41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:30 Page 1

Durham University

Skeleton Science

Teacher's Resource Pack

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:30 Page 2

Crouched burial at the Anglo-Saxon Bowl Hole Cemetery at Bamburgh Castle, Northumberland (courtesy of the Bamburgh Research Project)

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:30 Page 3

Introduction

This booklet has been created by Dr. Kirsty McCarrison of Durham University Library's Learning Team in association with Prof. Charlotte Roberts of Durham University's Archaeology Department.

Skeleton Science is a travelling exhibition which was originally exhibited at Durham University's 'The Old Fulling Mill Museum of Archaeology' during 2012/13. It introduces methods of scientific analysis of archaeological human skeletons and aims to offer a behind the scenes look at an archaeological specialism that studies the human past using key primary evidence. The exhibition includes the display of a single skeleton whose past is pieced together, revealing a life that is recognisable to the average person today. It is a story of travel, belief and the inevitable aging of the human body; and allows a better understanding as to why bioarchaeological study is useful, necessary, and relevant to the 21st century.

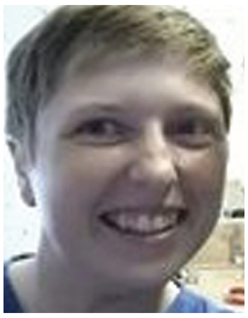
With the curriculum changes in 2014, it was recognised that many elements of the exhibition would be useful to help support teaching across a range of topics in school including biology, history and chemistry. The resources created span all key stages and GCSE and above. Contained within the booklet are a mix of teacher's notes, activity ideas, templates and student hand-outs designed to support teaching in the classroom.

For those based in the North-East of England, or even perhaps further afield, please note that Durham University Library's Learning Team offers outreach sessions for KS1 and KS2 on the topic of 'Skeleton Science'. For older students, a great many relevant resources (particularly relating to history and archaeology) can be found on our Learning website which is free to access: **www.durham.ac.uk/4schools**

For further information relating to the sessions offered by the Learning Team, please contact us on: **4schools@durham.ac.uk**

Professor Charlotte Roberts

Charlotte is a Professor of Archaeology in the Department of Archaeology, and a bioarchaeologist with a background in nursing (SRN), archaeology (BA), environmental archaeology (MA) and human bioarchaeology (PhD). She is a Fellow of the British Academy (2014), and a member of the Paleopathology Association, American Association of Physical Anthropologists, and British Association of Biological Anthropology and Osteoarchaeology (BABAO). She does research on the history of disease and medicine, and especially infectious diseases such as tuberculosis, leprosy and syphilis. For more information, see her webpage: **www.durham.ac.uk/archaeology/staff/?id=163**



Dr Kirsty McCarrison

Kirsty completed her doctorate in bioarchaeology in 2012 and is now a Learning Officer based at Palace Green Library. She works with schools, families, community groups and adult learners on a variety of projects across all of Durham University's heritage sites including (but not limited to!) the Oriental Museum, Durham Castle and the Botanic Gardens. Although her teaching is now varied, she jumps at any chance to talk about skeletons and remains a member of BABAO. She is now looking forward to teaching prehistory from the redeveloped archaeology gallery at Palace Green.

The Skeleton

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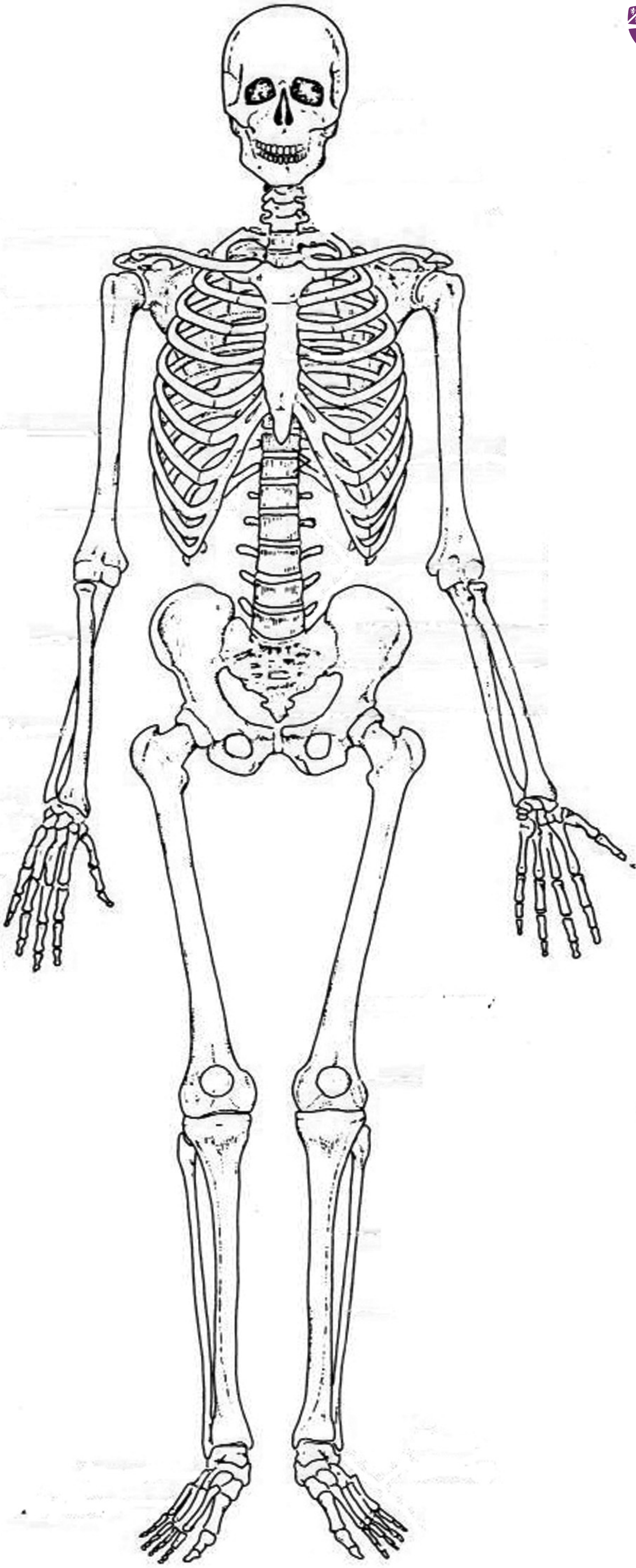

Label Me!

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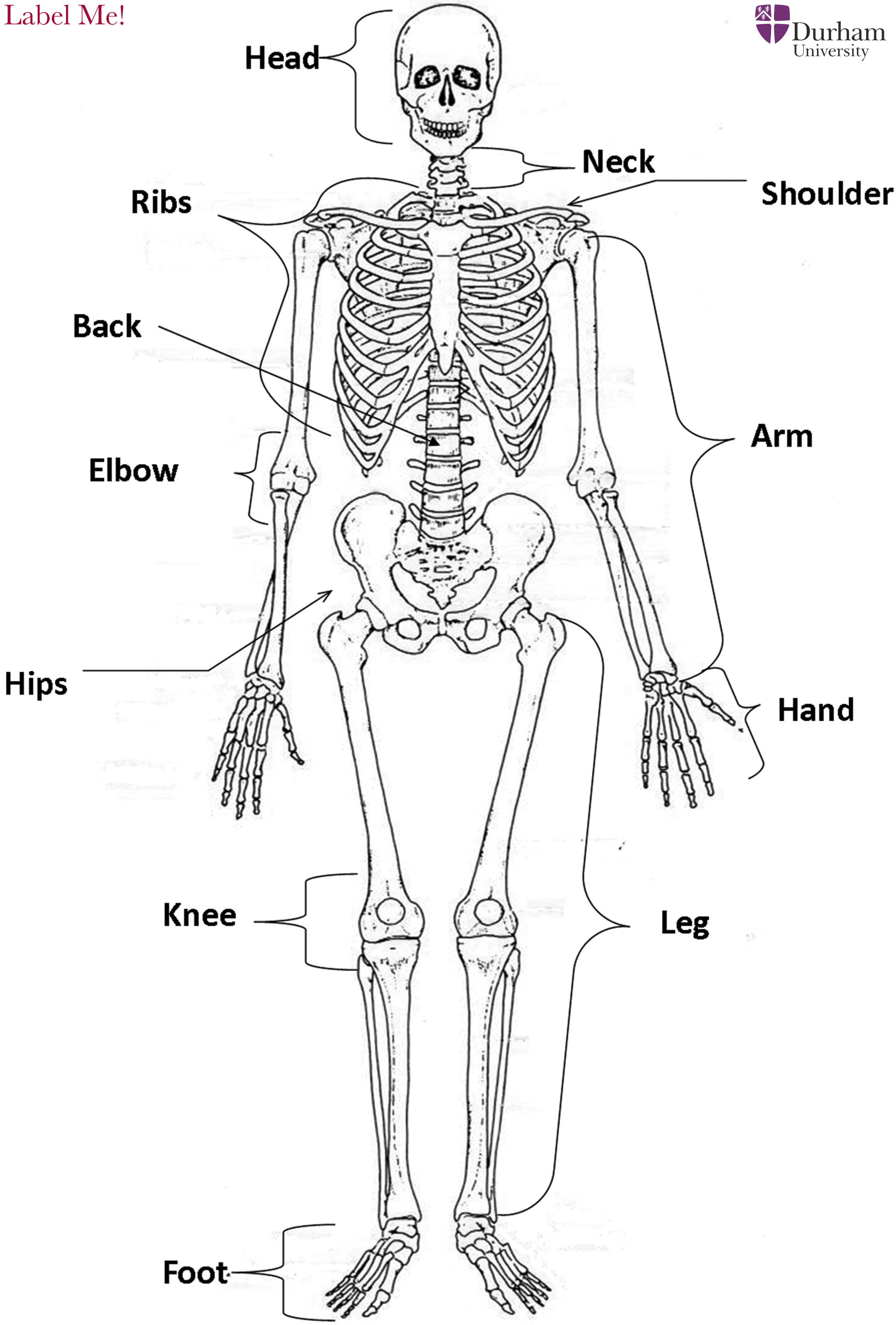


Classroom Activities

(templates on following pages)

Activity 1

Dangling Skeleton

Materials:
Template (provided) / string / split pins / scissors / hole punch

Instructions:
Give one template to each student (2 pages). Students must cut out the template and articulate the bones, connecting with the split pins. This can then be hung up as part of a display.

Activity 2

Skeleton Snap

Materials:
Template (provided) / laminating pouches

Instructions:
This game is pre-prepared and very simple. Laminate a set of playing cards with different individual bones on them and/or different diseases. Students can then play one of two games, Snap or Pairs (also known as Memory).

Activity 3

Day of the Dead Mask

Materials:
Template / card / coloured pens or pencils / scissors / hole-punch / lollipop stick

Instructions:
Introduce the students to the Mexican Day of the Dead festival (begins 31st October). Give each student a copy of the mask and ask them to colour it in as brightly as possible. Either hole-punch the mask at either side and attach string or attach a lollipop stick so that the student can hold the mask in front of their face.

Activity 4

Skeleton Says

Materials:
None

Instructions:
This is a quick activity to test your student's memory of the parts of the skeleton. Adapt the game 'Simon Says' but using bone names, for example, "Skeleton says, touch your knees". This can be adapted to suit ability.

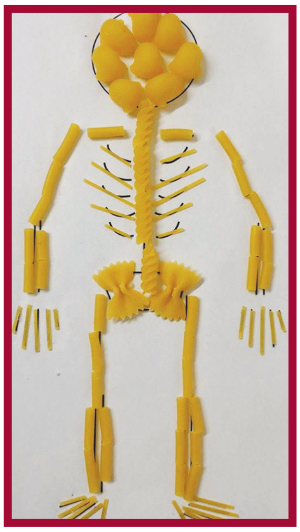
Activity 5

Pasta Skeleton

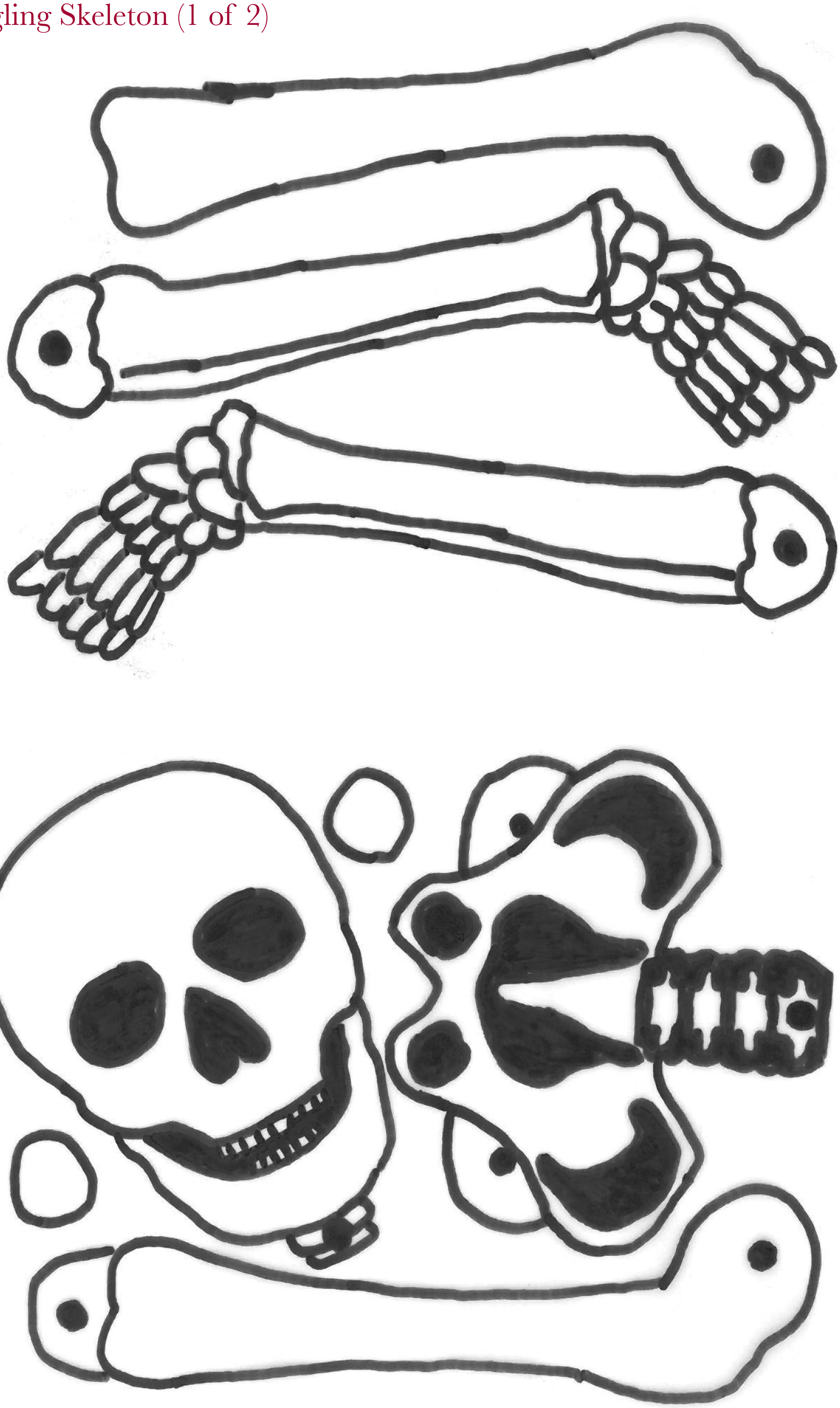
Materials:
Choice of pasta shapes (e.g. penne, spaghetti, spiral, macaroni, shells, fusilli etc.) / dark coloured card (with simple outline of skeleton – optional) / glue / white paint

Instructions:
Give each student a piece of coloured card and allow them to select whichever pasta they like to represent the various bones in the body. Use PVA glue (glue sticks will work but are less effective) to stick the chosen pasta shapes to the card and allow plenty of time to dry. Paint the pasta white or leave pasta coloured if preferred (white is more accurate for living bone, brown/beige is more accurate for archaeological bone).

