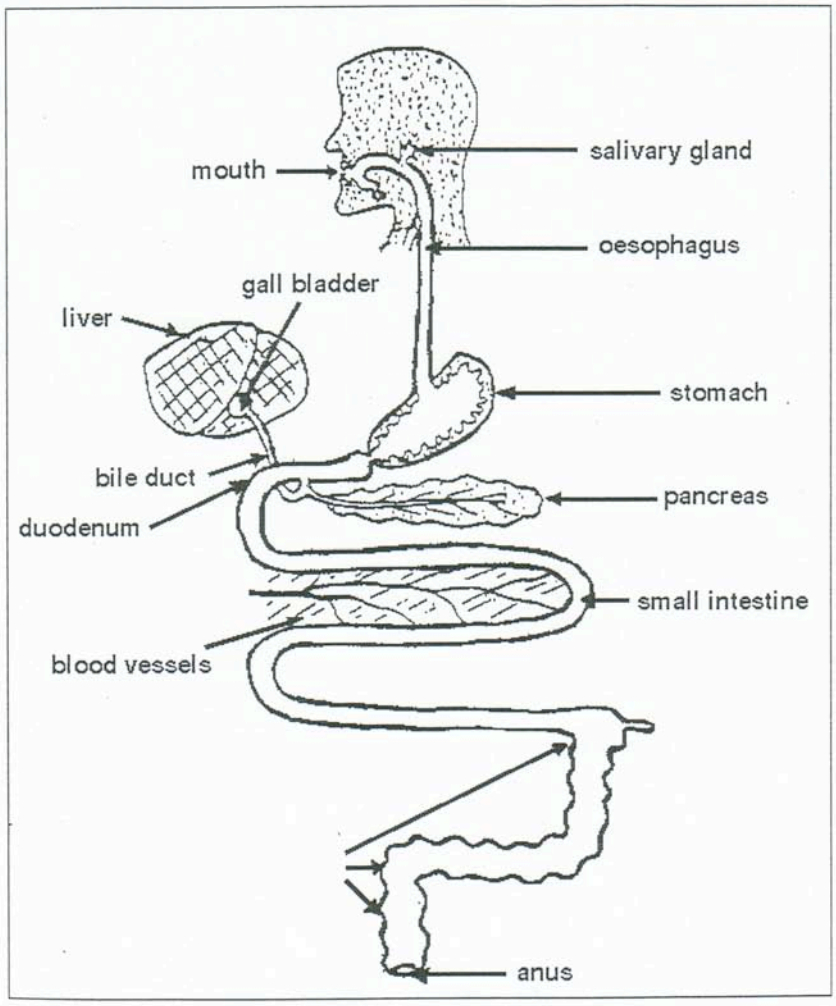
Q4: **In effect, food which is inside the digestive tract is actually outside the body. Can you explain why?**

A4: Starting at the mouth and staying within the gut wall, draw a line along the digestive tract (se next page) all the way down to the anus. Your line does not actually come into contact with the body tissues and so in effect, it remains outside the body. Thus food remains outside the body until it has been absorbed across the gut wall by the small intestine, and to a lesser extent, by the stomach.

Q5: **Maintaining a constant environment is known as what process?**

A5: Homeostasis

Human Digestive Tract



Answers to Exercise 1

Table 1

For the example given in the video:

Surface area of a sphere	$4\pi r^2$	=	50 cm^2
Volume of a sphere	$\frac{4\pi r^3}{3}$	=	34 cm^3
Surface area to volume ratio of the sphere		=	**1.5**
Surface area of a disc =2 circles	$2 \times \pi r^2$		
+ side	$2\pi r \times h$	=	88 cm^2
Volume of a disc		=	34 cm^3
Surface area to volume ratio of the disc		=	**2.5**

Additional formulae

If you start with a sphere you will need only one formula i.e. $4\pi r^3/3$ to calculate the volume. The volume will be the same for all shapes.

surface area of a pyramid (square base) = $L \times \sqrt{4h^2 + L^2} + L^2$ (base)
surface area of a cylinder = $2\pi rh + 2\pi r^2$ (2 x base)
surface area of a cube =$6\ L^2$
(L=length, h=height, π=3.14)

