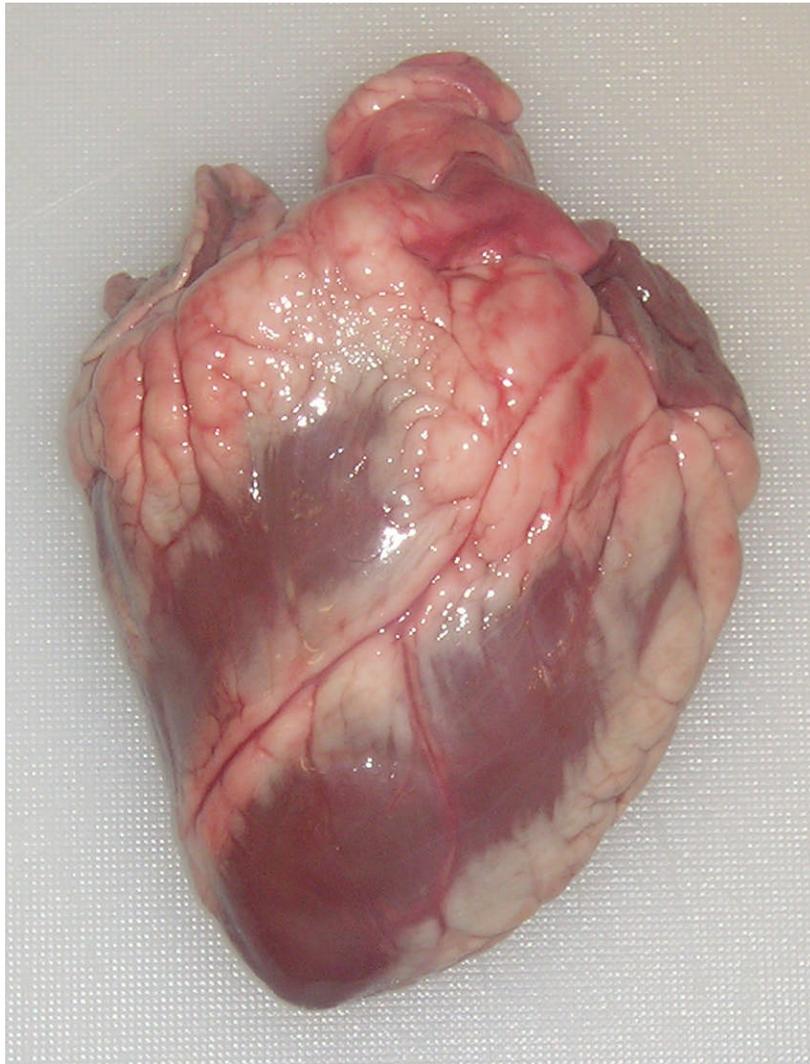


The Anatomy Cook Book



A dissection guide with recipes

by

Donal McNally

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Introduction

Practical, hands-on, wet dissection has to be the best way to learn anatomy. There are many fantastic textbooks, software, models and even web sites. However, none of these resources can communicate the full 3 dimensional, deformable nature of body structure. Sadly, dissection has largely disappeared from schools and now is absent even in some medical schools. This book was written to accompany an anatomy and physiology course for bioengineers who would otherwise have missed out on the opportunity to study real organ systems at first hand.

This book is not an alternative to a standard anatomy text, it acts more as a laboratory supplement. The fun bit is that your kitchen takes the place of the dissection room. Each recipe provides an insight into one or more organs, and all you need to do is go to the supermarket and be prepared to think about your food in a radically different way.

I hope you get a great deal of fun out of the following dissections and that the meals they precede are both tasty and memorable. Do be careful about which dinner guests you choose to share your anatomical insights with.

Ribs, thoracic wall and costal cartilages

Maple-Glazed Ribs

A succulent rack of ribs glazed with maple syrup is an ideal start to study the ribs and costal cartilages as well as the muscles of the thoracic wall.



Ingredients (serves 4)

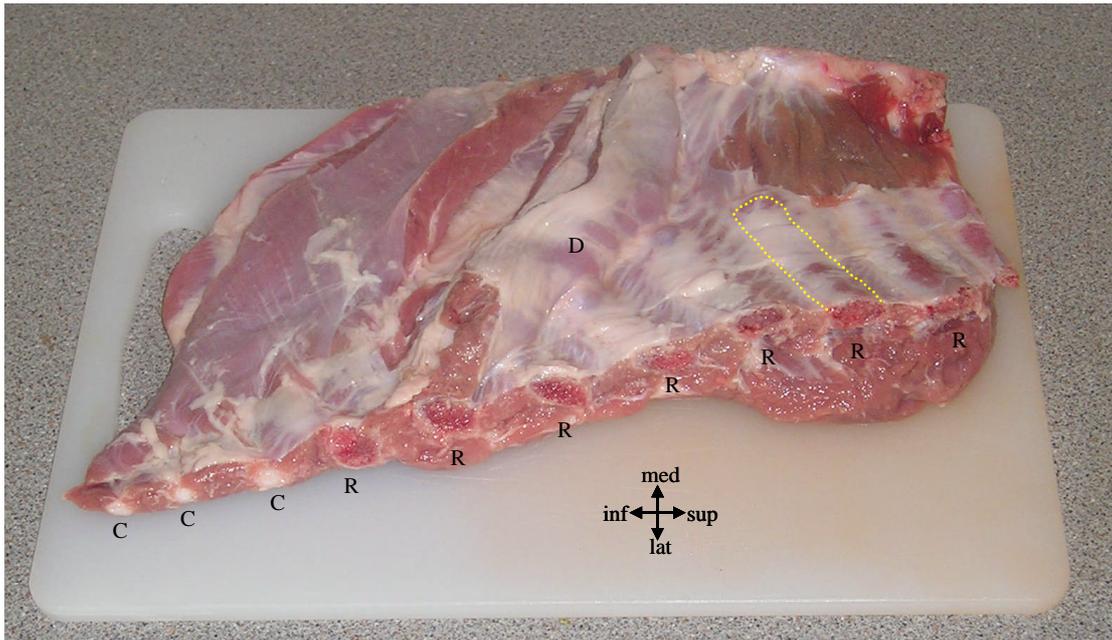
1.5 kg	3 lb	pork ribs (preferably in one piece)
175 ml	$\frac{3}{4}$ cup	maple syrup
25 ml	2 tbsp	brown sugar
25 ml	2 tbsp	tomato ketchup
15 ml	1 tbsp	cider or white wine vinegar
15 ml	1 tbsp	Worcester source
2 ml	$\frac{1}{2}$ tsp	salt
2 ml	$\frac{1}{2}$ tsp	mustard powder

Buying the meat

If possible buy a 'rack' of ribs, i.e. a single piece of meat (like the one over). If this is not possible, buy ribs that have been separated out into single ribs – select the meatiest ones available.