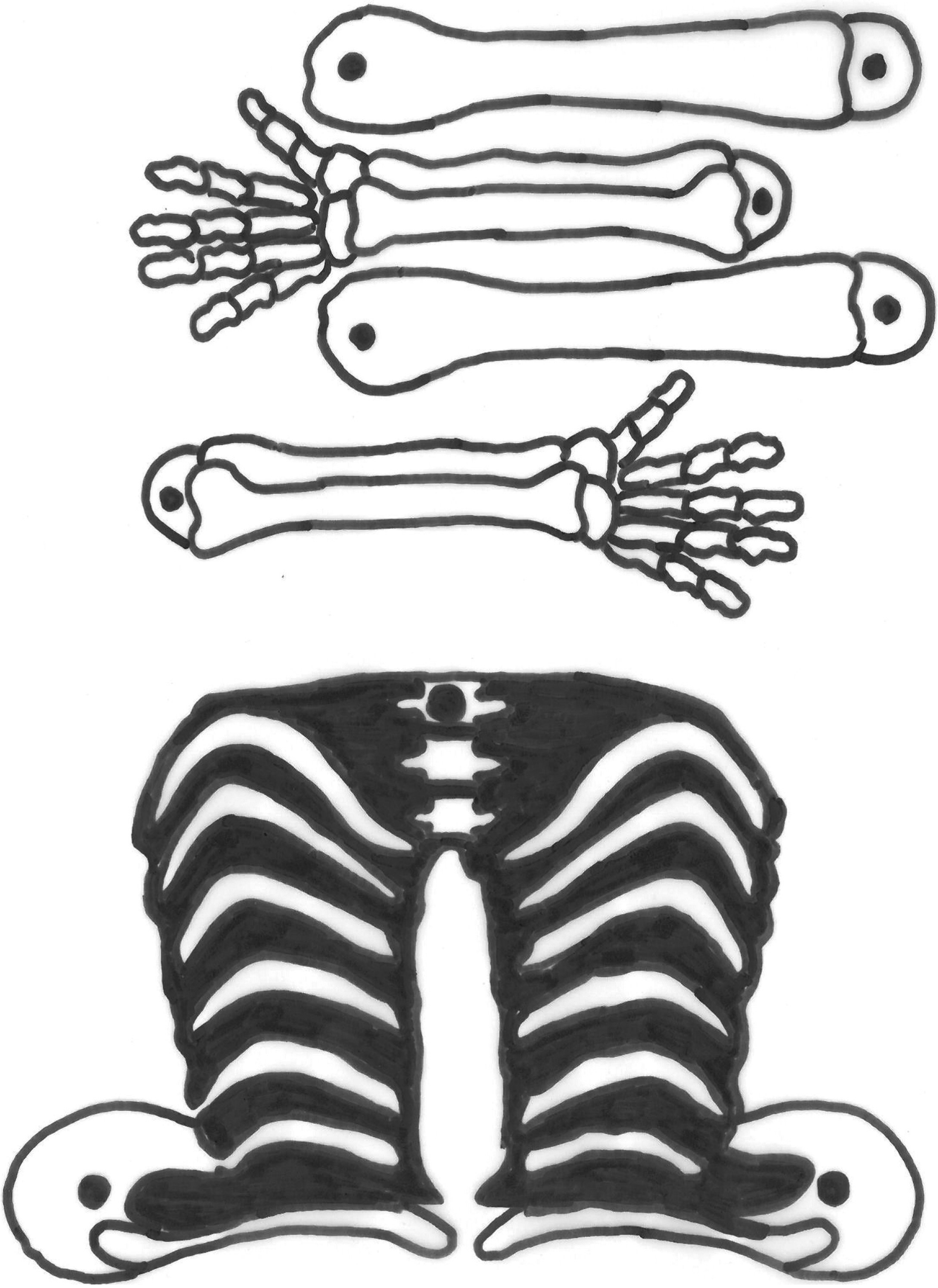
Skeletons can be made to be quite accurate or, depending on the ability level of the students, quite basic. Alternatively each student can be given a different part of the skeleton to focus on in more detail.



Dangling Skeleton (1 of 2)



Dangling Skeleton (2 of 2)



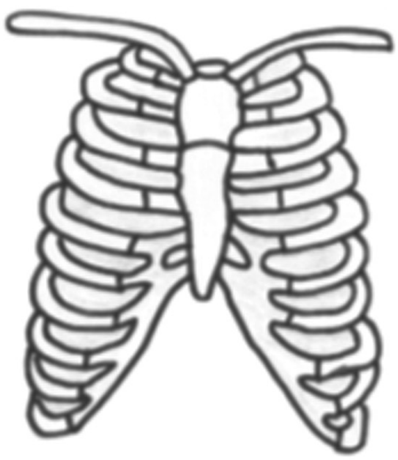
41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:31 Page 9

Skeleton Snap (1 of 2)

head / skull

leg

hand



ribs

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:31 Page 10

Skeleton Snap (2 of 2)

arm

foot

back / spine

hips

Pasta Skeleton Outline

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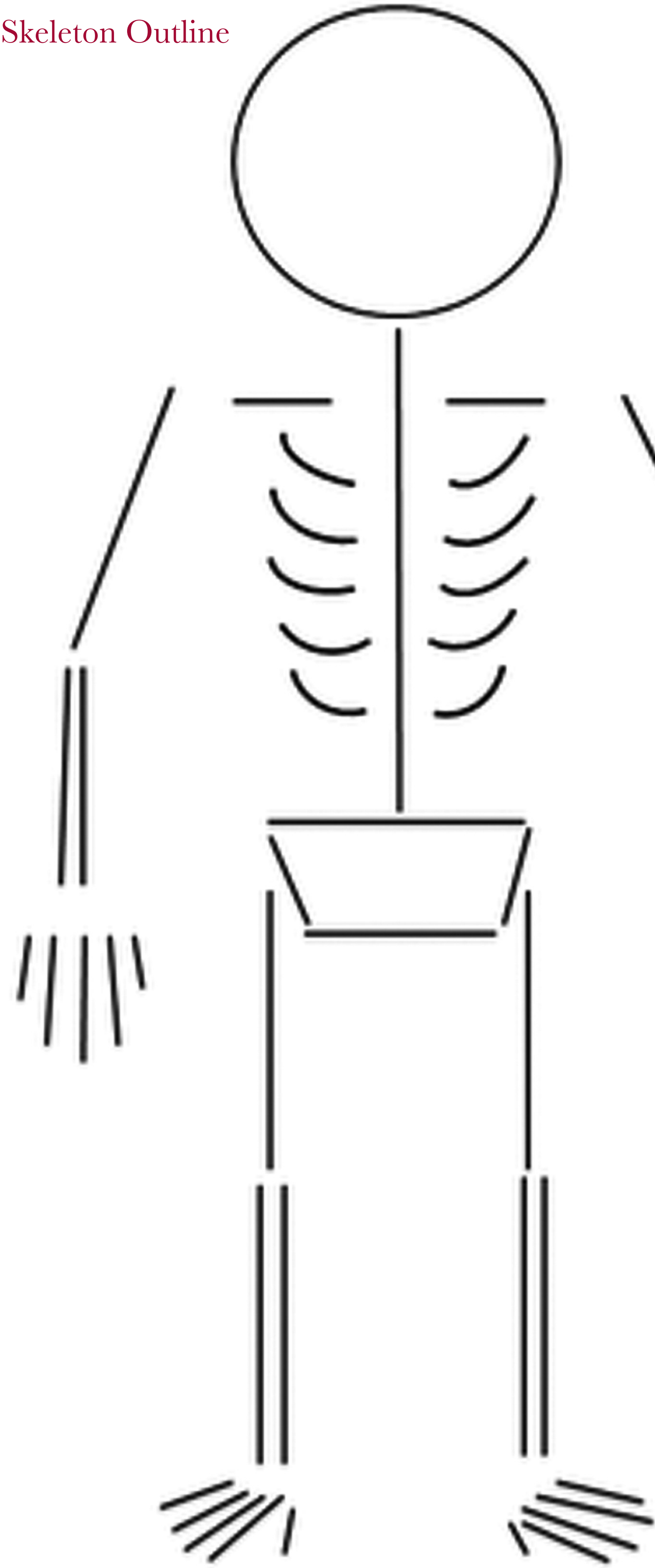

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:31 Page 12

Day of the Dead Mask

Skeleton Word Search - Can you find all the hidden words?

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W	M	H	S	P	L	B	X
S	K	E	L	E	T	O	N
B	W	A	R	M	S	N	M
A	H	A	N	D	L	E	G
C	H	E	S	T	W	V	P
K	I	Z	P	S	P	O	Z
O	P	B	S	K	U	L	L
W	S	F	O	O	T	H	C

LEG
ARMS
SKULL
CHEST
HAND
FOOT
BACK
HIPS
SKELETON
BONE

The Skeleton

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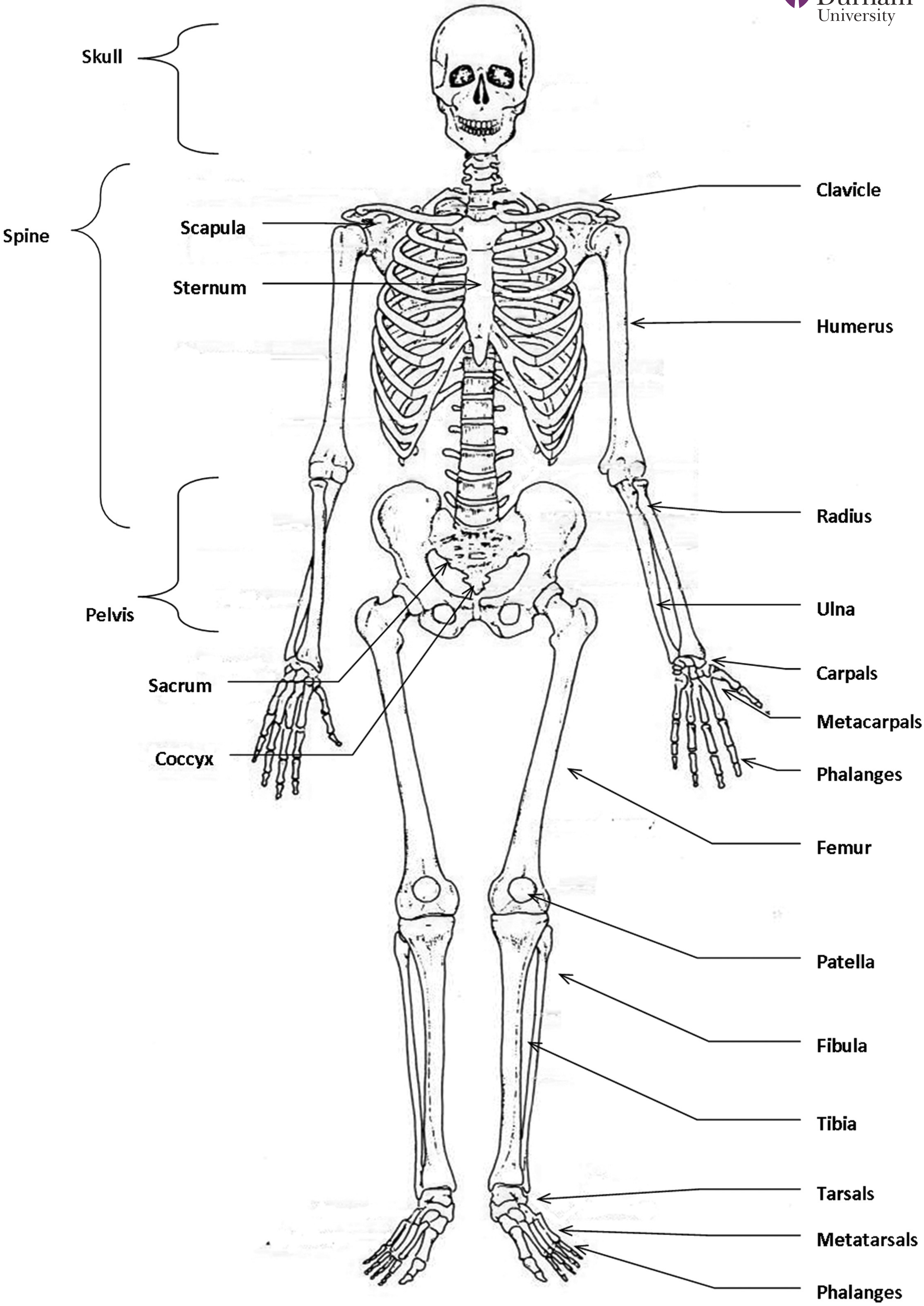


41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:31 Page 15

Spot the Skeleton

Match the name of the animal to its skeleton.

Cow

Fish

Frog

Squirrel

Dolphin

Gorilla

Bat

Lion

Human

Lizard

If I Didn't Have a Skeleton

Aim: To get students to think about why they have a skeleton and what functions it performs.

Pre-Knowledge Requirement: Students do not need to have any prior knowledge as this activity is designed to encourage them to discover the functions of their bones and skeletons. If they have a basic level of understanding already, this activity can be built upon and become a more complex English / Drama project.

Materials: Paper and pen or props if choosing to explore this as a drama activity.

Instructions: Ask the students to consider this sentence starter:

'If I didn't have a skeleton…'

If writing: Encourage the students to first think very simply about what would happen if this were true; ask them to complete the sentence.

If dramatising: Encourage the students to act out the end of the sentence. Most children will probably go floppy or fall to the floor – this is great as it means they already know one of the most important functions of the skeleton!

Ask them what they did or wrote and why, just to clarify their understanding.

Keep going with the activity, giving gentle clues if necessary, until the students have worked out these three functions:

SUPPORT

PROTECTION

MOVEMENT

You may also wish to explain to the students that bones are where your red blood cells are made, so there are lots of hidden uses for your bones too.

You could extend this activity into a creative writing session, making up poems, songs or stories with this, or a similar story starter. In drama, students could develop a short play about how important the skeleton is.

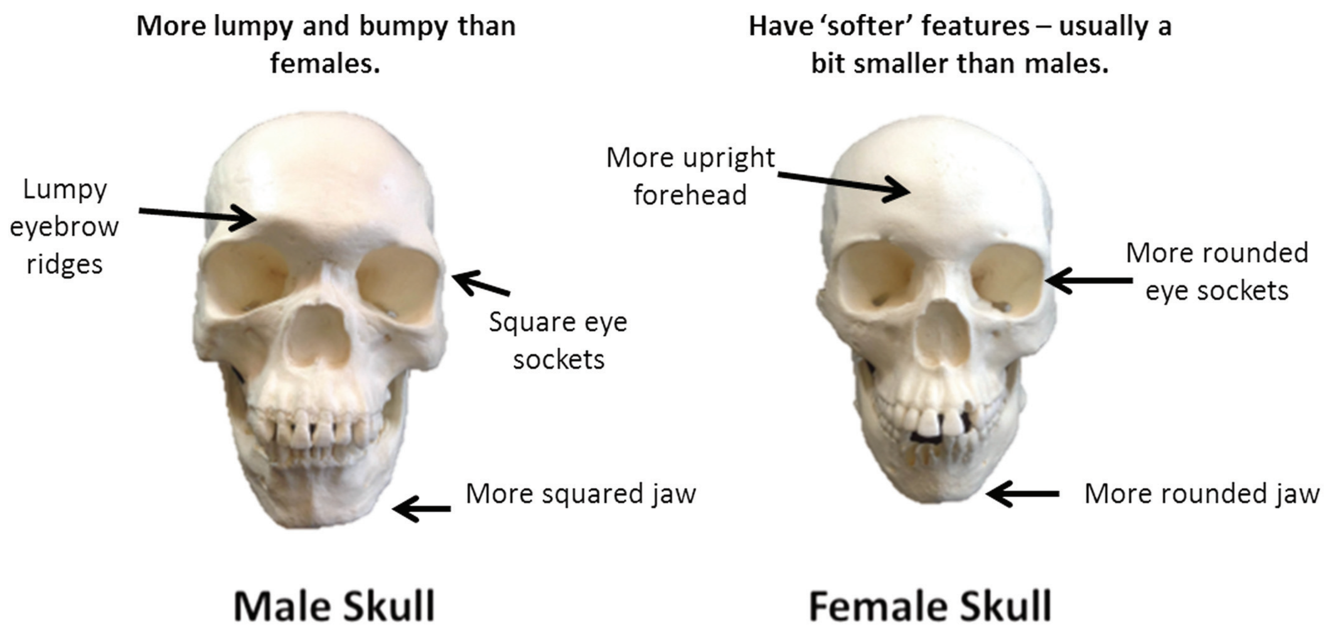
This is also a great starting point for comparing vertebrates and invertebrates.

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:31 Page 17

Male or Female?

As children grow up and start to go through puberty, there are some things that we can see happening; a boy's voice might start to get deeper or a girl might start wearing a bra as her body develops. There are lots of things happening inside our bodies that we don't necessarily see and that most people don't know about. For example, the shape of your bones start to change as you get older so men and women's bones are a slightly different shape; children's skeletons look the same whether they are a boy or a girl.

This is great for bioarchaeologists, who only see the skeleton of a person, because they can usually work out if the person was a man or a woman just by looking at the skull and the pelvis. Every individual is different though so it doesn't work all the time and sometimes it's very difficult, especially if the skeleton is not well preserved!



Different angles – the 'sub-pubic' angle is one example below. See how the female's is wider?

How Old?

As children grow, their bones develop too. Most people know that the average adult skeleton has about 206 bones but a child's skeleton has over 300!