Answers to Exercise 2

Table 2

Species	Average gestation period (days)	Breeding cycle	Litter size (average)	Potential no of offspring in 1 yr
Human	280	monthly	1	1
Chimpanzee	236	monthly	1	1
Dog	60	bi-yearly	6	12
Rabbit	30	continuous	9	108
Rat	20	continuous	10	180

Additional Information and Exercises

1: What aret he four features mentioned in the DVD which distinguish the rat as a mammal? Other features not mentioned include a larger brain (relative to reptiles from which mammals evolved), and external ear or pinna, three auditory ossicles in the middle ear, specialised teeth and the division of the mouth cavity into two passageways by the false palate which permits breathing while chewing and swallowing. Another mammalian modification of the reptilian architecture is the separation of muscles which move the hind leg backward, from the tail vertebrae, freeing the tail for other purposes such as gripping, fly swatting and balancing. Describe the differences between rats and humans with regard to their: teeth and diet; eyesight; metabolic rate; gall bladder; and lifespan.

2: Describe the differences between monotreme (egg laying), marsupial (pouched) and eutherian (placental) mammals.

3: Mammals are able to regulate their body temperature. Which other group of vertebrates can regulate their body temperature?

4: Keeping in mind the surface area to volume ratio principle, which do you think would lose heat more slowly in a cold climate, a large or a small animal? How does the elephant avoid overheating?

5: Unlike the limbs of reptiles, those of mammals do not stick out at the side of the body, but rest underneath it. When the limbs are fully stretched they lift the body clear off the ground without the press-up action of many amphibians and reptiles. At the museum: compare the height of limbs to length of body ratio in animals which run very fast like the cheetah, to those of slower moving grazing animals like sheep; determine what fish have in common with humans; compare the fore-limb of a rat, dolphin, bat, bird and human. How do they differ and how are they used differently by these animals. Also compare the different types of specialised teeth in carnivores and herbivores. Which do human teeth resemble more, carnivores or grazers?

Some Ethical Considerations

1.Some claim that dissection of dead animals in school and undergraduate biology classes can help students to learn about the internal structures of animals, how the tissues and organs look and feel and how they are interrelated. Dissection also gives students a hands-on experience of the complexity and intricacy of organisms, and can help students to develop practical, manipulative and surgical skills.