Pork spare ribs are normally cut from the inferior rib cage of the animal cutting the ribs before they articulate with the vertebrae and through the costal cartilages close to the sternum.

Anatomy



View of the deep (internal) surface of the specimen showing ribs (R), costal cartilages (C) and remnant of diaphragm (D).

1. Orient the specimen as shown in the photograph above.
2. Identify the cut ends of the ribs and any costal cartilages. Look carefully at the cut ends of the bone. Can you distinguish between the compact and cancellous bone? What colour is it? Does this tell you anything about the blood supply?
3. Look along the deep surface of the specimen, can you see where the diaphragm has been cut off?
4. Feel along one of the ribs. Can you follow its path in the thoracic wall? Can you feel the distal end of the rib where it joins the costal cartilage?
5. You should be able to see the intercostal muscles between the ribs.

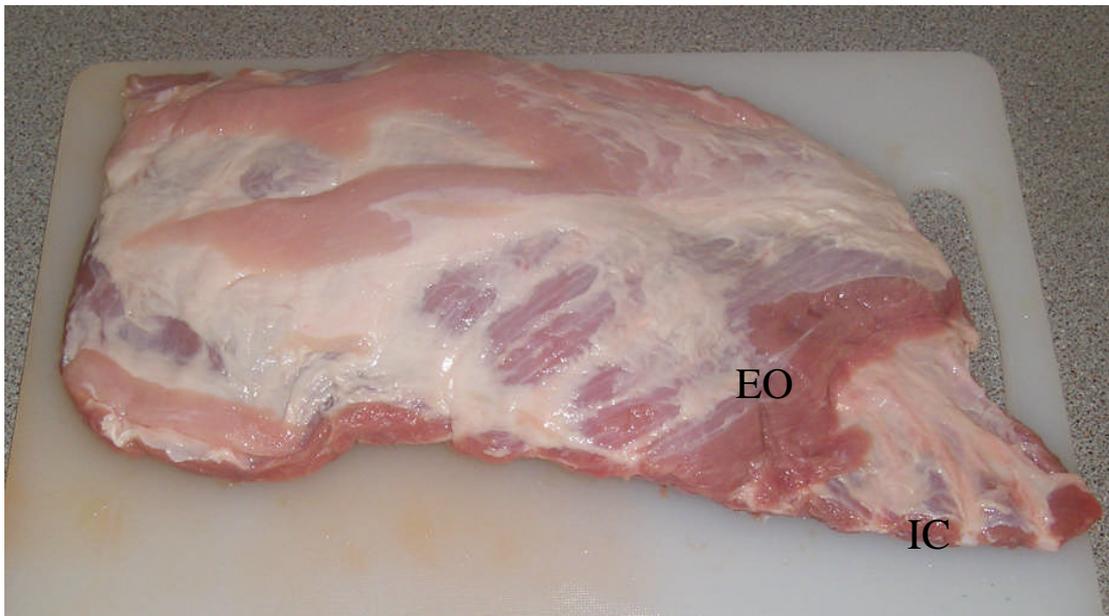


6. Lining the deep surface of the thoracic wall, you should see a silvery white membrane firmly attached to the ribs and intercostal muscles. This is the parietal pleura.
7. Look carefully at the inferior margin of one of the ribs. You should just be able to make out a neuro-vascular bundle (see above). If not, try running your finger along the inferior margin of the rib towards the cut end. You should be able to see a small drop of blood squeezed out of the vein.

Food for Thought

How can a spare rib dinner help when re-inflating a collapsed lung? A chest drain is normally inserted to let air out of the pleural space. The (very large) needle is put in close to the superior margin of the rib to lessen the risk of damaging the neuro-vascular bundle, avoiding paralysis and messy legal action. The 5th intercostal space is normally chosen to minimise the chances of perforating the liver or other important structure.

8. Turn the specimen over to look at the superficial surface (see below). The butcher will have removed the skin and most of the sub-cutaneous fat.



Superficial surface of the specimen showing the external oblique (EO) and intercostal (IC) muscles.

Recipe

1. Remove the parietal pleura from the specimen. This is easier said than done, but if you loosen an edge with a knife and then hold the membrane with some kitchen paper, you should be able to do it. If it all seems too much trouble, don't worry, the ribs will taste fine, it is just a little tough and fibrous.

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2. Put the ribs into a large saucepan can cover with water. Simmer gently for at least an hour but better two. There is a large amount of collagenous tissue in this cut that needs to be broken down by heat without drying out the meat – hence the long simmering time. Alternatively, microwave on medium for about 20 minutes in a shallow covered container. Remove the ribs and drain.
3. Combine all the other ingredients in a small saucepan and bring to the boil. Pour over the ribs and allow to marinade for at least 2 hours in the refrigerator.
4. Drain the ribs, but keep the marinade. They are best finished off on the barbeque, but you could do it under the grill. Cook for about 20 minutes, turning occasionally and brushing with the reserved marinade. Be careful not to let the sugary glaze burn too much.
5. Cut into suitable portions or individual ribs. Warm any remaining marinade up and pour over as a sauce.

Food for Thought

When you are flossing away the last bits of you rib supper from between your teeth, marvel that you know that the bits are probably periosteum.

Spine

Grilled lamb chops

Lamb chops provide an almost ideal view of the vertebrae and spinal muscles, the butcher has even done all the dissection for you.