Some of our bones fuse (join) together as we get older to make one big strong bone. Different bones in the body fuse at different ages which means that a bioarchaeologist can work out, quite accurately, how old a person was if they were a child or young adult (20-30 years) when they died.

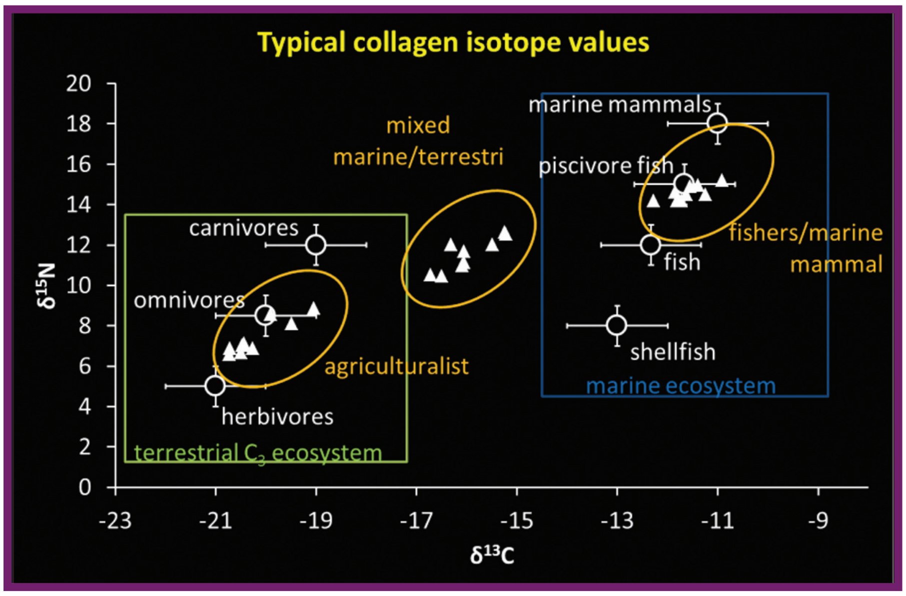
Once an adult is fully developed it becomes much harder to work out the age just from the skeleton as you have to start looking at the wear and tear on the body. For example, this might be how much the teeth or joints have worn down. Why do you think this would be difficult if you were looking at a skeleton from modern Britain?

The femur at different stages of development

Ancient Diet

Isotopes

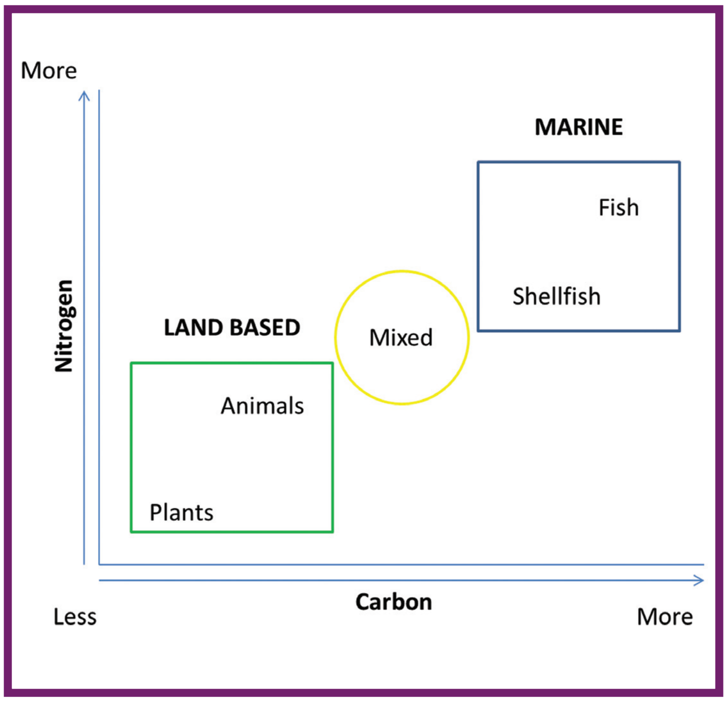
Isotopes are variants of a specific chemical element, like carbon. All isotopes of a particular element have the same number of protons but each has a different number of neutrons resulting in carbon-12 (^{12}C), carbon-13 (^{13}C) and so on.



Carbon and nitrogen isotopes found in the collagen of bones mainly enter the body from protein in the diet. The ratio of ^{13}C to ^{12}C can be measured to show the source of food being eaten, with marine foods (e.g. fish) having a higher ratio than land-based foods (e.g. beef from cattle). The ratio of nitrogen isotopes, ^{15}N to ^{14}N, can also be measured, with values being lower for plant foods (e.g. barley) than meat and milk, and marine foods being higher still. Measurements can therefore demonstrate whether or not a population was reliant mainly on food from animals eating off the land or marine ones. **You really are, in effect, what you eat!**

Activity:

Create a simple graph on the board like the one provided. Ask each student what kind of food they think a person would have been eating 2000 years ago. Answers should include basic, non-refined food items such as meat, fish, and plants (e.g. cereal crops like barley and wheat); these can be plotted on the graph and should give you a good distribution into the land-based, marine based or mixed sections. Ask the students to think about what this would tell you about different people – does it suggest that some groups lived near the sea or inland, were they farmers, or foragers?



Now plot another graph but this time, ask the students what their favourite foods are. You should end up with a graph that has marks all over it (once you break down foods into their constituent parts – e.g. a meat pizza or fish pie!). Ask the students why their graph does not look as simple as the 'old' graph. What has changed? This is a great activity to spark discussions about nutrition, changes in diet over time and where our food comes from.

For example, do they think people would have been healthier a few thousand years ago? (Yes they would – despite now having good healthcare services, lots of factors have led to humans actually becoming less healthy over time. This includes the development of processed foods, pollution in towns and cities and extensive travel, and increased population densities which can very quickly spread communicable diseases. We have evidence of this change in health over time from archaeological skeletons).

Otzi's mummified body in the position he was found

Ötzi's Last Meals

Ötzi was discovered in the Alps of Northern Italy in 1991. His body was frozen in the ice but the ice around him had begun to thaw and a walker noticed bits of him sticking out! Ötzi lived about 5000 years ago but it is not known entirely why he died alone in the Alps.

An arrowhead was discovered in his back which has led some people to believe that he may have been murdered by other hunters; some people even think he may have been sacrificed. At the moment we don't have any definite answers and we may never get any but, what we do know, is that Ötzi wasn't going hungry in the hours before his death.

In the early years of the 21st century, scientists looked at what was inside Ötzi's lower intestine. They discovered that he ate a meal which included grains and maybe even cooked red deer and goat meat. Scientists couldn't study the contents of Ötzi's stomach though because they couldn't find it!

A few years later, scientists were looking at some very detailed scans they had taken of Ötzi's body and realised that his stomach had shrunk after his death because of the natural mummification process and had moved all the way up to where the lower part of his lungs would normally be.

The scientists were able to sample what was in his stomach and found that it was a yellow/brown mushy mix which contained some bits of meat and wheat grains. This showed that the Iceman ate his meal less than two hours before his death.

DNA tests (which are done in a laboratory because DNA is too small to see with your eyes) showed that the meat came from an ibex which is a wild goat species. Ibex would have been a great source of meat for Ötzi and other hunters at that time.

We don't know if Ötzi cooked his meat before eating it but little pieces of ash were found inside Ötzi's lower intestine, possibly from cooking fires, but also bits of animal hair and flies were found - so he probably didn't clean his meat (or his hands) before eating!

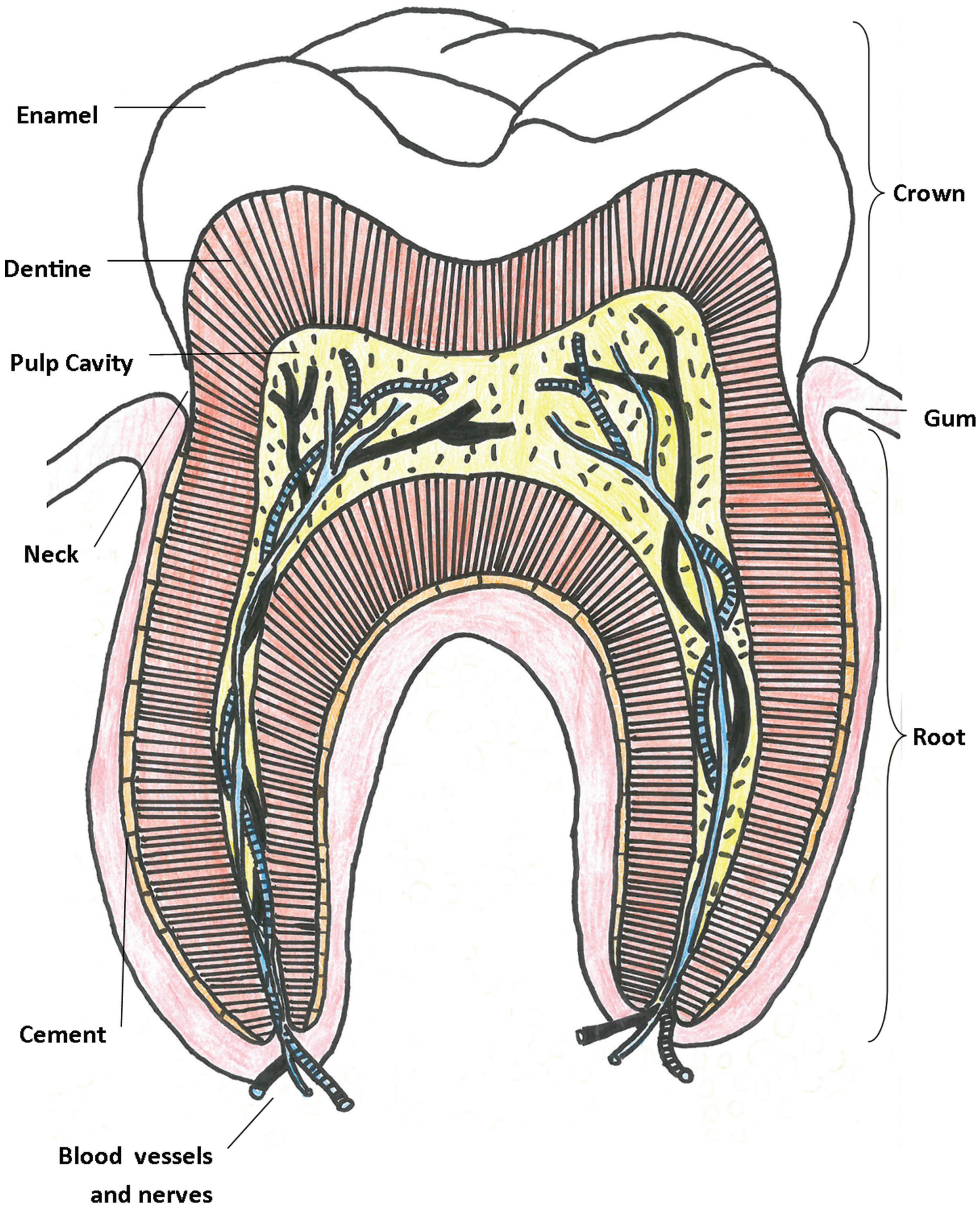
Activity 1:

Make a simple nutrition chart on the board and fill in what has and has not been found in Ötzi's stomach and intestines. What is missing? Does it seem like he had a healthy diet? What else would he need to stay healthy? Did he eat the '5 a day'?

Activity 2:

Try and recreate Ötzi's last meal – without the Ibex and deer! It is likely that he ate some kind of unleavened bread (this contains no yeast or other raising agent) made with einkorn, an ancient early wheat grain (available to buy today). The bread made was probably hard, somewhat like a cheese cracker. It's possible that he simply ground down the einkorn, mixed it with some water and cooked it on a stone near to a fire (which may account for the bits of ash found in his digestive system).

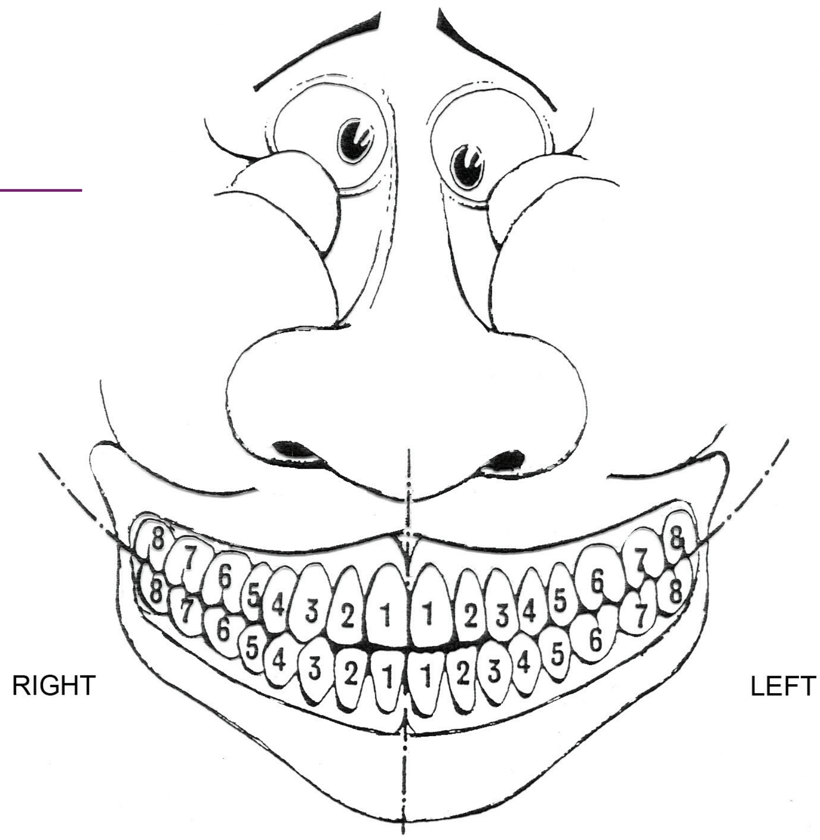
The Tooth

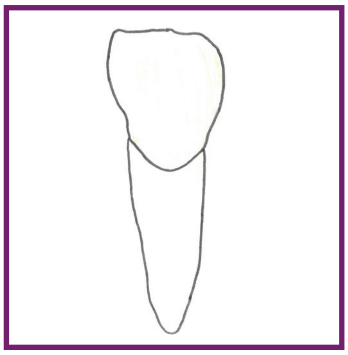

Enamel
Dentine
Pulp Cavity
Neck
Cement
Blood vessels
and nerves
Crown
Gum
Root

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:32 Page 22

The Teeth

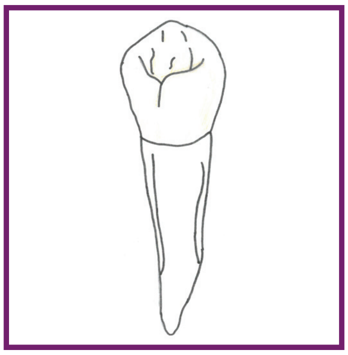
A normal adult mouth contains 32 teeth; 16 in the top and 16 in the bottom. The different types of teeth look different from one another because they are designed to do different jobs.





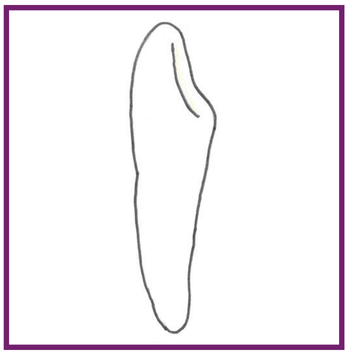
Incisors

There are 8 of these at the very front of the mouth. They are very sharp and designed to cut food whilst pushing it into the mouth.



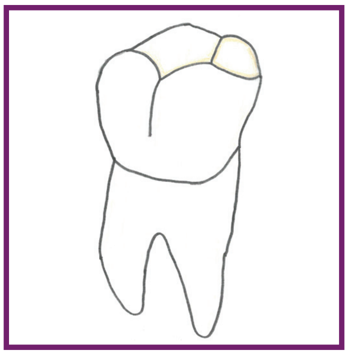
Premolars

These are the teeth between the canines and molars and are meant for crushing food; there are 8 of them.



Canines

There are 4 of these that sit just next to the incisors. They are built for grasping at and tearing food.



Molars

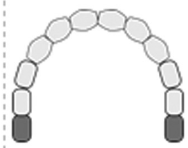
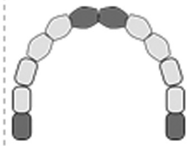
Eight flat teeth at the back of the mouth which are bigger and flatter than all the other teeth because they are designed to chew and grind food into smaller pieces.