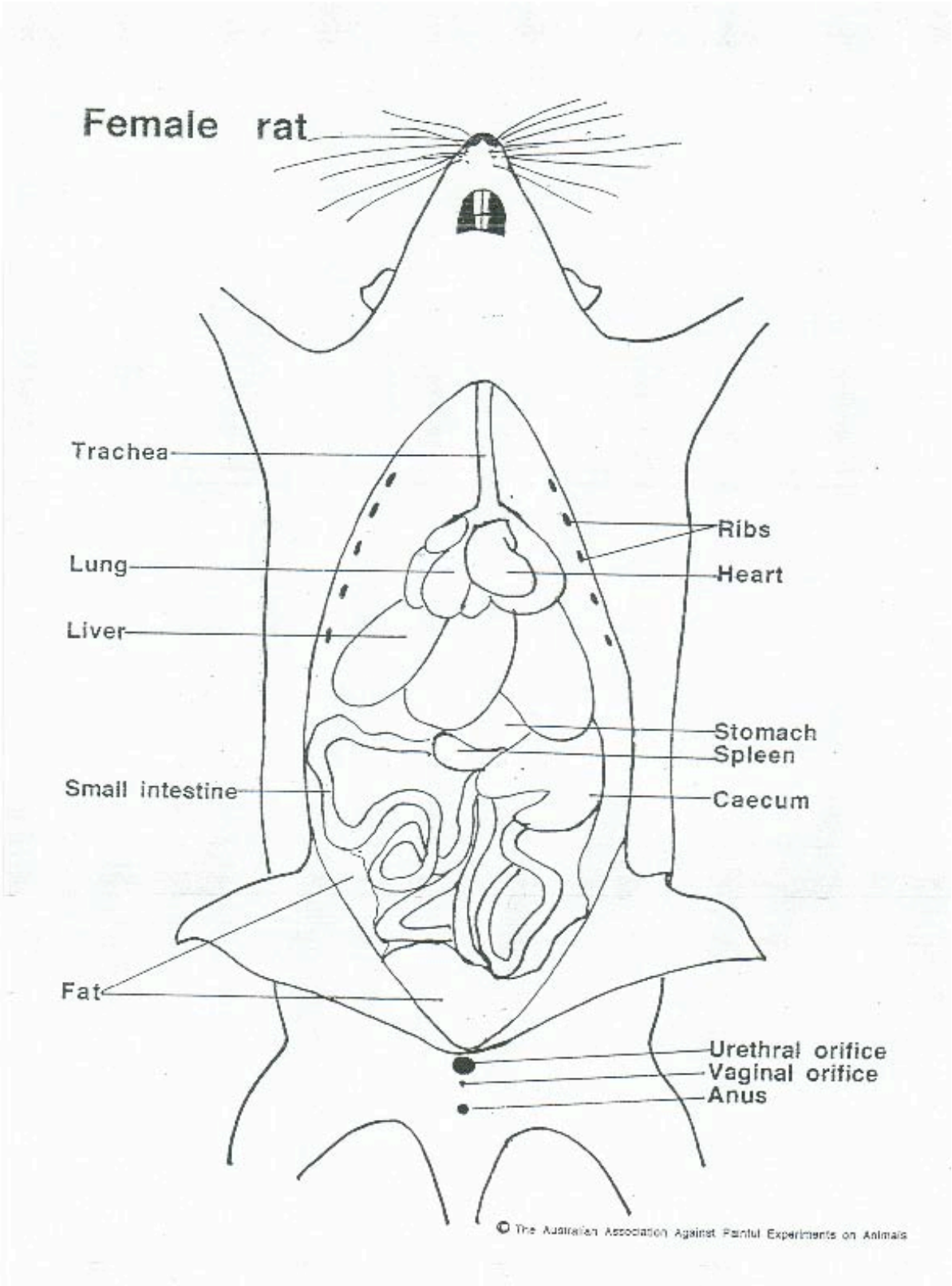
If it is accepted that there is a place for dissection in the training of mature students who have made a career choice, should animals be sacrificed for students who have no background in animal science, or any intention of studying subjects like zoology or veterinary medicine?

2. Speciesism, like racism and sexism, is a prejudice. Speciesism involves prejudice by one species to the detriment of the rights and interests of other species. We know that animals, particularly the well developed mammals, have the capacity to suffer, feel pain and distress. The DVD demonstrated many similarities between rats and other mammals including humans, yet rats are treated differently to other species such as cats and dogs. Clearly we do not raise humans or other species specifically to kill and dissect them simply because we want to see inside them. Do you think the practice of raising, killing and dissecting an animal to learn about how it lived increases our desensitisation to some species like rats, or increases our respect for them?

3. The dissection of a single species will not illustrate the enormous diversity of structure and function in the animal kingdom. For example, dissecting a rat will not illustrate the differences between mammalian, amphibian and insect circulatory, respiratory and digestive systems. Nor will it explain the variation of structure and function in terrestrial animals compared to aquatic animals. Therefore, how much can be taught about the whole animal kingdom with one dissection performed on a single species such as the rat?

4. Dissection is not legal or educational requirement in Australian schools, it is only one of a number of alternatives that students can use to reach a learning objective. It is costly and can be distressing, turning interested and compassionate students away from biology altogether. For each of the following factors, rate them from 1 to 5 depending on the importance you feel they have and evaluate the case for and against dissection:

- teaching benefit
- technical advantages over alternatives like this education package
- economic cost
- the cost in terms of suffering to the animals raised and killed
- the cost in terms of distress to students