Ingredients

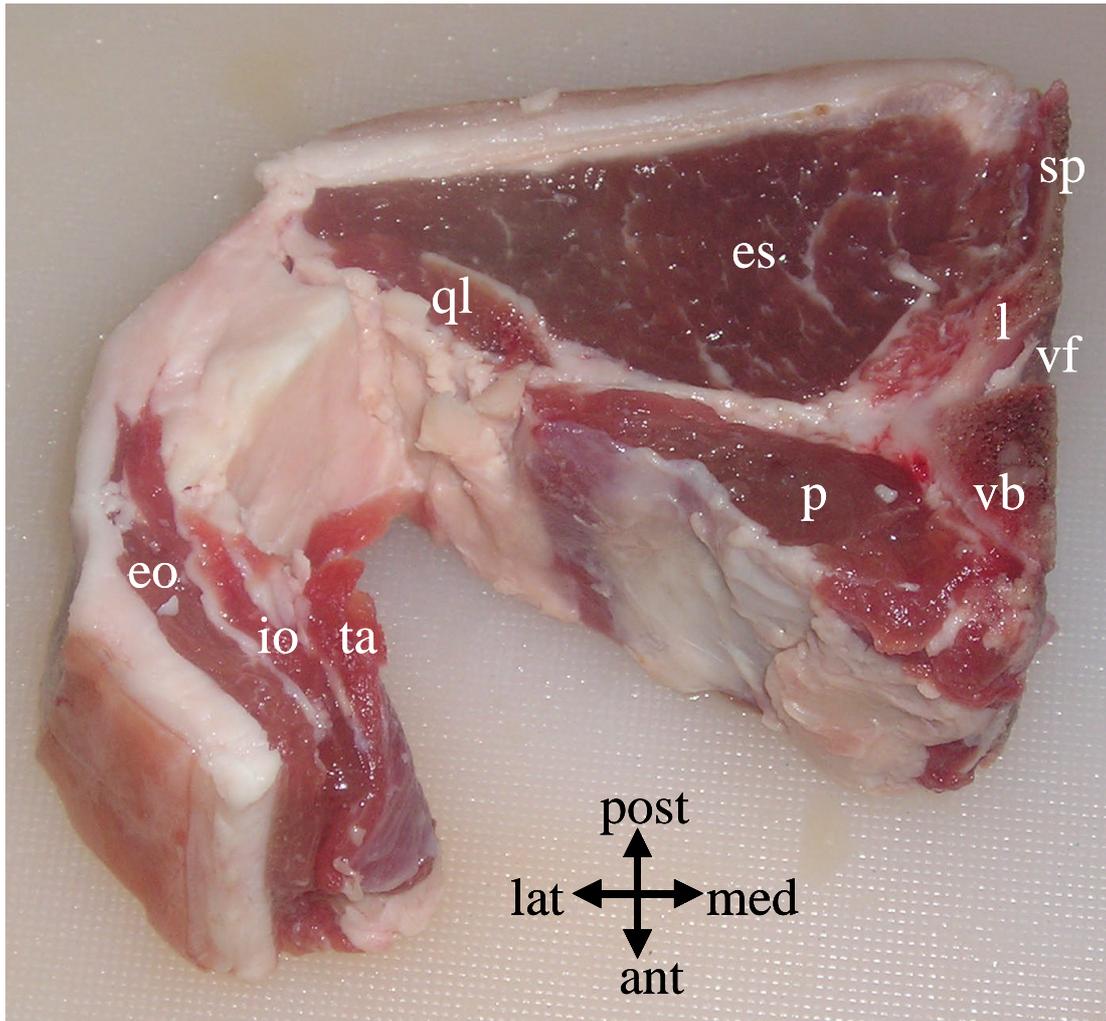
2 loin chops per person should be enough. You may want to grill the meat with olive oil, garlic, thyme, rosemary etc. (see recipe).

Buying the Meat

Try to choose nice thick chops, 2.5 cm (1") is not too thick! Loin chops are effectively axial sections of the lumbar spine and are usually also cut along the mid-sagittal line. They contain half a vertebra, often an intervertebral disc and of course the para-spinal muscles. Should you wish to save money, you can see most of the anatomy using pork loin chops instead of lamb, they will be thinner and may need more cooking.

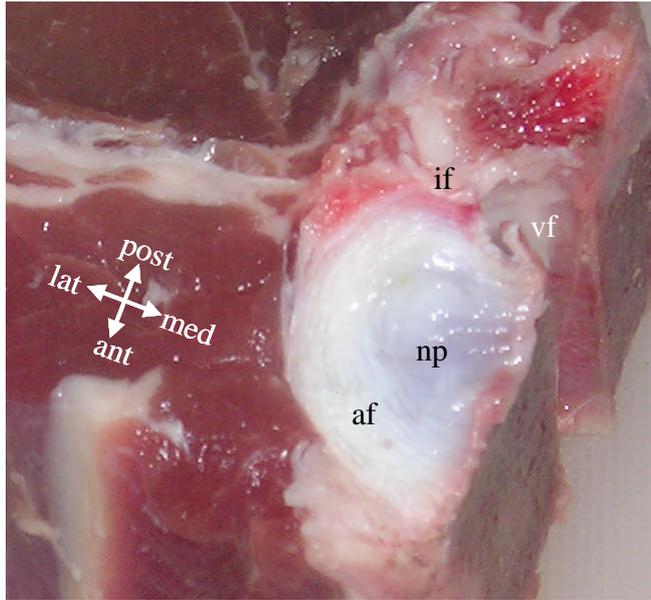
Anatomy

1. Place a chop on the board in front of you. Is it a normal chop (divided at the mid-sagittal line) or a double (Barnsley) one?
2. Identify the vertebral body. It will probably be sawn/chopped at the cut face.
3. Identify the vertebral body and the components of the neural arch. You can usually do this by gently feeling around the vertebral canal even if you cannot see the bone.



Structures of the posterior abdominal wall and spine: vertebral body (vb), lamina (l), spinous process (sp), erector spinae (es), quadratus lumborum (ql), psoas (p), external oblique (eo), internal oblique (io), transverses abdominus (ta).

4. Identify the different para-spinal muscles. Can you see or feel the transverse process?
5. Identify the muscles of the abdominal wall.
6. Can you see an intervertebral disc? If so look carefully at its structure in particular the nucleus pulposus and the lamellae of the annulus fibrosus. Feel the difference in material properties between the annulus and the nucleus.
7. Looking at the mid-sagittal surface of the specimen identify the vertebral foramen (the spinal cord will probably have been removed). Can you see an intervertebral foramen. If so, is there any nerve tissue remaining?