Wisdom teeth (a third molar)

These teeth erupt at around age 18, but are sometimes taken out because they can push other teeth out of the way. This is because over time, through the process of evolution, people jaws have become smaller meaning there's not as much room for our teeth as there used to be. This is why lots of people have braces now, because teeth are often fighting for a place in our mouth and can become wonky! There is one in each corner of the mouth although sometimes they never come through at all because there's no room.

Dental Development

Babies' teeth begin to develop before they are born, but usually come through the gums between the ages of 6 and 12 months. Most children have 20 milk or baby teeth and these are fully developed by about the age of three years; they start to fall out from around five years old.

	How Many Teeth?			
Age	Adult	Baby	Upper	Lower
6 - 7 Years	4	20		
6 - 8 Years	8	16		
7 - 9 Years	12	12		
9 - 11 Years	16	8		
10 - 11Years	20	4		
Key: Adult Teeth		Baby Teeth		

Class Activity:

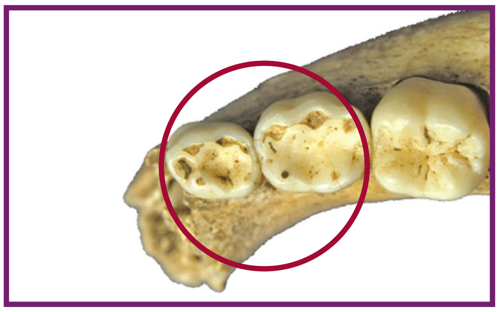
1. **Take a survey of the class – is everybody at the same stage of development?** Ask them to count their own, or each other's teeth. It doesn't matter if they are not because this only acts as a guide, some people's teeth will develop a little slower and some a little faster, depending on lots of things such as the diet they eat, and girls' teeth develop a little earlier than boys' teeth.

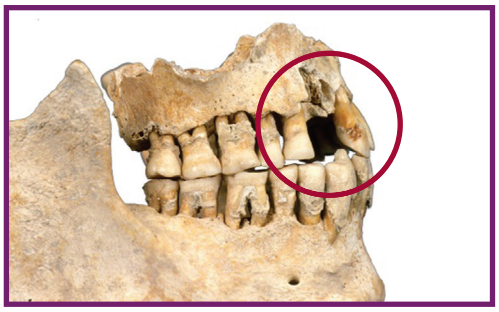
2. **Why not turn this into a school activity?** Ask the students to take a survey of people's teeth in break times to see how much people's dental development varies even when they are at the same ages. The children could analyse their answers as part of a maths or biology lesson.

When Teeth go Bad

Problems with the teeth are some of the most common health issues a person can experience. This is partly because everything we eat goes into our mouths and come into contact with the teeth. People today are very lucky because they have dentists to check their teeth and give treatment, where necessary, good toothbrushes and tooth paste, and lots of education to encourage us to eat healthily. People in the past were not so lucky but if you don't look after your teeth, you can still experience some of the same problems that have been seen for thousands of years. In fact, people's health in general has actually become worse as time has gone on! Here are some examples of tooth problems that are often found in archaeological skeletons.

Activity: See if you can match up the description of the problem with the right teeth.





Plaque and calculus

Calculus starts as plaque, and is a result of a build-up of bacteria in our mouths and on our teeth. The bacteria particularly like foods that contain sugars (milk, soft drinks, cakes and sweets). Plaque is easily removed by brushing the teeth, but otherwise it gradually builds up and forms a hard layer (calculus) which can't be brushed off. Plaque can cause red gums if not removed from the teeth. Ancient teeth throughout time often have calculus on them.

Tooth Wear

This is where the enamel on the surface of the tooth gradually wears away. The amount of tooth wear increases with age and is worse if you have a very gritty diet like the ancient Egyptians did. Today the foods we eat are much softer and therefore our teeth do not wear down like they did in the past.

Abscess

An abscess is caused by an infection in the tooth because of bad bacteria; it is often very painful. The abscess is made up of lots of pus which can spread to the gum and bones around it. Dentists today can treat abscesses well but in the past people would have suffered.

Caries

If plaque is not brushed away the bacteria react with the sugars and a cavity or tooth decay occurs. A hole forms in the tooth because of infection and if it's not treated straight away it can become very deep and very painful. This is the most common problem dentists see and it usually results in having a filling to stop the tooth getting any worse. Skeletons in the past show that caries was a problem for people when they started to eat more sugary foods. The Romans particularly ate figs, dates and honey that all contain lots of sugar.

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:32 Page 25

Egyptian Mummification

The Mummification Process

1. The body was washed in water from the Nile to clean it. The water was mixed with natron to make it salty, which would have helped to preserve the body and act as antiseptic to clean it.
2. The brain was removed through the nose!
3. A cut was made on the left side of the body, and the stomach and intestines removed. Next the lungs and liver were taken out and all the organs were dried and each put in special canopic jar.
4. The body was packed with stuffing and covered with natron for 40 days. The body would turn a darker colour and become lighter in weight as it dried out.
5. The stuffing was taken out, the body was rinsed, dried and then stuffed with linen. The slit was stitched up and the body 'anointed' with oils, spices, beeswax and other nice smelling things.
6. The body was bandaged up (this took 15 days) and magical spells were spoken over the body.
7. A mummy mask was fitted over the head and shoulders of the mummy.

Set of four canopic jars

The Science of Salt:

Natron is a salt (a natural mix of sodium carbonate and bicarbonate) that could be found as crystals along the edges of salt lakes in ancient Egypt.

Salt absorbs water, via osmosis. In mummification, it removes moisture from the body, causing the tissues (the skin, muscles etc.) of the body to dehydrate, but stay flexible.

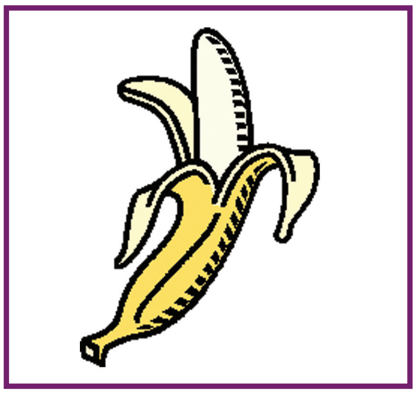
This means that the body will be preserved. If a body is not mummified then bacteria in and on the body will start to cause the body to decay. However, bacteria cannot live in very dry conditions.

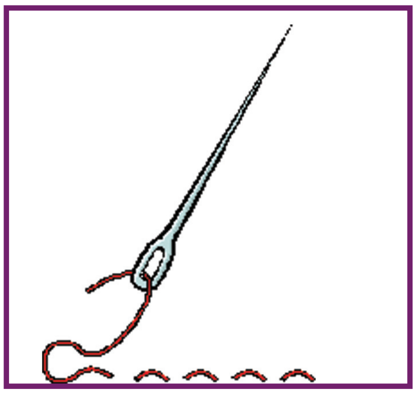
Nowadays, we would use a freezer to preserve a body, as very cold temperatures also have the same effect.

Can you find anything in your house that has been dried to help preserve it?

Anubis was the Egyptian God of Mummification

How to Mummify a Banana



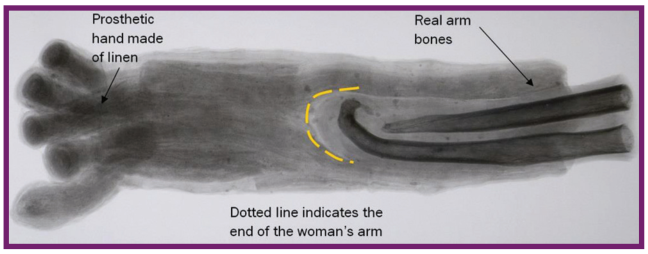


1. Find a banana.
2. Peel open the banana – eat the inside if you like (they are very good for you!) – and keep hold of the skin.
3. Put the open banana skin in table salt. Make sure all the skin is covered.
4. Leave the banana in the salt for at least a week – 2 weeks would be best. Be patient!
5. When the banana is dry, try to brush off the salt. Now you need to sew up the banana skin! Start from the bottom and leave a gap at the top.
6. Stuff the skin with sawdust and nice smelling herbs and spices. Now finish sewing up the skin so that the filling doesn't fall out.
7. Wrap the stuffed banana skin in strips of cloth – maybe use an old t-shirt if you don't have any plain cloth – now it really looks like a mummy!
8. Wait a few weeks and you will have a dry, lovely smelling, mummified banana that won't go rotten! (Unless you get it wet!).

Example of a banana mummy

Seeing inside a mummy

By looking inside the wrappings of a mummy we can detect all sorts of things, such as whether a person was a man or a woman and if they had any diseases or injuries during life that left marks on their bones.



Radiograph of the mummy's arm at the Oriental Museum

We would never unwrap a mummy because it would cause a lot of damage - so we take pictures of the inside using x-rays. (If you've ever broken a bone, you've probably had an x-ray taken in the hospital.) Sometimes archaeologists take a mummy to the hospital at night time (when it's very quiet and not busy with real patients), so that they can use the big x-ray machines!

This mummy is over 2000 years old and now lives in the Oriental Museum in Durham. For many years the mummy was thought to be a man but x-rays suggest she is probably a woman. X-rays also show that during her life she suffered from a poor diet in childhood, a slipped disc in her back, a kidney stone, dental abscesses and a broken toe.


The mummy at the Oriental Museum

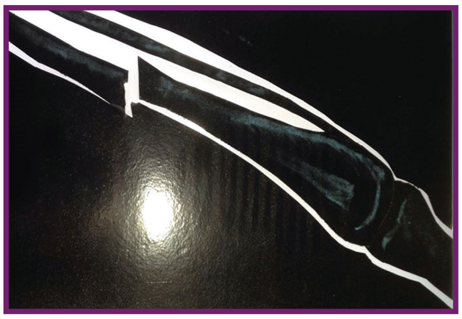
This mummy is one of the most important in the world because she was born without a fully formed left arm. A fake hand was added when the woman was mummified, so that she would have both hands in the Afterlife. The limb was made of linen cloth, carefully shaped to fit over the stump and even equipped with fingers and thumb!

Make a Radiograph:

Background:
We know that people broke bones in the past and that splints were used, just like today. We also know that some people had these breaks treated because we have examples of bones that have been 'put back' or 'straightened'. We have lots of evidence of treatment for broken bones from lots of historical periods, for example during the medieval period in York.

Materials:
Dark coloured card (black or blue preferable) / scissors / laminating pouches / laminator / chalk

Instructions:
Explain to the students that a radiograph is the picture we see, created by x-rays. Many people call this picture 'an x-ray' but that is not actually correct; it is a radiograph.Give each student a piece of coloured card and ask them to draw an outline of a bone, showing some form of break; try shading the bones with a bit of blue chalk. Cut out the drawn image and keep hold of the card it was cut from. Using this card, cut along the line created by the original cut by a few mm – just to make the gap between the 'bone' and the background wider when you put them back together. Fit the 'bone' shape back into the piece of card it was cut from and place both into a laminating pouch and laminate - be sure to keep hold of the pouch as it goes through the machine as the small pieces tend to jump about because of the static (it depends how bad your break was as to how many pieces you have!).



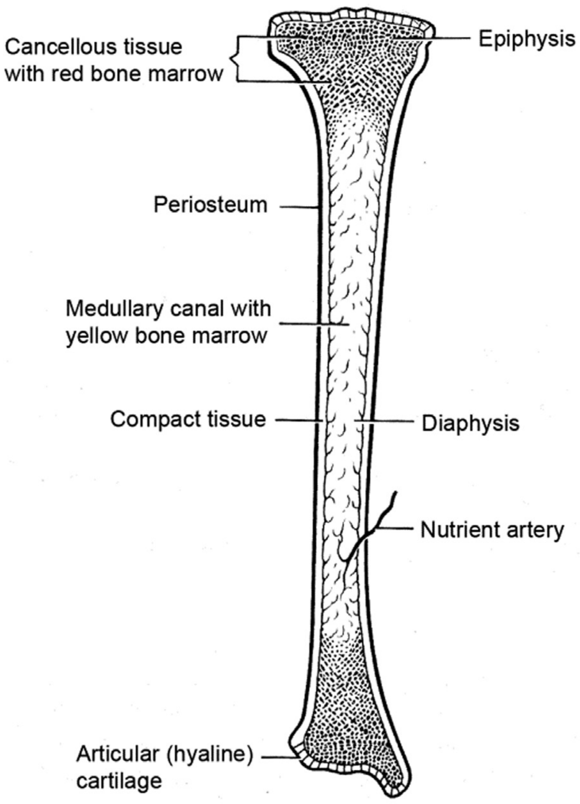
Place the x-ray on a light box or against a window to see it clearly.

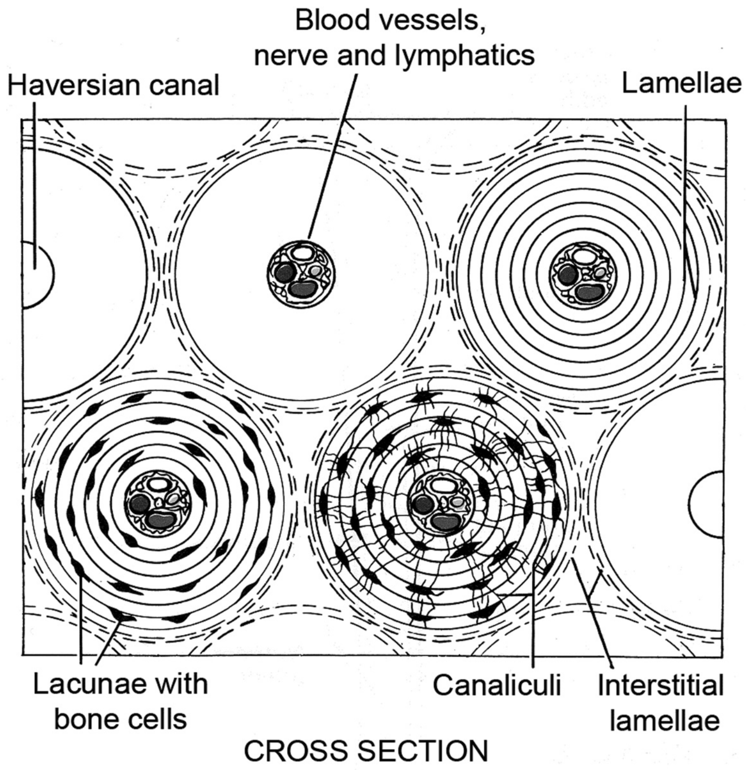
The Neolithic Revolution

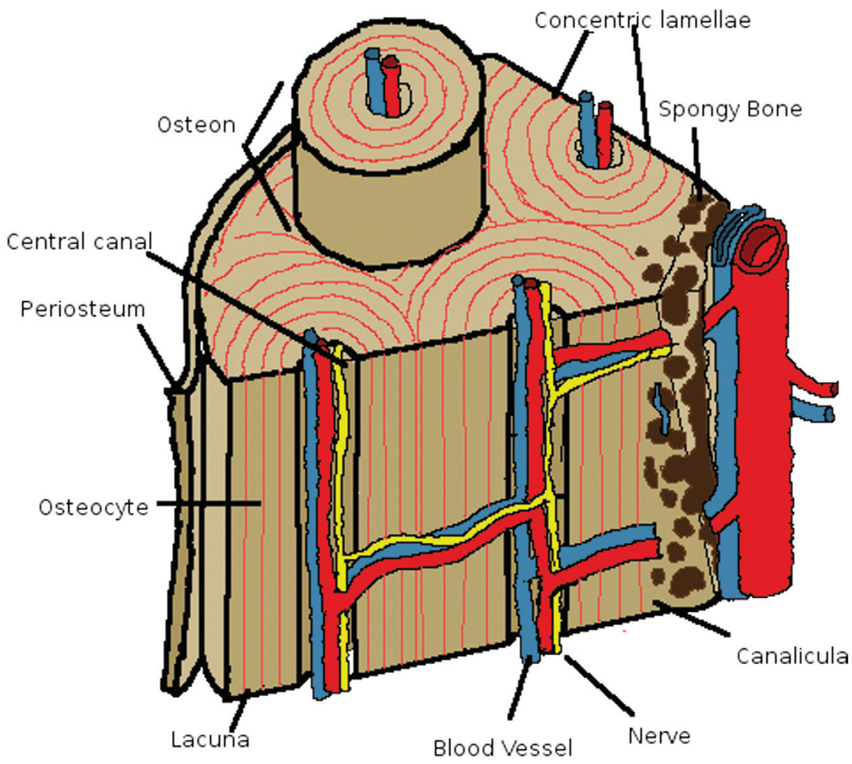
The 'Neolithic Revolution' describes the time when people in Britain started producing their food through farming crops and animals instead of hunting wild animals and gathering wild plants. Without a doubt, the 'Neolithic Revolution' was one of the most important turning points in human history. Have a look at what people were doing as hunter-gatherers and then as farmers. Which do you think was the healthiest way of living? Why?