Female rat
Trachea
Lung
Liver
Small intestine
Fat
Ribs
Heart
Stomach
Spleen
Caecum
Urethral orifice
Vaginal orifice
Anus
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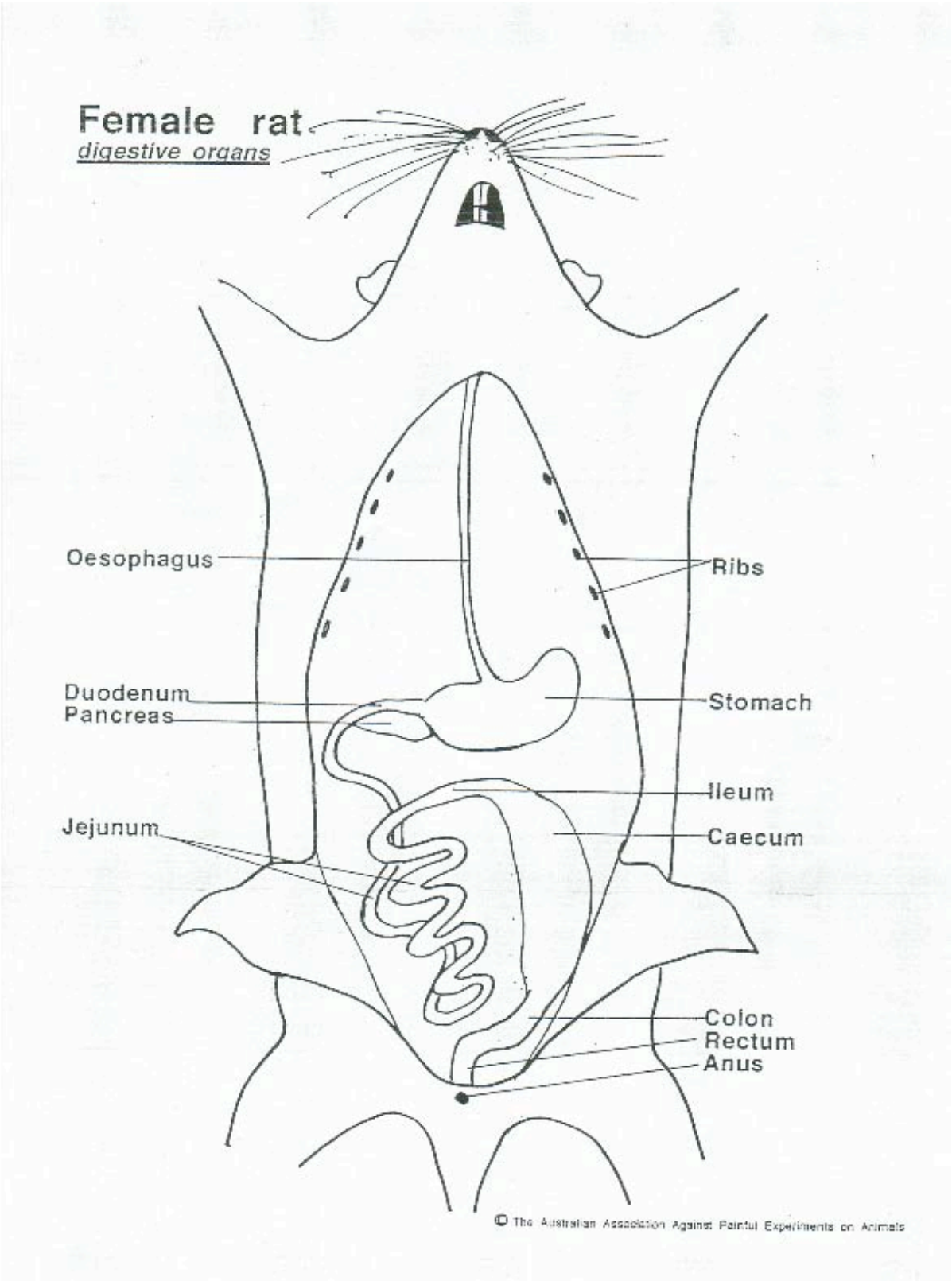
Female rat
digestive organs
Oesophagus