Structures around the intervertebral disc showing nuceus pulposus (np), annulus fibrosus (af), vertebral foramen (vf), intervertebral foramen (if).

Food for Thought

A 'slipped disc' occurs when material from the nucleus pulposus bursts through the annulus. This normally happens in the posterolateral corner of the disc where nucleus material can impinge on the nerve root in the intervertebral foramen. If the person is lucky, this causes excruciating pain often referred to the buttock or leg. If they are unlucky, they may loose sensation or become paralysed.

Recipe

1. The chops can be grilled without further attention. However, you might want to rub them with crushed garlic, lemon juice, olive oil, finely chopped leaves from woody herbs such as thyme or rosemary, or any combination of the above that appeals.
2. Place under a pre-heated hot grill (or better on a cast iron grill pan) for 3 minutes.
3. Turn and grill for about another 3 minutes. Cooking times vary considerably with grill temperature and thickness of chop. As the chop cooks the meat becomes springier and less soft to the touch. With experience you will be able to cook it to your liking by feel. Until you are confident, however, you can simply cut into one of the chops and look to see how well the meat has been cooked – you can always put it back under the grill. Ideally, lamb chops should be pink most of the way through with just the outside slightly charred. If the meat is well done and grey, you will get significantly less pleasure out of eating it.

Knee Joint and Bones of the Lower Limb

Roast leg of lamb stuffed with blue cheese and mango chutney

This wonderfully simple roast gives a fantastic insight into the anatomy of the knee. The dissection is a bit more involved but definitely worthwhile.



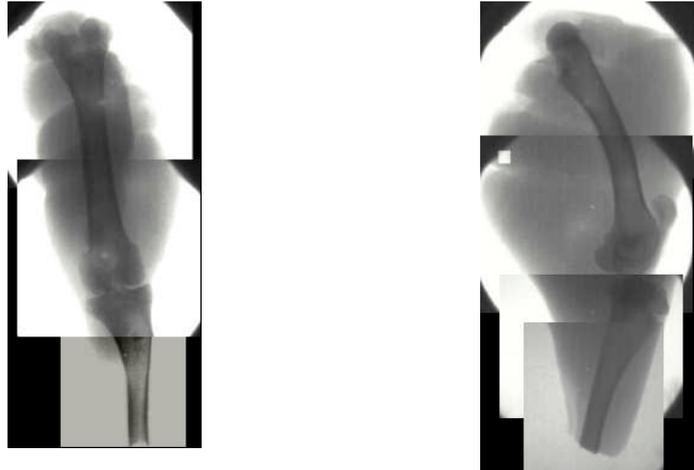
Ingredients (serves 6-8)

1.75-2.25 kg	4-5 lb	leg of lamb
170 g	6 oz	blue cheese (e.g. stilton)
170 g	6 oz	mango chutney
		string

Buying the meat

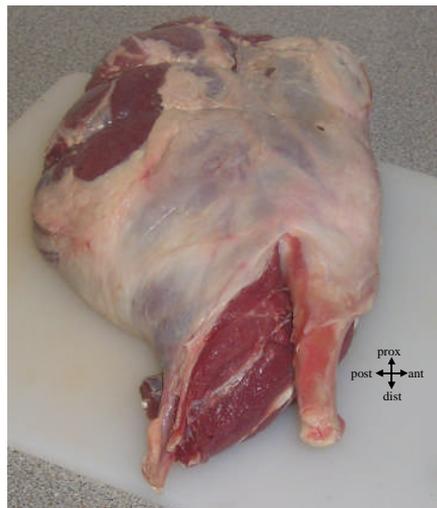
Ask for a whole leg of lamb, it is important that it should not already be boned and rolled. You should get the entire back leg from the head of the femur to the distal end of the tibia.

Anatomy



anterior-posterior (AP) radiograph lateral radiograph

1. The radiographs above show clearly the bones within the joint of meat – the femur, tibia and patella are clearly visible. Note that sheep do not have fibulas.
2. Look carefully at you specimen, can you tell whether it is a right or left leg?
Hint: the cut end of the Achilles tendon should be visible on the posterior side of the distal tibia, and the ball of the head of the femur should be seen sticking out on the medial side of the specimen.
3. Try to feel the bones within the specimen and also try to flex the knee joint.
4. Place the specimen in front of you with the lateral surface uppermost. Cut the bone away from the flesh carefully, starting at the distal end of the tibia (see below).



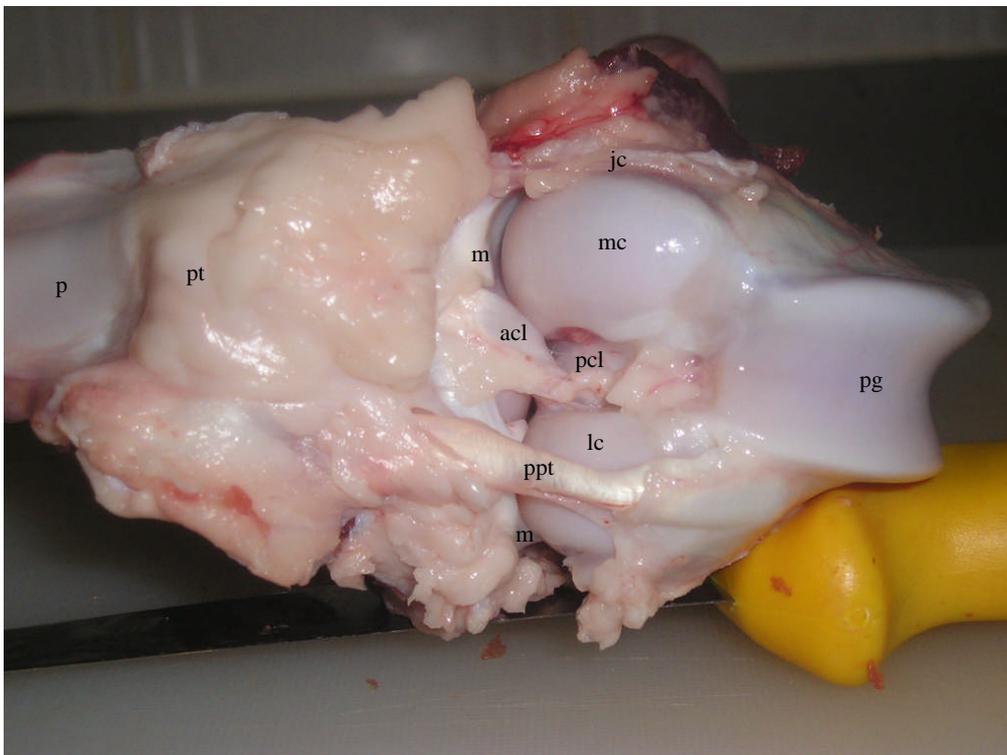
5. Continue to cut the bone away from the flesh moving towards the knee. Be careful as you reach the knee, the epiphysis of the tibia bulges out quite a long way. You will see quite a large tendon from the popliteus muscle entering the knee joint. As you cut away the meat, you will become very aware as to the

regions where muscles insert into the bone, and others where the muscle is not attached. Finally, after a lot of trimming you should have the femur, tibia and knee joint in one piece as in the picture below.