	Hunter-Gatherer	Neolithic Farmer
What is the definition?	A society where most or all food comes from wild plants and animals.	A person who cultivates land or crops and/or raises animals.
Where did they live?	In various places, such as caves, throughout the year, depending on the season and the movement of animals.	4500BC - 2500BC, but farming has continued ever since.
What kind of house did they live in?	Temporary shelters which would be built and then abandoned, or caves. They may have been used again in following years.	Solid, permanent structures, and sometimes their animals lived in the same structures.
What kind of settlement did they live in?	Small family groups living in temporary shelters or caves. Low numbers of people.	Larger communities made up of lots of families. Lots of people.
Where did they get their food?	By hunting wild animals and gathering wild plants, nuts and fruits.	By growing crops such as wheat and raising domesticated animals such as sheep, goats and pigs. They may also have gathered some wild plants and fruits. Their food also needed more preparing (e.g. making wheat into flour into bread).
What tools did they use to get their food?	Stone tools (e.g. flint arrows).	Stone tools.
What kind of food and drink did they have?	Fresh wild meat that was not very fatty, and fish, nuts, berries and plants as they become available during the year, water from rivers or other natural places.	Wheat, barley, oats, fresh meat, dairy foods, cultivated fruit and vegetables, water from rivers or other natural places, beer, some wild nuts, plants and berries.
Why did they eat in this way?	Tradition. This was the way people had always obtained their food – by understanding the land, the seasons and wild animals and plants. Some people live this way today.	The idea developed all over the world. It was a way of controlling food production, meaning that lots more food could be produced.
When did they live?	Mainly before 4500BC but the transition to farming was gradual.	After 4500BC.
What factors affected the availability of their food?	The seasons, climate, and weather. The movement of animals. Ability to catch animals and collect plant foods. Natural disasters.	The seasons, climate, and weather. Availability of people to work. Spread of disease (human and animal). Pests. Soil quality. Water quality. Natural Disasters.

Structure of Bone





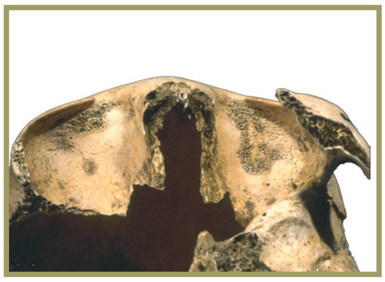


What Can Happen When You Don't Have a Healthy Diet?

Evidence of all these diseases can be found on the bones and/or teeth of archaeological skeletons, but people can still suffer from them today.

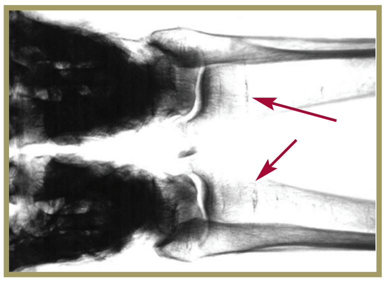
Enamel Hypoplasia was very common in the past and is described when there is not enough of the hard white protective material (enamel) which covers and protects the teeth. It can cause teeth to become weak and break and can be seen as lines, pits or grooves across the teeth. It can either be caused by a baby's teeth not developing properly, a child not getting a well-balanced diet, or it can happen after a child has been ill (for example with chicken pox or measles).

Rickets is a disease where the bones in a child's legs become soft and weak and bend outwards. It is caused by not getting enough vitamin D (our skin makes vitamin D when we spend time outside and some foods contain vitamin D, such as oily fish). If we don't make enough vitamin D we cannot absorb calcium and phosphorus that make our bones strong. Rickets was common in the past when people worked long hours in dark factories, but is becoming more common again today because of children staying indoors a lot on their computers or watching TV!



Scurvy is caused by a lack of vitamin C in the diet. It leads to muscle and joint pain, tiredness, red dots on the skin and bleeding and sore gums because the blood vessels are very fragile. If it is not treated, scurvy can become very serious. Although it used to be common in sailors who went on long journeys without fresh food, today it is very rare. Our bodies get vitamin C from many fruits and vegetables. In archaeological skeletons, the bleeding can cause extra bone to grow on the skeleton, especially in eye sockets.

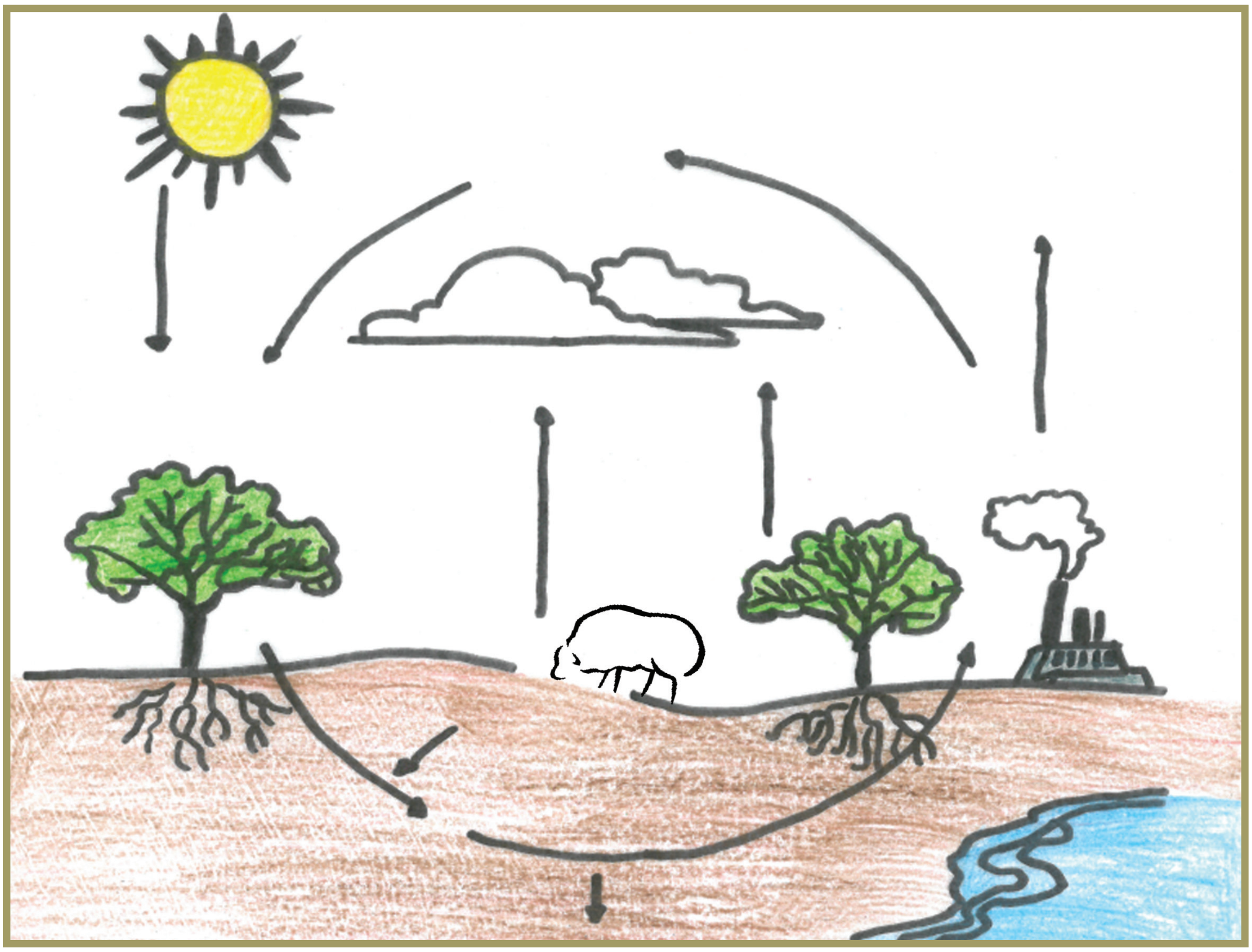
Osteoporosis is a condition that weakens bones, making them fragile and more likely to break, especially at the hip and wrist and in the spine. This is a very common problem in modern Britain and is related to people living longer. Eating a diet with lots of calcium and vitamin D in it and taking lots of exercise when you are young is important to prevent this happening when you are older.



Harris lines are lines which can be seen on some people's bones when they have an X-ray, especially on the leg bones. They show that the person (as a child) stopped growing for a period of time. This was either because they were very seriously ill or because they were malnourished. This means that they weren't getting a well-balanced diet to help their body to grow or that they were ill. Harris lines are seen in archaeological skeletons of all time periods.

The Carbon Cycle

Carbon is an element which is present in all living organisms and is essential for life on Earth. Most chemicals that make up living tissue contain **carbon** and when these organisms **die**, the carbon is **recycled**. The model that describes the processes involved is called the **carbon cycle.** Carbon enters the atmosphere as **carbon dioxide** from respiration and combustion. Carbon dioxide is absorbed by producers to make **carbohydrates** in photosynthesis. Animals feed on the plant passing the carbon compounds along the food chain. Most of the carbon they consume is exhaled as **carbon dioxide**, formed during respiration. The animals and plants eventually **die**. The dead organisms are eaten by **decomposers** and the carbon in their bodies is returned to the atmosphere as carbon dioxide. In some conditions decomposition is **blocked**. The plant and animal material may then be available as **fossil fuel** in the future for combustion.



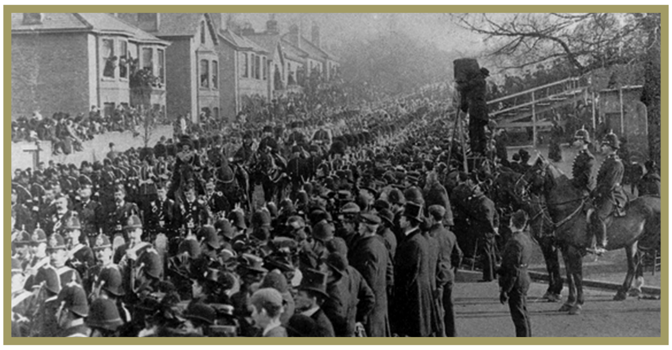
Radiocarbon dating (sometimes called carbon dating) is the most common and most well-known dating technique used by archaeologists. Being able to date a skeleton means that we can better understand the historical context in which a person lived, worked and died.

Radiocarbon dating is based on the decay of carbon (specifically the isotope carbon-14 or ^{14}C). The ratio of ^{14}C to 'normal' carbon (^{12}C) in the air and in all living things and at any given time stays pretty much the same. Once a living organism dies, the ^{14}C decays but is not replaced, whilst the level of ^{12}C in that organism remains constant. We know that the half-life of carbon-14 is around 5,700 years, which means 5,700 years after an organism has died, there will be half as much carbon-14 present as at the time of death. Comparing the ratio of ^{14}C to ^{12}C in an archaeological skeleton therefore means we can estimate a year of death, sometimes to within a few decades.

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:33 Page 32

Changing Burial Customs

African funeral procession



Queen Victoria's funeral

The way in which people bury their dead is diverse, depending on their religion, their customs and traditions and the place and time in which they live. Some funerals are very celebratory events with parties that can last for weeks whereas others are very solemn and quiet.

A traditional Christian funeral in the UK has not changed much since the Victorian period. Funeral processions are easy to spot; guests will mainly wear black out of respect for the dead person, a hearse will transport the coffin to the church or crematorium, and flowers and wreaths adorn the coffin. After a service to celebrate the life of the person, the body is either buried in a cemetery or cremated and their ashes scattered somewhere.

Although this might be what we see as traditionally 'British', funeral customs have been changing in this country for thousands of years; people are buried or cremated, depending on the fashion of the time. Burial customs can also change, or are influenced by people coming into Britain from other places, and this can certainly be seen in the archaeological record from as far back as the Bronze Age (from about 2500BC), if not earlier.

Sometimes however, people migrating to Britain have been found to integrate and use local customs, or at least be buried alongside local people so that we wouldn't know that they weren't locals. Luckily, by taking samples of their bones or teeth, we can work out (using chemical markers called isotopes) where they came from. One famous North-East example comes from Anglo-Saxon skeletons originating from Scandinavian countries, such as Norway, and further afield, being found buried in the Bowl Hole, Bamburgh Castle cemetery in the 7th-8th century AD, alongside locals and others from elsewhere in Britain.

The UK is now a very multicultural country and the variety of burial customs that be found within communities is diverse, particularly amongst different religious groups. Even the traditional 'British' burial customs are now changing. Most people used to be buried in graveyards but due to a lack of space (there are so many people in the world!), about 75% of people are now cremated. There has also been a move towards 'green burials' where people are buried in the ground (often in coffins made of cardboard), in dedicated woodland areas.

Activity:

Speak to people in your class and see if any of them are from communities that mourn death in different ways to what you are used to. Consider making a display to show the diversity of beliefs just in your class and investigate different burial customs from around the world.

Woodland burial site

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:33 Page 33

Extracting DNA from a Strawberry

Strawberries are a great fruit to use for this activity because they yield more DNA than any other fruit; they are octoploid, meaning that they have eight copies of each type of chromosome.

Learning Outcomes
Students will observe for themselves that DNA is in the food they eat and will also learn a simple method to extract this DNA.

You may choose to prepare the extraction buffer yourself and allow the students to use a pipette full for each of their individual experiments.

DNA Extraction Buffer:
- 900ml water
- 50ml dishwashing detergent
- 2 teaspoons salt
- Slowly invert the bottle to mix the extraction buffer.

If you would prefer the students to create their own extraction buffer, the following quantities will be enough for each individual: (roughly 100ml water, 1tsp detergent, 1 pinch of salt).

Materials and Equipment (per student)
- 1 strawberry
- Heavy duty zip close freezer bag
- Funnel
- Pipette or dropper
- 20 ml cold ethanol
- 10 ml DNA extraction buffer (soapy, salty water)
- Gauze, cheesecloth or coffee filter
- Beaker
- Test tube
- Glass rod or lollipop stick.

Procedure
1. Place a strawberry in a zip close freezer bag (remove most of the air before sealing).
2. Knead or mash the strawberry through the bag in your hand, but don't be too rough (do not hit the bag against the table). Do this for 2 minutes.
3. Carefully add 10ml of extraction buffer to the bag.
4. Continue mixing and mashing the bag in your hand for a further minute. Be careful not to break the bag!
5. Set up your filtration system by placing a piece of gauze, cheesecloth or a coffee filter sheet into a funnel, and place this into the opening of a beaker.
6. Carefully pour the strawberry mixture into the funnel making sure to catch all the solids so that only liquid drips into the beaker below.
7. Take a pipette or dropper full of the liquid in the beaker and place into a test tube (do this gently so as not to cause lots of bubbles).
8. Slowly add cold ethanol to the test tube. Do not tilt or tip the test tube; do not mix the two liquids.
9. Observe the line between the strawberry mixture and the alcohol. You will notice a white thread-like cloud appearing at this line. This is strawberry DNA. The DNA will clump together and float to the top of the alcohol layer.
10. Depending on the size of the test tube, you may be able to insert a small lollipop stick and twist the DNA around this to take a closer look.

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:33 Page 34

A Brief History of Anatomy

Human dissection was allowed in ancient times because philosophers like Aristotle (4th century BC) said that a person's soul left the body after death. However, it was not permitted for religious reasons in many parts of the Roman Empire.

This ban on dissection meant that anatomists such as Galen (a Greek doctor, surgeon and philosopher in the 2nd-3rd century AD Roman Empire) had to use animals such as apes, pigs and dogs instead. This inevitably led to some mistakes. While the basic bones are the same/similar, there are obvious differences between humans and other animals. However, Galen did work with Roman gladiators so gained some knowledge of human anatomy from studying them whilst treating their wounds. His work was so important that it became the basis of all doctors' training for 400 years.

The fall of the Roman Empire in the 4th century AD saw a rise in the belief of superstition and magic, and much of the knowledge of the ancient Greeks and Romans was lost. The knowledge that did survive was thanks to its translation and use in the Islamic world.