Ribs
Duodenum
Pancreas
Stomach
Ileum
Jejunum
Caecum
Colon
Rectum
Anus
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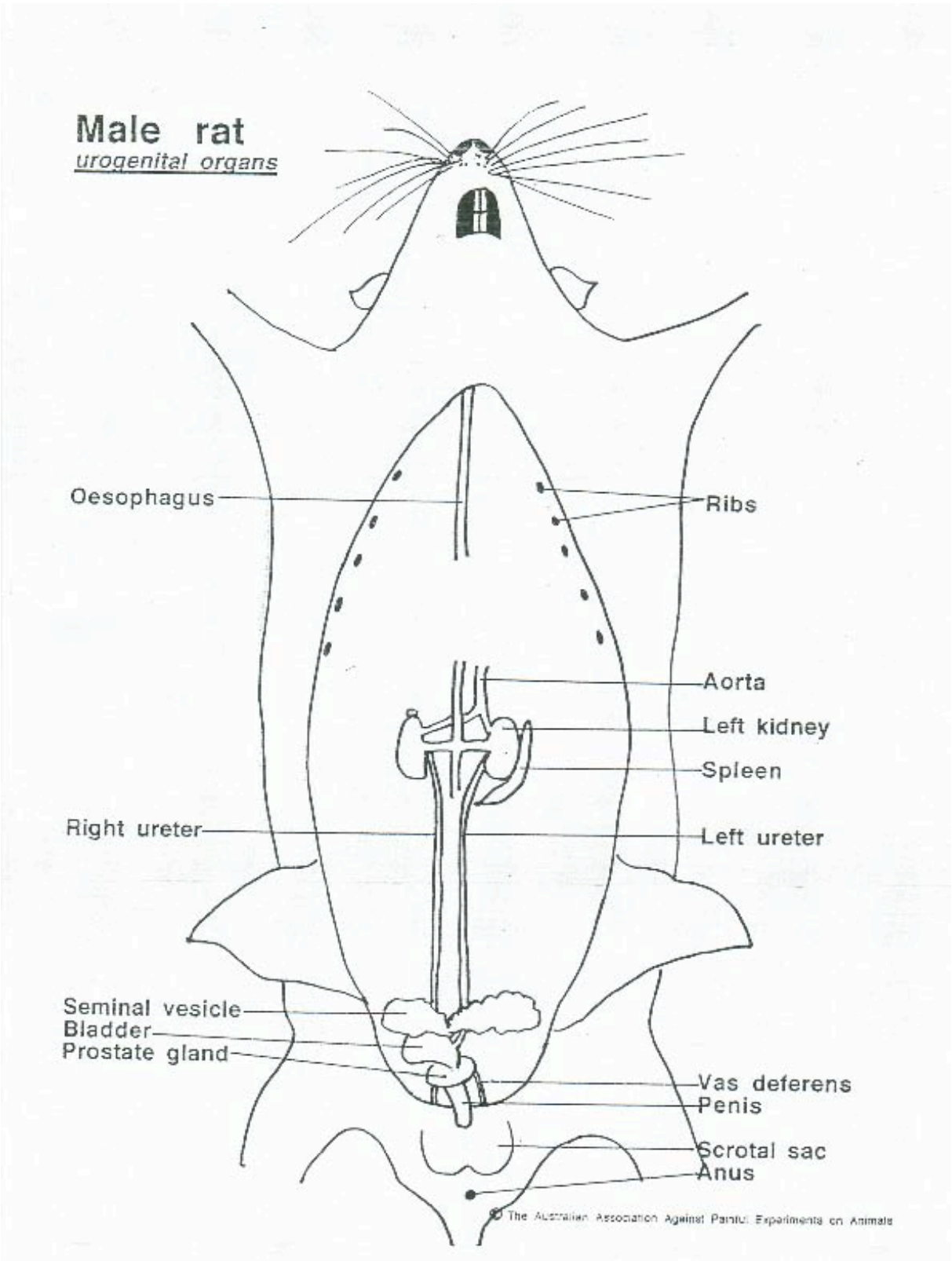
Male rat
urogenital organs
Oesophagus
Ribs
Aorta
Left kidney
Spleen
Right ureter
Left ureter