Dissected bony structures showing the tibia (t), femur (f), head of femur (hf), patella beneath cut end of quadriceps muscle (p) and the knee joint capsule (c)

6. Look carefully at the specimen. Identify the bones. Flex the knee joint, feel how smoothly it moves. Look carefully at the head of the femur. Can you see the small depression left by the round ligament.
7. From the proximal side, start to snip along the edges of the patella tendon with scissors. You will soon be able to open up the knee joint and get a clear view.



Anterior view of flexed knee joint showing: patella (p), patella tendon (pt), patella groove in femur (pg), medial and lateral femoral condyles (mc, lc), anterior and posterior cruciate ligament (acl, pcl), joint capsule (jc), meniscal cartilages (m) and popliteus tendon (ppt)

8. Make sure that you can identify the various joint structures. You may find that you need to carefully cut away some of the fat pads to view the cruciate ligaments and menisci.

Food for Thought

A common footballer's injury is a ruptured anterior cruciate ligament (ACL). This is normally caused by turning on a bent knee. There are various surgical techniques for repairing such a rupture; from specially designed textile implants (rarely used now) to grafts taken from the patellar tendon.

Recipe

1. Make up the stuffing by mashing the blue cheese with the mango chutney.
2. You should now have a neatly boned leg of lamb in front of you (the bones can be discarded, given to a pet, turned into a sumptuous stock or simply worn in the beard possibly with a discrete bow).
3. Place the stuffing into the slot left by removing the bone. Neatly roll the joint back into shape and secure with string. Sounds easy doesn't it! Cutting a few lengths of string to approximate length and putting them under the joint before rolling it up helps. You will end up with a beautifully prepared boneless joint like the one shown below. Weigh the joint.



Boneless joint, stuffed and rolled ready for roasting.

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4. Place the joint skin side up into a roasting tin. Add 1-2 cm of water to the tin. This will stop any ooze of stuffing from burning and will also develop into a wonderful and zero effort gravy.
5. Place the joint into a oven pre-heated to 180°C (convection) or 160°C (fan) for 25 minute per lb (454 g) plus 25 minutes. Baste occasionally with the liquid in the bottom of the tin, which will act as a glaze to give a wonderful deep chestnut gleam to the cooked joint. Keep the liquid level topped up to prevent things burning.
6. Remove the joint from the oven and allow to rest for 20-30 minutes. While the meat is resting make the gravy simply by skimming any fat from the top of the liquid left in the bottom of the tin. If you are feeling extravagant you could supplement the gravy by stirring in some beer, cider, wine or port as the fancy takes you.
7. To serve simply carve the meat in slices and serve with the gravy.

Heart

Marinated heart with fresh herbs

Don't be put off. This recipe is actually very tasty, the heart slices have a firm, slightly crunchy texture (remember cardiac muscle forms a network rather than parallel fibres), and the dissection really helps to put things into 3 dimensions.



Ingredients (serves 2)

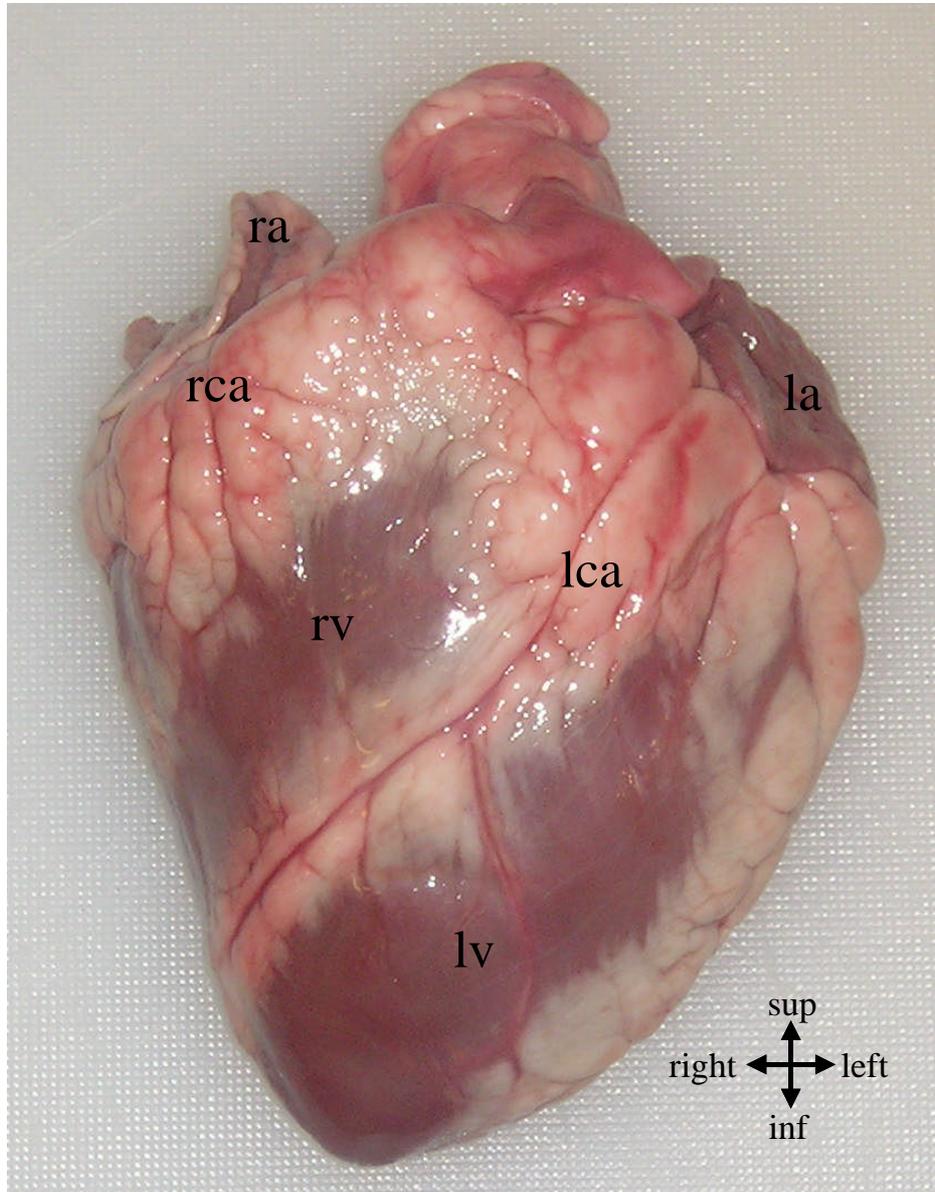
4		Lambs' hearts
1		Medium onion (chopped)
2		Cloves garlic (chopped)
		Fresh herbs (chopped)
		Olive oil
		Red wine
		Butter and oil
25 ml	2 tbs	Crème fresh, natural yoghurt or cream