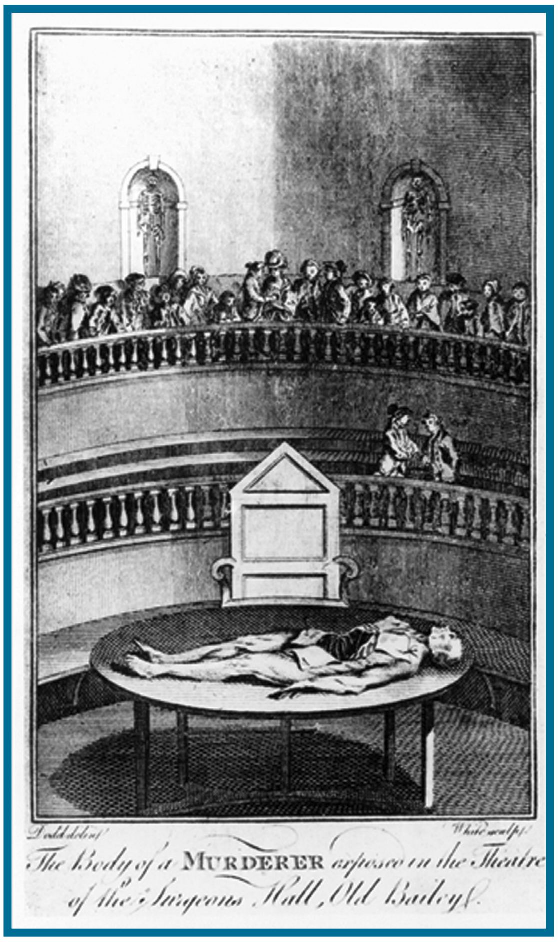
The Christian Church started to become important in Europe from the 11th century AD, and although it favoured belief in supernatural causes to disease (i.e. a punishment sent by God) it did also accept the work of Hippocrates (5th century BC Greek doctor) and Galen. There was also a widespread belief in astronomy and astrology and these were used in the practice of medicine.

As medicine started to become more professional from the end of the 11th century AD, medical schools started to be established, and by the 14th century AD Departments of Medicine had been set up at some of the universities across Europe.

Some European countries began legalising the dissection of executed criminals for educational purposes (and no doubt as an additional deterrent for would be criminals!) in the late 13th and early 14th centuries, with the first known public dissection taking place in approx. 1315 AD. The Murder Act of 1752 in England gave permission for this same fate for executed murderers, although human dissection had remained entirely prohibited in England until the 16th century and, even then, only a very few groups of doctors were permitted to carry out dissections. With access to a total of 10 cadavers each year between both the Royal College of Physicians and the Company of Barber-Surgeons in the mid-18th century, it was no wonder that body-snatching (dug up from cemeteries) became a frequent, though obviously illegal, trade. This situation ultimately led to the Anatomy Act in 1832 which allowed a much greater legal supply of cadavers for educational dissection. Today medical students dissect human bodies that have been donated before death by their owners. This is very important to enable future doctors to be able to understand their patients' illnesses better and to treat them effectively.

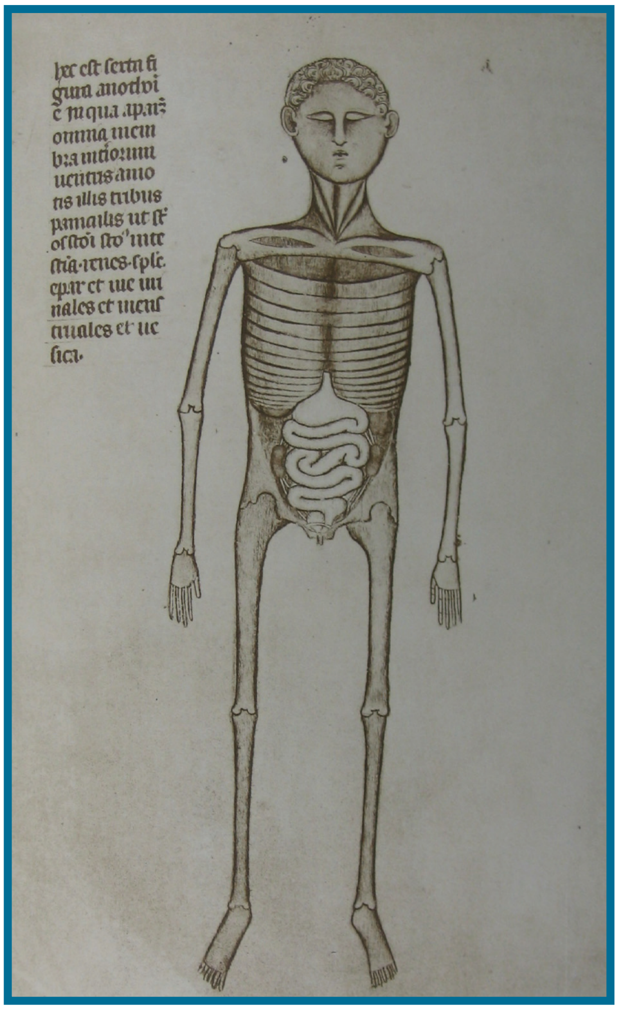
Look at the 4 anatomy images on the next page and consider these questions:

- What can we tell from the study of anatomy from these illustrations?
- Why are the images so different from each other?
- How are they posed?
- Why are they drawn like this?
- What does this tell us?

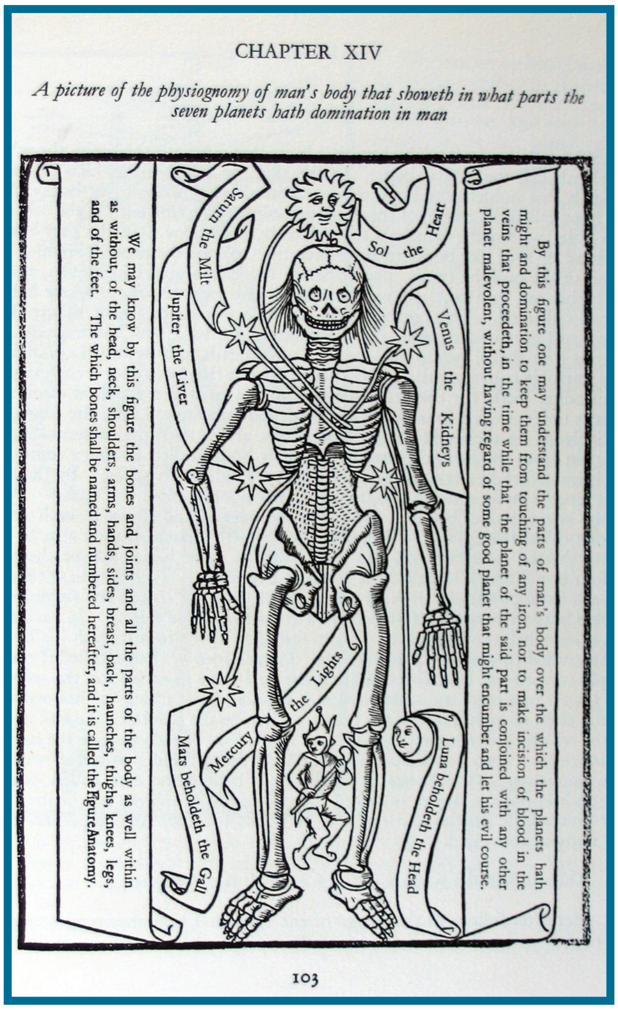


Dissection of a murderer – c18th

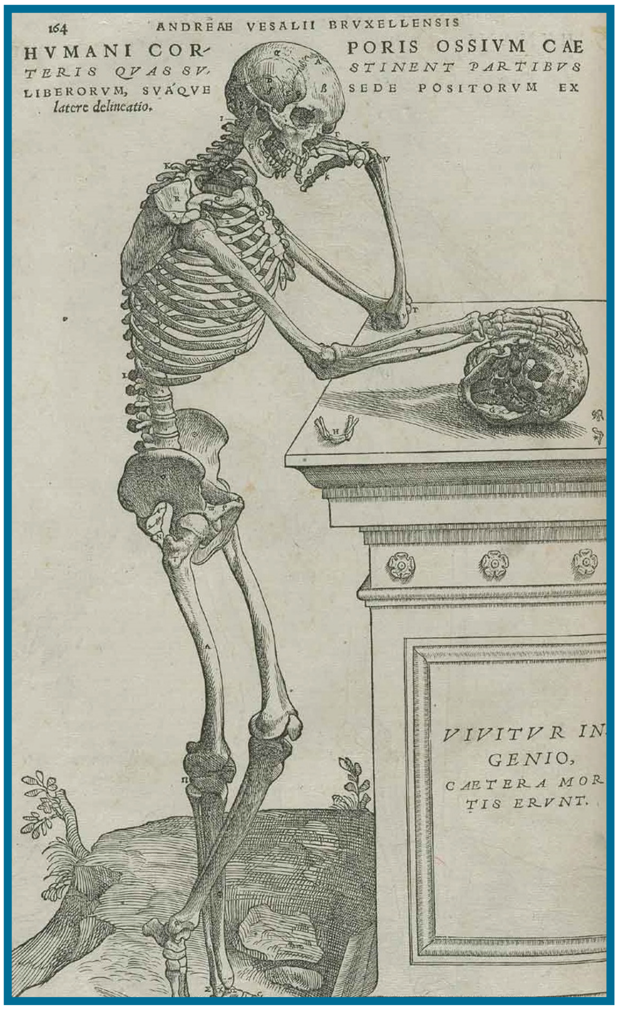
41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:39 Page 35



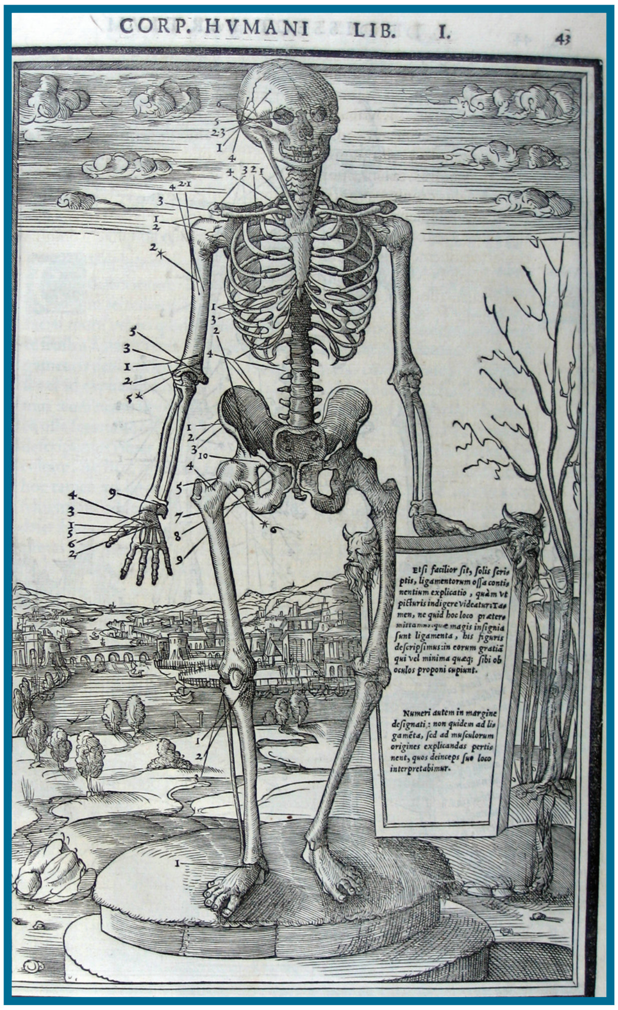
14th century - Guido da Vigevano



1493 - Marchant



1543 – Vesalius



1545 – Estienne

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:39 Page 36

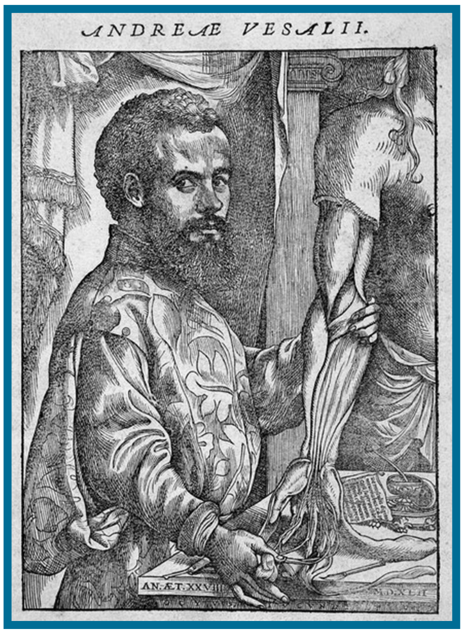
Vesalius

"Anatomists retard the inexperienced student if they do not first explain the bones…"

Vesalius' book *De humani corporis fabrica* is one of the landmarks of Renaissance Science. It placed the study of anatomy on a firm foundation of observation.

Vesalius was born in Belgium and studied at the Universities of Leuven and Paris before moving to Padua. He was offered the Chair (Professorship) of Surgery and Anatomy, which he accepted. Vesalius broke with tradition in many ways – by doing the dissections himself (previously the actual dissection had been done by assistants). He dissected the bodies of humans (normally criminals) rather than animals and, having viewed the anatomy of the bodies for himself, he criticised the findings of Galen.

Although remarkable in itself, Vesalius' work did not necessarily revolutionise the study of medicine although such detailed anatomical drawings had never been produced before. Pointing out the inaccuracies of Galen had been met with derision from the Church and many doctors refused to accept his work. Vesalius also didn't offer any theories on diseases or cures but his work did allow others to make progress.



Portrait of Vesalius

The Frontispiece of *De humani corporis fabrica*

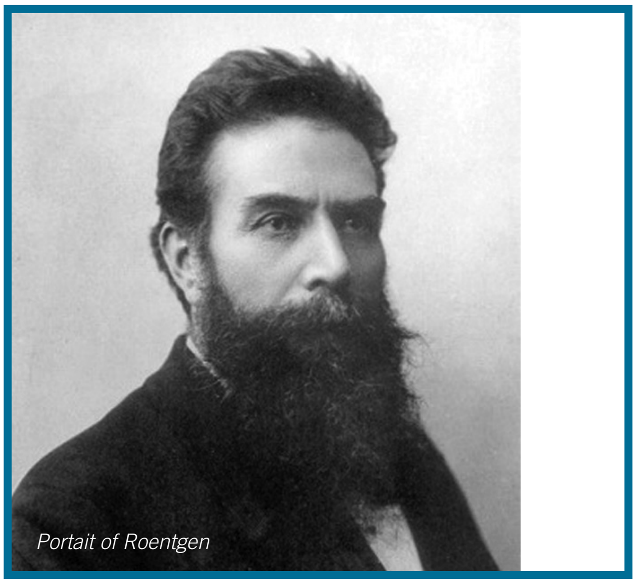
1. It has been argued that the image is a subtle criticism of Galen whereas others have suggested that Vesalius would have been respectful of earlier teaching and not intended it as such.
2. At the top of the image is Vesalius' family crest with the image of 3 weasels.
3. The naked man looking toward the dissection from the left of the image demonstrates lifelike musculature, perhaps making reference to surface anatomy. This figure contrasts directly with the female form being dissected on the table.
4. The presence of the monkey and dog refer to the importance of these types of animals in dissection. Depending on how you view the image as a whole, these may refer to Galen's use of them in his understanding of anatomy.
5. The barber-surgeons would previously have done the actual dissection but they have now been relegated to sharpening Vesalius' tools.
6. The figure being dissected is that of a woman. It has been suggested that this is the body of a woman who was scared of being hanged and, as such, declared herself pregnant. After examinations from midwives she was found to be lying and was thus sentenced to death and subsequent dissection. Other interpretations are that a female figure (the vast majority are male) is a novelty.
7. The skeleton in the centre of the image demonstrates the importance of osteology (the study of bones) in the study of anatomy. It is perhaps slightly larger than life to emphasise this point.
8. There are two figures amongst the crowd holding books. One is reading the book rather than watching the dissection, and the other holds a closed book and points towards the dissection. It could be argued that the former is engaged in the reading of earlier anatomy texts, such as Galen, and is unwilling to accept Vesalius' teaching, and the latter has closed the book on the old teaching and is learning from the new.
9. This picture is the first known illustration of an anatomical theatre – the background may have been copied from a woodcut of a normal theatre.
10. Vesalius himself is pictured in the centre of the image. The way he is stood and positioned here is very similar to that in his portrait.

What else do you notice in the image?

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:39 Page 37

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:39 Page 38

Discovery of X-Rays



Portait of Roentgen

In 1895, an amazing leap forward was taken for medicine; the discovery of the X-ray. With this discovery, medical professionals could look inside a human body without the need for surgery – bones were visible through a photographic image.

The person to discover this revolutionary technique was a Professor of Physics in Bavaria called Wilhelm Roentgen. He discovered the potential of electromagnetic radiation to create X-rays which in turn can create radiographs (what most people inaccurately refer to as ‘x-rays’).