Seminal vesicle
Bladder
Prostate gland
Vas deferens
Penis
Scrotal sac
Anus
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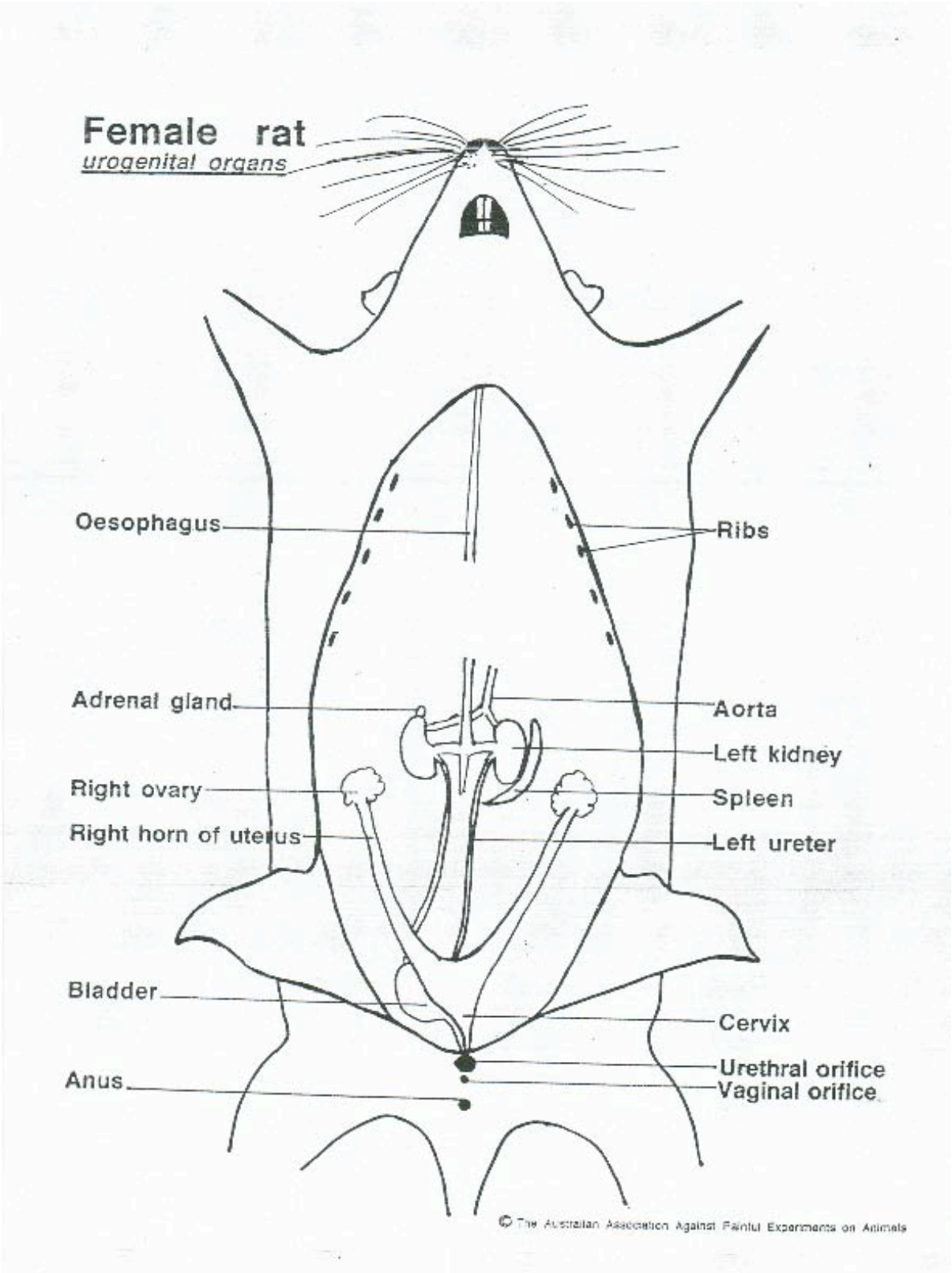
Female rat
urogenital organs
Oesophagus
Ribs
Adrenal gland
Aorta
Left kidney
Right ovary