Buying the meat

Lambs' hearts are inexpensive, but you may have to go to a butcher to get them. Unfortunately, butchers normally trim off most of the tubing as a service to their customers. It is worth comparing your hearts carefully to check which has which bits still left on.

Anatomy

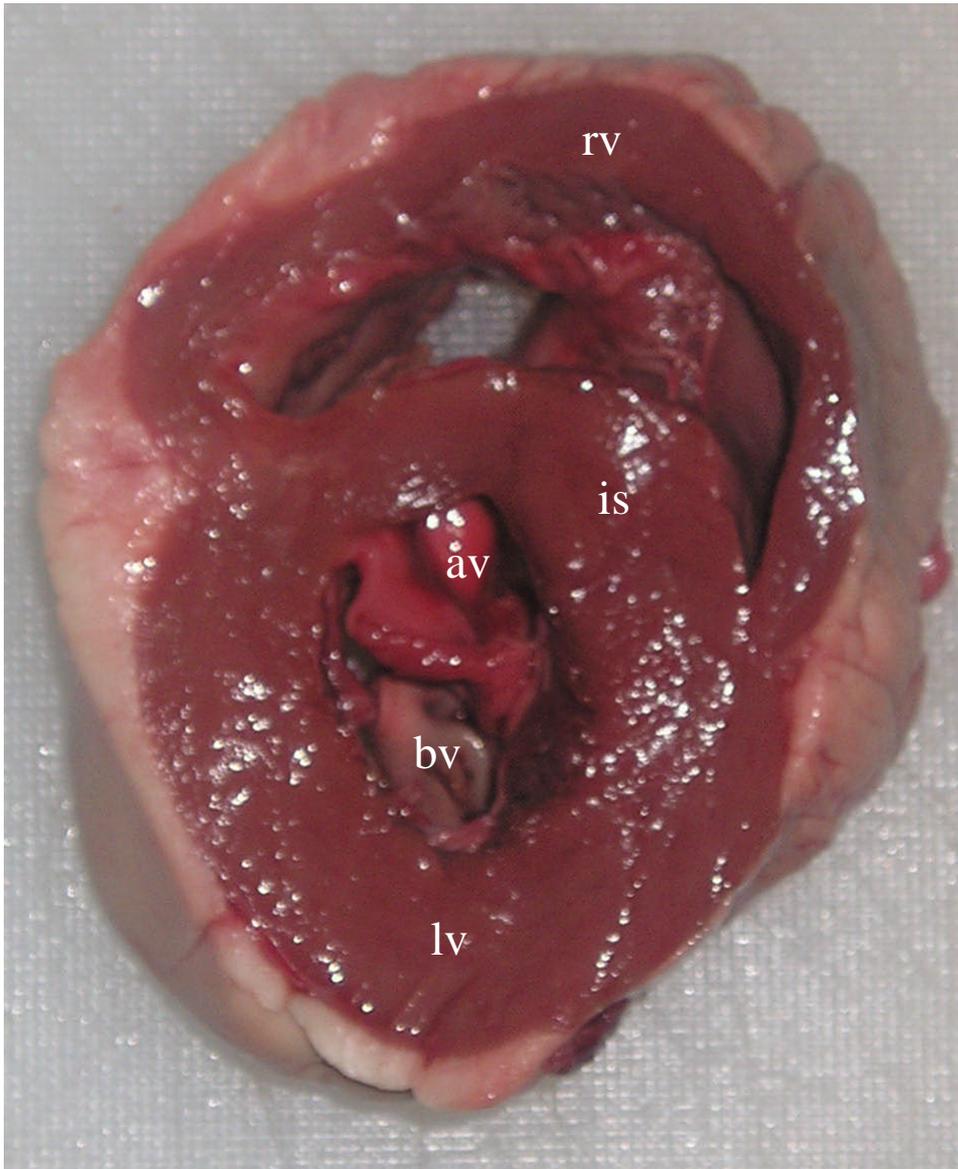
1. Take the most complete heart and set it on a board in front of you. Move it around until its anterior (ventral) surface faces you and the apex of the heart is at the bottom. You should have something that looks like the picture below:



Anterior view of the heart showing: left ventricle (lv), right ventricle (rv), branches of the left and right coronary arteries (lca, rca), left auricle of left atrium (la) and right auricle of right atrium (ra).

2. Identify the stumps of the arteries and veins emerging from the superior aspect of the heart. You will find that it helps to stick your fingers into some of the openings to see where they go. This step is most valuable in understanding the complex 3-dimensional arrangement of the vessels.
3. It is probable that most of the atria have been removed. See if you can see the atrio-ventricular valves (they may well be badly damaged). Similarly, you may be able to see the pulmonary and aortic valves.

4. Starting at the apex of the heart take 1.5 cm thick slices (perpendicular to the axis of the heart).



Section through heart showing: walls of the left ventricle (lv), right ventricle (rv), interventricular septum (is), aortic valve (av) and bicuspid valve (bv). Note also the fat in which the coronary vessels lie.