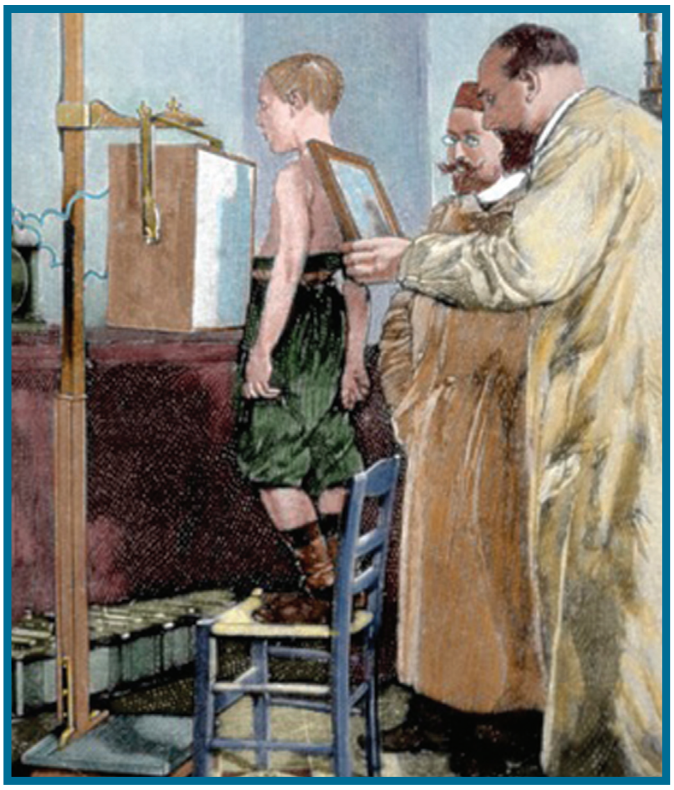
Roentgen realised that a number of objects could be penetrated by electrical rays. By using a photographic plate, Roentgen was able to capture an image of his own hand where there was a clear contrast between the opaque (“white”) bones and translucent (“black/grey”) flesh.

By the following year Glasgow Royal Infirmary had established an X-ray department where some incredible radiographs were produced, including that of a kidney stone and one showing a penny in the throat of a child. Additionally, in 1896, Dr Hall-Edwards discovered a needle embedded in a woman's hand, making him one of the first people to make a diagnosis on the basis of a radiograph.

Following Roentgen's discovery, radiographs were used to help treat soldiers fighting in the Boer War, and then the First World War, by locating bone fractures and embedded bullets. A rather more unique use of x-rays has also been to radiograph Egyptian mummies (but also skeletons). Using X-rays for this purpose means that huge amounts of information can be extracted without needing to unwrap and dissect a mummy, which is highly destructive and unethical (CT scanning is also now used to achieve high resolution “sliced” images). A person’s age, sex, and even disease and injury profile can be discovered by using radiographs.

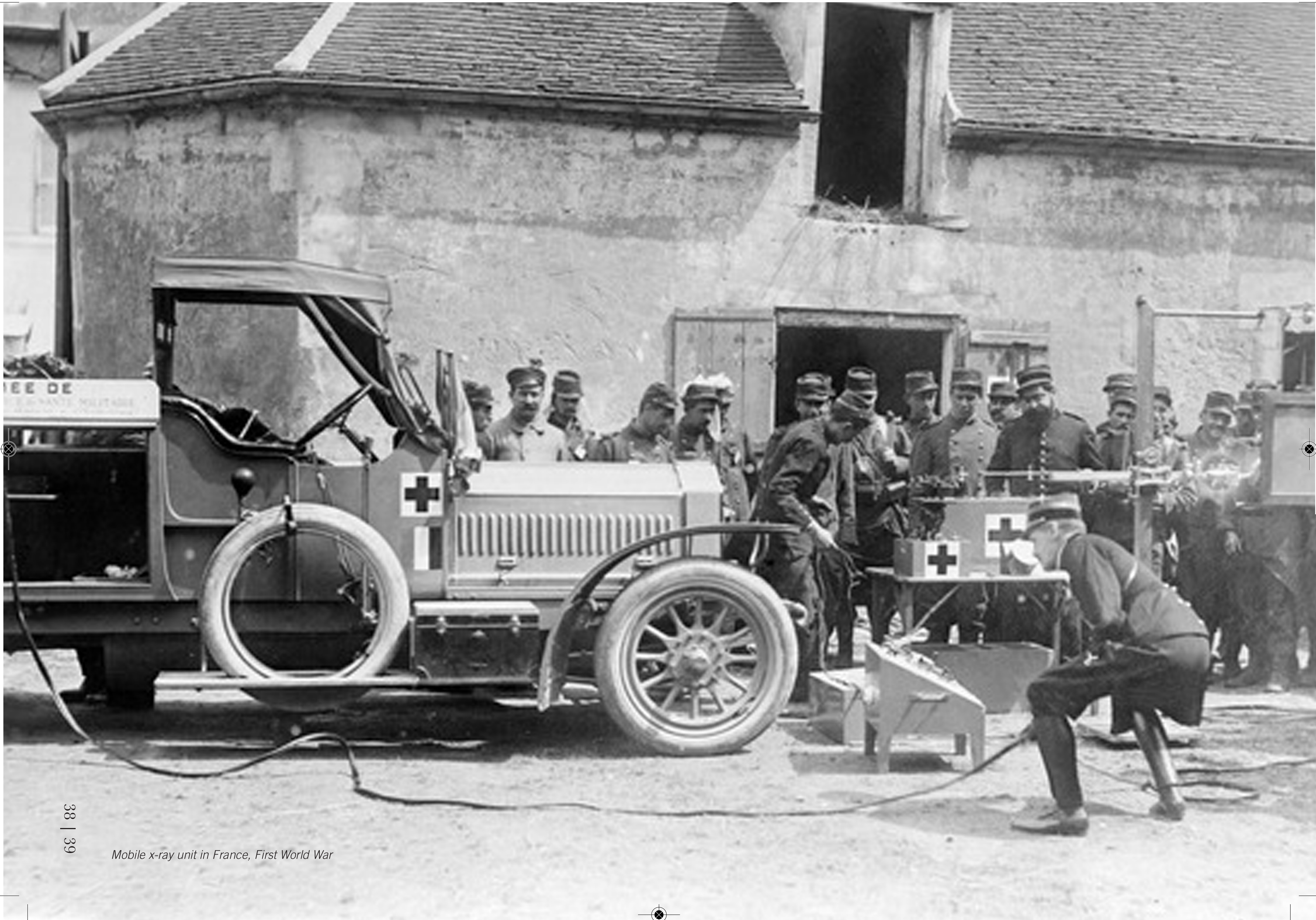
Hand of Anna Bertha Ludwig (Röntgen's wife).

Once it was recognised that frequent exposure to X-rays was harmful, safety measures were introduced, meaning that now patients and doctors are protected through the process. Another positive outcome of this technology was recognised by the early 1900s when the destructive qualities of x-rays were shown to be very powerful in fighting cancers and skin diseases.



Röntgen examining a child with an X-ray device

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:39 Page 39



Mobile x-ray unit in France, First World War

Disease Profile: Tuberculosis

Tuberculosis (TB) is an infectious disease caused by a bacterium. Two species of the bacteria, Mycobacterium tuberculosis (M.tb) and Mycobacterium bovis (M.bovis) are the main ones affecting humans. People inhale M. tb into the lungs and ingest M. bovis into the digestive tract (infected meat and milk from animals). TB affects the body in many ways. Depending on whether the TB affects the lungs or gut, people become weak, lose their appetites and weight, are pale, have difficulty in breathing, cough up blood and have chest pain, have diarrhoea and abdominal pain, and experience night sweats and a high temperature. There are many underlying risk factors for contracting TB, including poverty, a poor diet, living in crowded conditions, contact with infected animals through work, migration to new places, and having the viral infection HIV.


Sneezing sends out millions of droplets


Many people still live and work with their animals

Nearly two million people die from TB each year in the world, and about one third of the world's population is carrying the disease and/or is suffering from it. It is described as a "re-emerging infection", meaning that it was thought it had been conquered in the 20th century with vaccination, antibiotic treatment and improved living conditions and quality of food, along with TB testing of animals and pasteurization of milk. However, by the early 1990s TB started to rise again all over the world and people began to become resistant to the antibiotics used to treat TB. The World Health Organization declared a global emergency and, although TB frequency has declined since then, it still kills a lot of people every year.

KEY TB FACTS

- In 2012, 8.6 million people fell ill with TB and 1.3 million died from it, including 320 000 among people who were HIV-positive. In 2012, there were an estimated 450 000 new cases of multidrug-resistant TB.

ACHIEVEMENTS

22 million
lives saved and
56 million people cured
since 1995

45% decrease
in TB mortality rate
since 1990

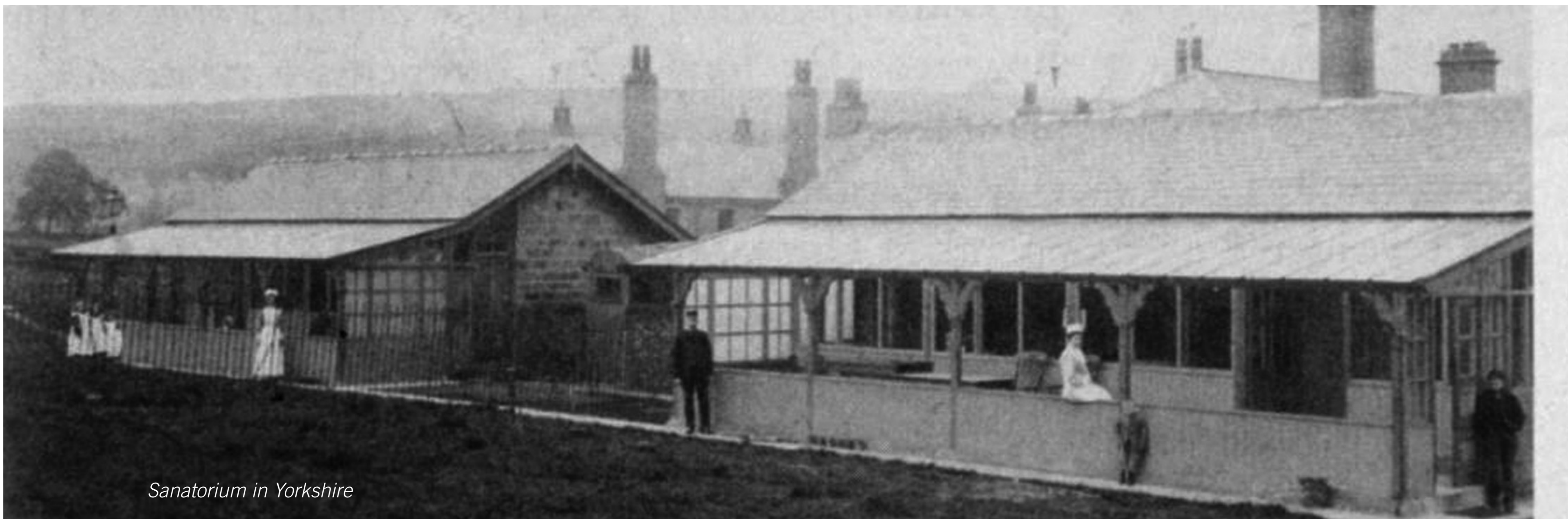
CHALLENGES

3 million people
who fall ill with TB still
unreached every year

MDR-TB crisis
detection, waiting lists
for treatment and
quality of care

WHO Global Tuberculosis Report 2013

Tuberculosis Continued



Sanatorium in Yorkshire

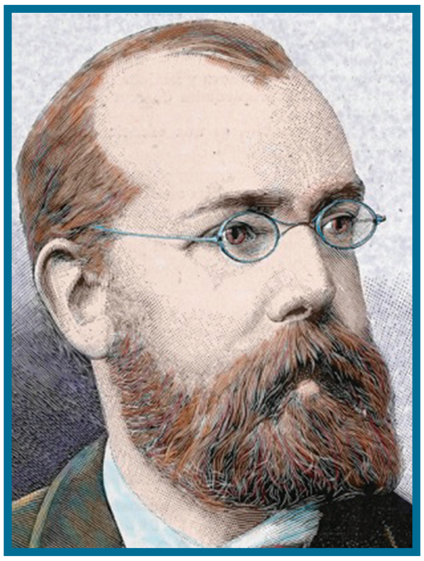
Spine showing evidence of TB

TB has had a long history stretching back several thousand years in the archaeological record, but it is likely that it emerged about 70,000 years ago, originating in Africa and spreading as people migrated. It is possible to detect TB in archaeological skeletons.

If, as was the case in the past, people did not get treated once the bacteria entered the lungs or the gut, the bacteria could spread to other parts of the body through the bloodstream. In the skeleton the bacteria likes to deposit themselves in the vertebrae that make up the spine. There, they destroy the bone of the body of the vertebra and eventually the spine collapses in the region affected. This can be recognized as TB related damage and this is how TB is diagnosed in skeletons. It is possible to also diagnose TB by finding and analysing DNA of the bacteria, which can be preserved in skeletons and mummies. In this way, not only can a diagnosis of TB be confirmed, but the actual species of TB (M. tb or M. bovis) can also be identified, along with different strains that appear to be related to different locations in the world, and even within countries. This type of work can tell us much more about how TB was being spread around the world in the past. It is also relevant to understanding the impact of rapid and frequent travel on TB transmission amongst people today.

The earliest evidence of TB is in skeletons excavated from cemeteries in Germany and Hungary, dating back c7000 years. Evidence from skeletons and mummies with TB from the Americas suggest a much more recent date (the oldest from Chile, about 1300 years old). Some old documents also record that TB affected people, for example in a Chinese text that is nearly 5000 years old. The frequency of TB increased with the Neolithic revolution when people started to practice agriculture, worked with domesticated animals that can contract TB, such as cattle, and lived in permanent houses and in more crowded conditions. When people started to live in towns and cities in Europe, especially from the 12th century AD onwards, TB increased in frequency until the early 20th century when living conditions got better and antibiotics were developed for treatment. Prior to antibiotics people had been treated with herbal remedies, and in the 1500s to 1700s AD in England and France people with TB were touched on the head by the king or queen and given a gold piece. This was meant to cure them of their TB. The bacterium that causes TB was identified in 1882 by Robert Koch, and further advances in medical treatment came after 1895 when X-rays were discovered. X-rays enabled people to be diagnosed more effectively and then cared for in sanatoria opened specially for sufferers ("TB hospitals"). During The First and Second World Wars, mass radiography ("X-ray") led to more people with TB being detected and treated. Today, governments around the world are very aware of the problem with TB that people face, and much work is being put into developing more effective treatments, reducing poverty and improving health education.

Koch's Contribution



Portrait of Robert Koch

"If the importance of a disease for mankind is measured by the number of fatalities it causes, then tuberculosis must be considered much more important than those most feared infectious diseases, plague, cholera and the like."

These words were spoken by Robert Koch, a German doctor and scientist, on March 24th, 1882. He was presenting his discovery of Mycobacterium tuberculosis, the bacterium that causes tuberculosis (TB), at what is now considered to be one of the most important lectures in medical history. Koch demonstrated a new staining method and asked his audience to check his work for themselves.

He brought with him tissue dissections from guinea pigs infected with TB introduced from the lungs of infected apes, from human brains and lungs infected with blood-borne TB, from tuberculous masses found in human lungs and in the infected abdominal cavities of cattle. The key finding was that the cultures of bacteria taken from the artificially infected guinea pigs were exactly the same, no matter where the bacterium was originally sourced.

It's reported that no applause was heard that evening – the audience was stunned into silence by the giant leap forward just taken in medicine and bacteriology.

Shortly afterwards, as news of the discovery spread, Robert Koch became known as "The Father of Bacteriology" and was eventually presented with the Nobel Prize in Physiology or Medicine in 1905 "for his investigations and discoveries in relation to tuberculosis."

Tuberculosis is still a global issue and the disease is responsible for the deaths of around 2 million people per year, but huge steps forward in its prevention and treatments have been taken since Koch's discovery. For many years, even after Koch presented his findings, treatment primarily consisted of rest, preferably in the sanatorium. Despite isolating the cause of the disease, it was to be some years before an effective treatment could be created.

"Streptomycin" was the first effective antibiotic cure, developed in 1943, but the disease started to become resistant until combined in later years with other antibiotics. The multi-drug approach to curing TB is still used and can be highly effective, but unfortunately we are now seeing the emergence of multi-drug resistant TB too.

The TB bacterium

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:40 Page 43

DNA

Inside a DNA laboratory

DNA (deoxyribonucleic acid) is something everybody has heard of it is the set of genetic instructions that control the development and functioning of all living things. The work of Francis Crick and James D Watson in 1953 (also see Maurice Wilkins and Rosalind Franklin) in unlocking the human genetic code was one of the most important scientific breakthroughs in the 20th century. DNA is specific to a person and is, therefore, used in modern forensic investigations to prove (or disprove) a persons involvement with a crime, but also to identify bodies. It can also be used to show the whether a body is male or female, or even to identify a person's lineage. Many people do not, however, realise, that under the right conditions, DNA can survive for thousands of years and can be just as helpful for answering archaeological questions; we call this long surviving DNA, ancient DNA (aDNA).

aDNA can be extracted and analysed from the bones and teeth to learn more about the following:

- Biological sex (male or female). This is particularly important if skeletons are not adults, or if they are poorly preserved.
- Family links between skeletons.
- Migration of people from one place where they were born, to another, where they died and were buried.
- The presence of disease.
- Patterns of human evolution.