Spleen
Right horn of uterus
Left ureter
Bladder
Cervix
Urethral orifice
Anus
Vaginal orifice
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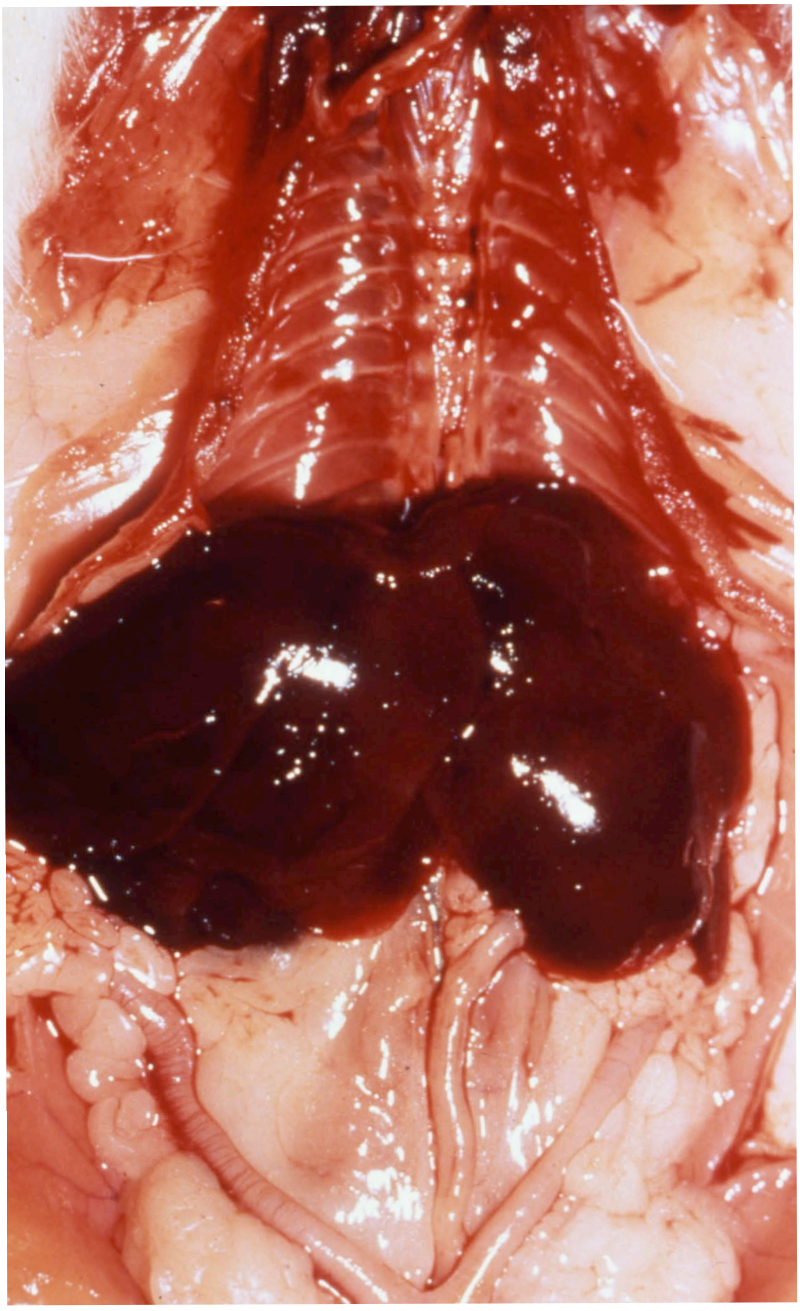
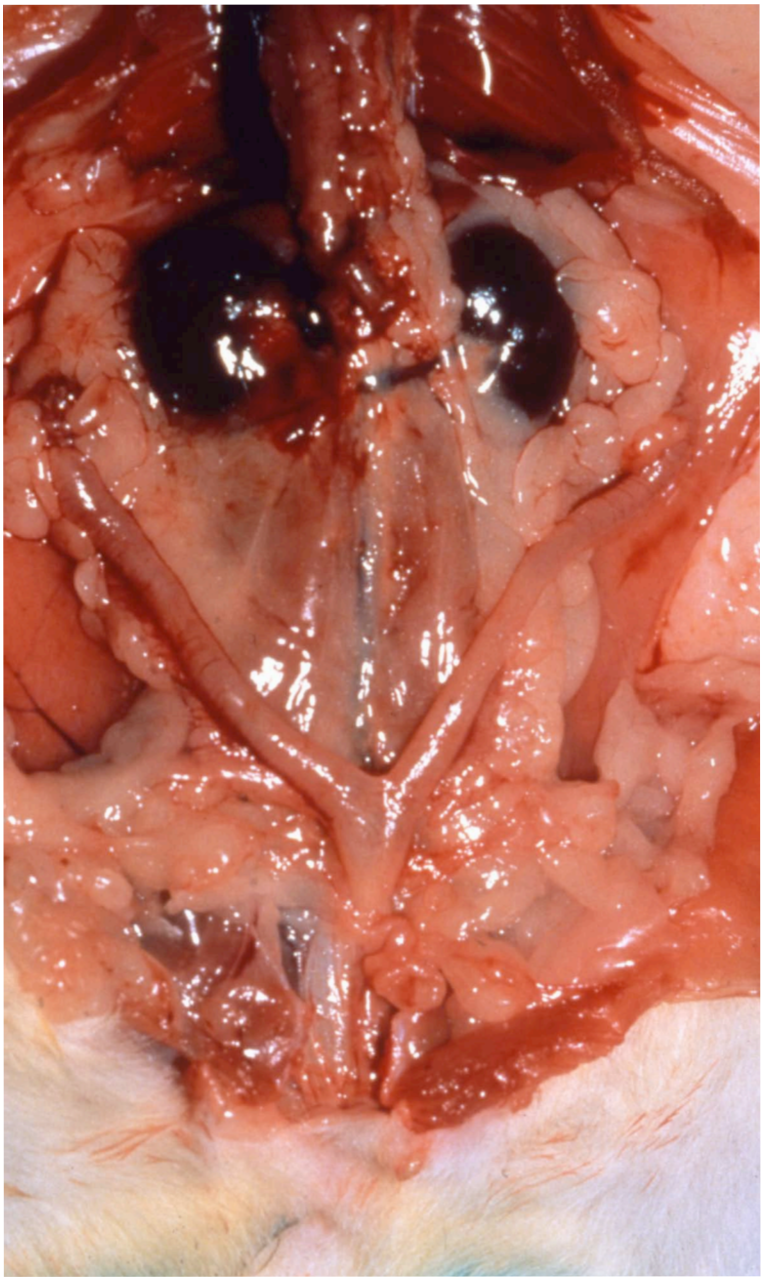
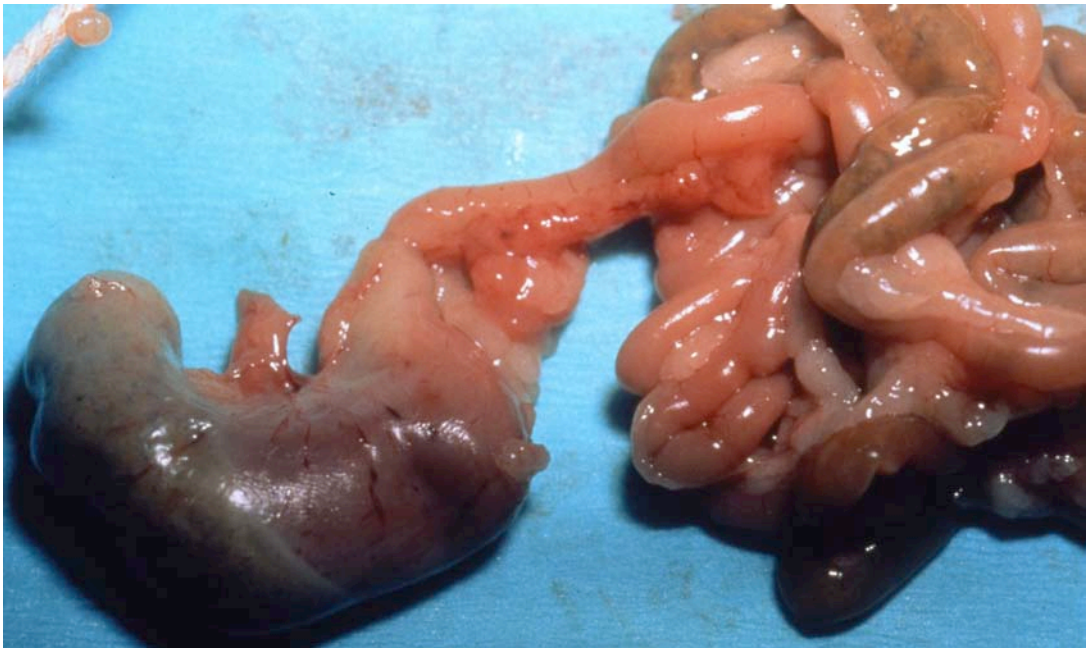
Female rat. Fur and body wall opened to reveal the thoracic and abdominal organs.



Lungs, heart, thymus and oesophagus removed leaving the digestive and urogenital organs.



Female urogenital organs.



Stomach and small intestine.