5. Note the difference in wall thickness of the left and right ventricles.
6. You should be able to identify the valves and chordae tendinae. Look carefully at the lining of the ventricles.

Recipe

1. Carefully trim the slices of heart to remove any vessels and large lumps of fat. Neither of these is pleasant to eat.
2. Place the slices in a bowl with the chopped onion and garlic, and mix in the chopped herbs (parsley, chives, thyme, oregano are all good).

3. Pour in equal quantities of wine and olive oil to cover the mixture and transfer into a plastic bag.
4. Seal the top of the bag and place in a fridge overnight, but even better is to leave the heart to marinade for a couple of days.
5. Lift out meat and pat dry with paper towels.
6. Heat some butter and oil in a frying pan and fry the heart slices for about 2 minutes per side. Transfer the cooked heart into a warm (100 °C) oven for 15 minutes to rest.
7. Strain the marinade and skim off as much of the oil as possible. Add the marinade to the frying pan and stir to dissolve the pan juices. Add the crème fresh or yoghurt and a handful of chopped herbs.
8. Pour the sauce over the heart slices and serve.

Food for thought

Listening to a heart beat is part of our culture from hospital dramas to horror movies, but what actually causes it? Blood flow is normally silent, except on the odd occasion where there is turbulence. When the heart valves close, there is a brief moment when the last bit of blood flow is turbulent. Of the *lubb – dupp* typical heart sound, the *lubb* corresponds to the atrio-ventricular valves closing, whilst the *dupp* corresponds to the aortic and pulmonary valves closing.

Liver

Calf's liver with grapes and Madeira

When it comes down to it, you either like liver or you don't. In this recipe the liver is cooked so that it is meltingly soft with a beautiful light, sweet sauce. Give it a go...



Ingredients (serves 4)

50 g	2 oz	butter
50 g	2 oz	Shallot or onion (finely chopped)
175 ml	6 fl oz	Chicken stock
100 ml	4 fl oz	Madeira or sweet sherry
24		Seedless grapes (halved)
400 g	1 lb	Calf's liver. A whole one weighs 2 lb so double the quantities and have a party.
		Fresh sage leaves

Buying the meat

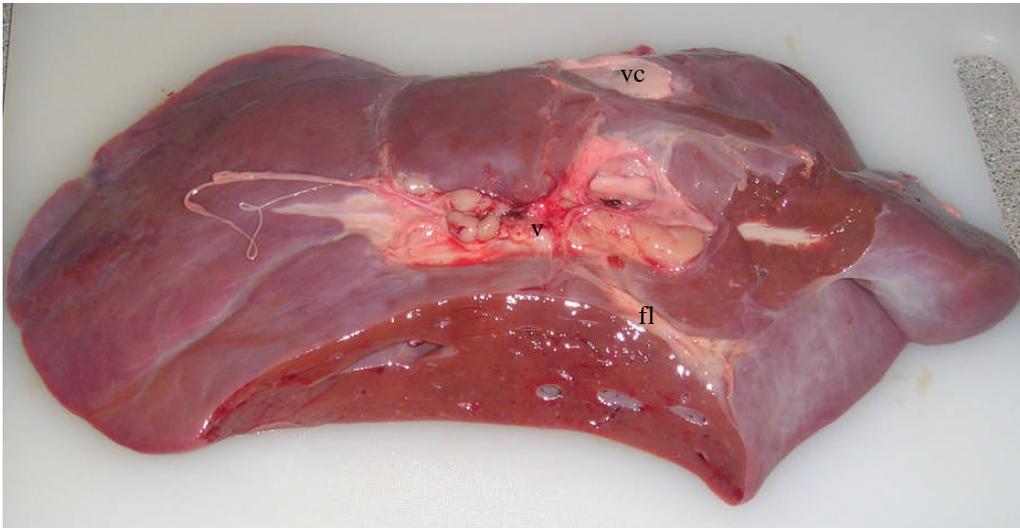
This recipe uses about half a calf's liver. The pictures correspond to a whole one. If you can, try to get the liver in one piece.

Anatomy

1. Put the liver onto a board and try to identify the features.



Superior surface of liver. Note how smooth it is.



Inferior surface of the liver showing: vena cava (vc), remains of hepatic artery, hepatic portal vein, bile duct (v) and falciform ligament (fl).

2. Cut the liver into 3-4 cm thick slices.
3. Look carefully at the cut surfaces. Note the large diameter vessels that permeate throughout the liver.
4. Look carefully at the lining of some of the large vessels. You will be able to see the openings of the central veins/portal vein branches.



Lumen of one of the large veins that has been opened out. Look at the texture of the venous epithelium and also at the openings of the smaller vessels.

5. Note the enormous difference in texture between the liver tissue and the blood vessels.

Recipe

1. Trim the slices of liver of any large surface vessels and ligaments. Do not worry too much about internal vessels – they should be OK when cooked.
2. Melt half the butter and fry the shallot (or onion) until golden. Add the stock and Madeira, season and bring to the boil. Boil rapidly for 5 minutes until it is reduced and has a syrupy consistency. Add the grape halves and warm through.
3. Melt the remaining butter in a frying pan and fry the liver with 4 sliced sage leaves. Turn the liver 1 or 2 times as it cooks. The liver should take about 5 minutes to cook.
4. The aim of cooking the liver is for it to still be pinkish most of the way through. Cooked much more and it will go vile and leathery (think the worst things about school meals). Either cut into a piece of liver to check that it is done, or poke it. Underdone liver feels very soft and squidgy; just right liver still feels soft (a bit like play dough); school dinner liver has the texture of rubber.
5. Remove from the pan, cover with Madeira sauce and serve garnished with sage leaves.

Food for thought

Liver is a good source of Vitamin A. Several polar explorers have died from Vitamin A toxicity after eating the livers of their sled dogs (meals on paws) – polar bears have similarly lethal levels of Vitamin A. You have been warned!

Kidney

Devilled kidneys

Have a go at anatomy before breakfast. Here is a way to see the rather beautiful structure of the kidney and kick-start your morning.



Ingredients (serves 4)

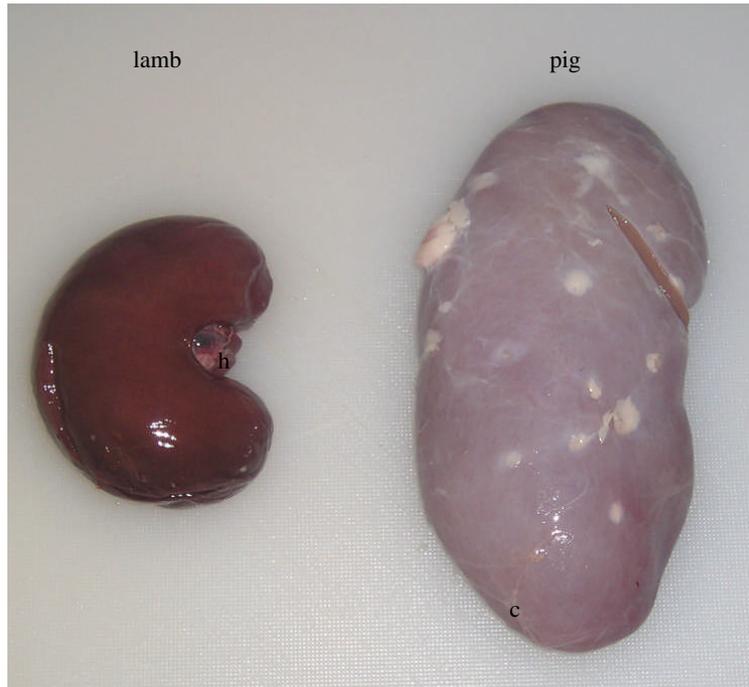
25 ml	2 tbs	Worcester sauce
25 ml	2 tbs	Ketchup
5 ml	1 tsp	English mustard powder
50 g	2 oz	Butter (melted)
		Cayenne pepper
8		Lambs' kidneys (or 2 pig's)
15 ml	1 tbs	Vegetable oil
		Chopped parley
		Lemon wedges

Buying the meat

The commonly available kidneys are lambs' pigs' of ox. Lambs' are smaller and less strongly flavoured; pigs are larger and very similar in size and shape to human kidneys; ox kidneys have a strange multi-lobed appearance (a bit like a bunch of grapes).

Anatomy

1. Place the kidney of a board and identify the external features.

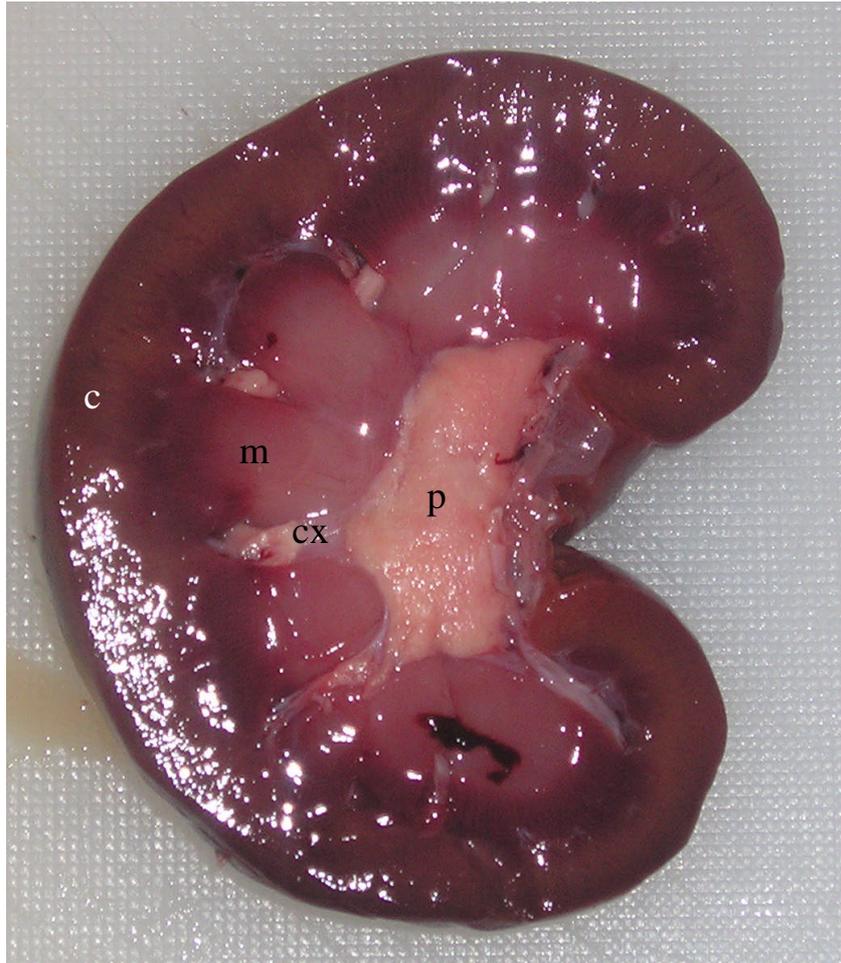


Lamb and pig kidneys showing: renal hilus (h) and renal capsule (c).

2. Remove any capsule from around the kidney. You may find that the butcher has done this already for you.
3. Slice the kidney in a frontal plane, but note quite on the mid-line of the kidney. You should get a section like the one below. Make sure that you can identify all the important structures

Food for thought

Every day, each of your kidneys will process 1,225 l of blood. That is enough to fill 6 baths, or put another way, your entire blood is processed nearly 500 times each day.



Section of kidney showing: renal cortex (c), medulla (m), calyx (cx), pelvis (p) covered in fat that facilitates contraction.

Recipe

1. Mix together the Worcester sauce, ketchup, mustard, a pinch of cayenne pepper and half the melted butter.
2. Cut the kidneys into about 4 pieces each discarding the tough calyces (called cutting out the core in other recipes). If you are using pig kidney, you will need to cut each into about 12 pieces.
3. Heat the remaining butter in a frying pan and cook the kidney pieces gently for about 5 minutes, stirring occasionally.
4. Pour the sauce over the kidneys and stir for 2 minutes to coat the kidneys.
5. Serve with lemon wedges and hot buttered toast.

The End



I hope that you have enjoyed the recipes in this book, that they have brought enlightenment as well as oral delight.

Donal McNally, December 2004.

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