Any surviving aDNA is released from a small piece of archaeological bone or tooth by a series of chemical and physical reactions. A method called PCR (polymerase chain reaction) is used to amplify – make millions of copies of – the DNA fragments which can then be 'read' and compared to known sequences.

Most aDNA work has so far concentrated on exploring infectious diseases, and so it is the aDNA of the actual pathogen (bacteria, virus, parasite) which is sought rather than human aDNA (which tells us about family relationships, for example). So far, attempts have been made to study a number of diseases in this way, including malaria and plague, that we cannot see in the bones, and some infections that do affect the bones: syphilis, leprosy (a disease much more common in the past than now) and tuberculosis, although not all successfully.

Identification of aDNA sequences based on known sizes (ladder on right)

The majority of successful work has been on tuberculosis aDNA which may survive better than others over time because of its structure. This type of analysis can, in some circumstances, even identify the particular strain of an infectious disease that affected a person. This might then also tell us about whether they moved around a region, country, or even across the world, taking their TB strain with them and infecting others.

There are problems associated with aDNA work, including poor survival of the aDNA and contamination of bone and tooth samples with modern DNA from both the burial environment and living people handling the bones or teeth (a major problem for modern DNA too). However, newer methods of analysis are attempting to overcome these problems, and appear to be doing so quite successfully. All aDNA work takes place in strictly controlled laboratory conditions, making bioarchaeologists look more like characters from CSI than the typical image of an archaeologist!

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:40 Page 44

Part of a letter from Francis Crick outlining the discovery of the structure and function of DNA

like this

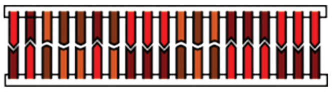
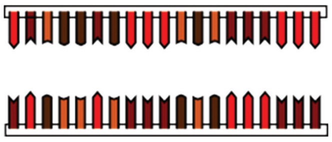
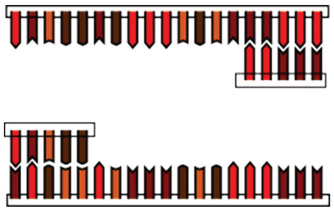
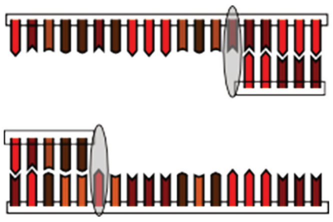
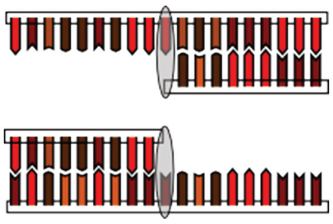
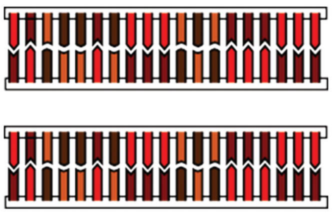
The model looks much nicer than this.

Now the exciting thing is that while there are 4 different bases, we find we can only put ~~them~~ certain pairs of them together. The bases have names. They are Adenine, Guanine, Thymine & Cytosine. I will call them A, G, T and C. Now we find that the pairs

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 45

PCR Activity

Cut out and mix up the following steps of PCR. Ask your students to put both the images and text in the correct order.

	The DNA is placed in a mixture of DNA primer and nucleotides
	The DNA is heated to ~95°C Causing it to become denatured
	The DNA is cooled to ~60°C . to allow the DNA primers to attach, known as Annealing
	The DNA is heated to 70°C this activates the DNA polymerase
	The DNA polymerase continues to add the complimentary bases to the strand, this is the Elongation step
	The DNA has been replicated - however this process will repeat many times to create millions of copies

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 46

Plague

Londoners fleeing to the country to avoid the Plague, 1630

Plague is an infectious disease caused by bacteria called Yersinia pestis that has been responsible for the deaths of many millions of people across the world. The most famous outbreaks of the plague in England are referred to as The Black Death (1348-50 AD) and The Great Plague of London (1665–66 AD), the last big recurrence of the disease in this country. Plague still affects people in some parts of the world, especially in tropical countries. The infection is spread from infected rats to humans by fleas that carry the bacteria; they then bite humans. There are three main types of plague: bubonic (affecting the lymphatic system), septicaemic (affecting the blood stream), and pneumonic (affecting the lungs).

Plague can spread and kill quickly. During The Black Death approximately 1.5 million people died out of an estimated population of 4 million in England and, in total, 30-60% of the entire population of Europe died. During The Great Plague of London approximately 15% of London's population died from pneumonic plague (spread amongst humans via the air).

For many years it has been believed that The Black Death was primarily caused by bubonic plague. Bubonic plague is well known because of the way in which it is thought to have been introduced by rats from Asia. Recent research has suggested that the speed at which plague spread during The Black Death could not purely have been the result of flea bites but, rather, must have been airborne and spread from person to person (pneumonic), but there is no conclusive answer to this question just yet and research is ongoing.

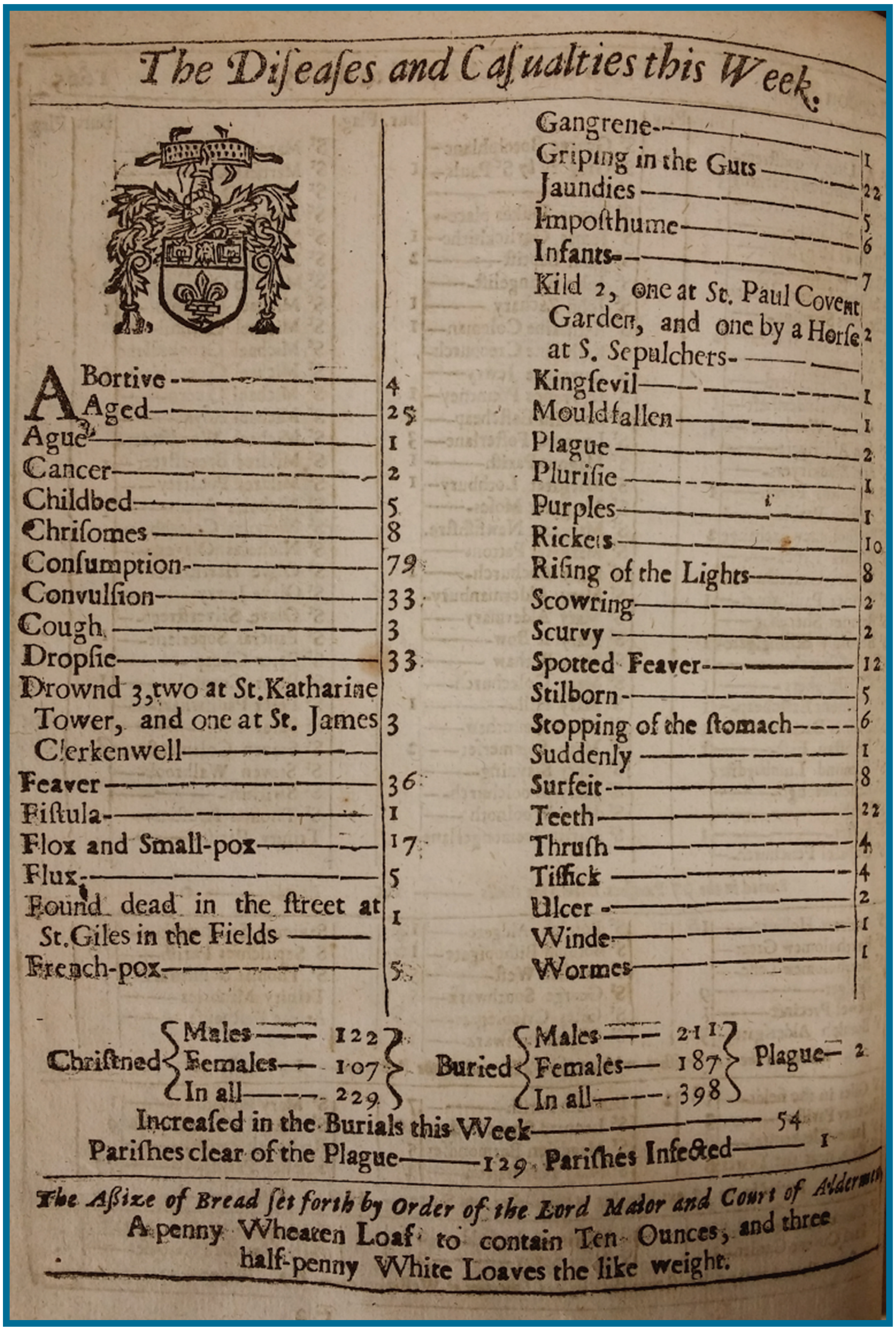
Plague does not affect the skeleton, but researchers have been able to extract the DNA of this bacterium from the bones and teeth of archaeological skeletons. The most recent research found that when compared to the DNA of bacteria causing modern plague, the DNA "codes" were an almost perfect match, meaning that the plague which caused The Black Death was no more virulent than that which we still see in the world today. Despite being able to now treat plague with antibiotics, it has not yet been eradicated.

- Why do you think the plague was able to spread so easily between the 14th and 17th centuries?
- Why do we not see plague death rates on the same scale today as during The Black Death or The Great Plague?
- Where might we be able to find more information about the death rates caused by plague in the past?
- Why do you think deaths from plague were higher during the summer months?

Group of plague artefacts

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 47

Bills of Mortality



The Diseases and Casualties this Week.

Abortive	4
Aged	25
Ague	1
Cancer	2
Childbed	5
Chrisomes	8
Consumption	79
Convulsion	33
Cough	3
Dropsie	33
Drownd 3, two at St. Katharine Tower, and one at St. James Clerkenwell	3
Feaver	36
Fistula	1
Flox and Small-pox	17
Flux	5
Found dead in the street at St. Giles in the Fields	1
French-pox	5
Gangrene	
Griping in the Guts	1
Jaundies	22
Impostume	5
Infants	6
Kild 2, one at St. Paul Covent Garden, and one by a Horse at S. Sepulchers	7
Kingsevil	2
Mouldfallen	1
Plague	1
Plurisie	2
Purples	1
Rickets	1
Rising of the Lights	10
Scowring	8
Scurvy	2
Spotted Feaver	2
Stilborn	12
Stopping of the stomach	5
Suddenly	6
Surfeit	1
Teeth	8
Thrush	22
Tissick	4
Ulcer	4
Winde	2
Wormes	1
	1

Christned	Males	122	Buried	Males	211	Plague — 2
	Females	107		Females	187	
	In all	229		In all	398	

Increased in the Burials this Week — 54

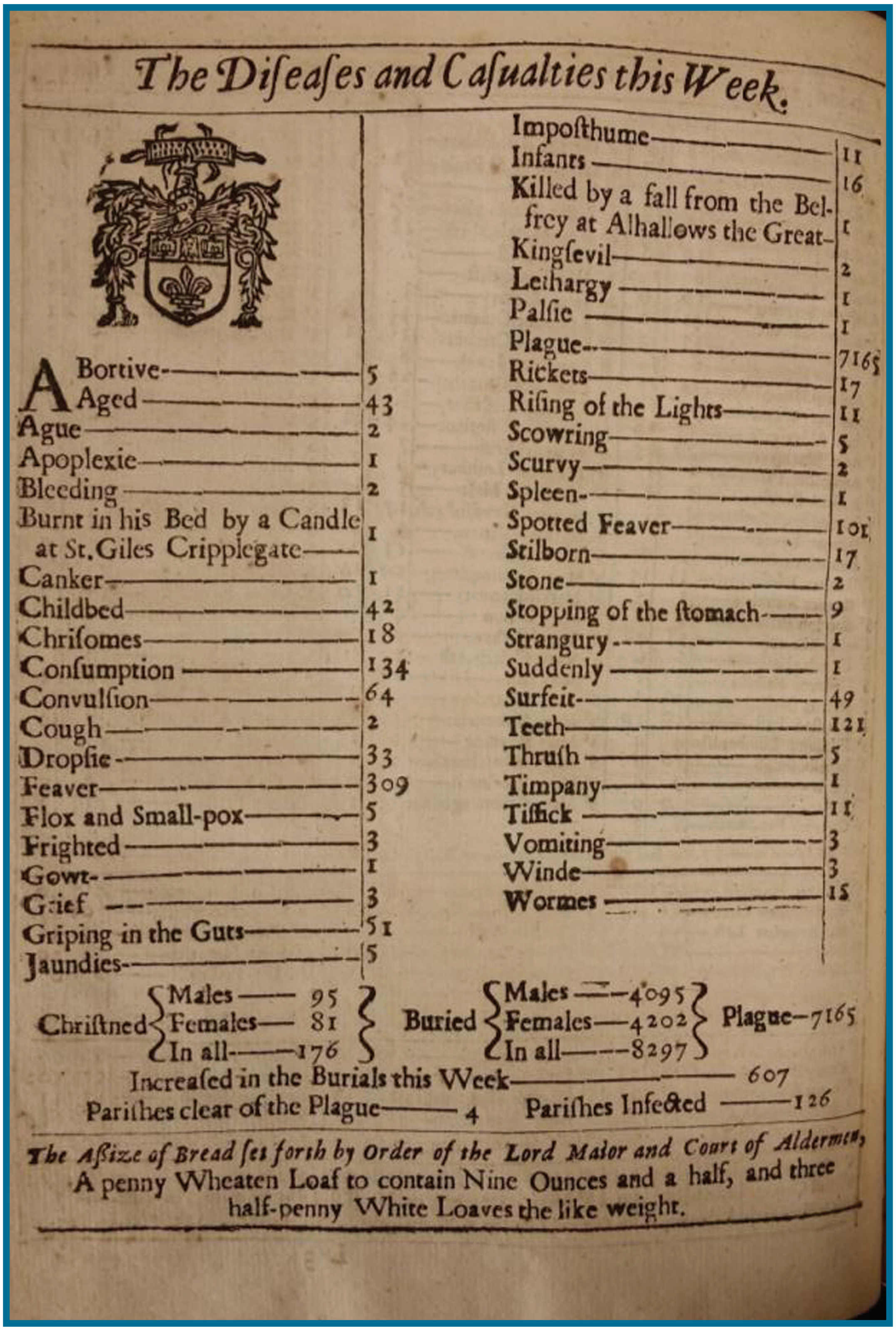
Parishes clear of the Plague — 129 Parishes Infected — 1

The Assize of Bread set forth by Order of the Lord Maior and Court of Aldermen, A penny Wheaten Loaf to contain Ten Ounces, and three half-penny White Loaves the like weight.

25th April – 2nd May 1665

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 48

Bills of Mortality



The Diseases and Casualties this Week.

Abortive	5	Imposthume	11
Aged	43	Infants	16
Ague	2	Killed by a fall from the Belfrey at Alhallows the Great	1
Apoplexie	1	Kingsevil	2
Bleeding	2	Lethargy	1
Burnt in his Bed by a Candle at St. Giles Cripplegate	1	Palsie	1
Canker	1	Plague	7165
Childbed	42	Rickets	17
Chrisomes	18	Rising of the Lights	11
Consumption	134	Scowring	5
Convulsion	64	Scurvy	2
Cough	2	Spleen	1
Dropsie	33	Spotted Feaver	101
Feaver	309	Stilborn	17
Flox and Small-pox	5	Stone	2
Frighted	3	Stopping of the stomach	9
Gowt	1	Strangury	1
Grief	3	Suddenly	1
Griping in the Guts	51	Surfeit	49
Jaundies	5	Teeth	121
		Thrush	5
		Timpany	1
		Tissick	11
		Vomiting	3
		Winde	3
		Wormes	15

Christned: Males 95, Females 81, In all 176
Buried: Males 4095, Females 4202, In all 8297 — Plague 7165

Increased in the Burials this Week — 607

Parishes clear of the Plague — 4 Parishes Infected — 126

The Assize of Bread set forth by Order of the Lord Maior and Court of Aldermen,
A penny Wheaten Loaf to contain Nine Ounces and a half, and three half-penny White Loaves the like weight.

19th – 26th September 1665

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 49

Treating the Plague

Treating the Plague

Primary resources can give us a glimpse into the ways in which 17th century people were advised to prevent and cure the plague.

Here are some suggestions:

- Specific plague doctors, apothecaries and surgeons were assigned to the city
- Neither 'men nor goods' were to be allowed to come from any infected places without a certificate of health
- Cats, dogs and tame pigeons were to be destroyed or 'kept sparingly'
- People were discouraged to flee to the countryside unless to an uninhabited house
- Bodies were to be buried at night with all relevant authorities informed
- No clothing or 'householdstuff' was to be removed or sold from an infected house
- Bonfires were to be lit in the street to clean the air
- Perfumes or pomanders were to be used.

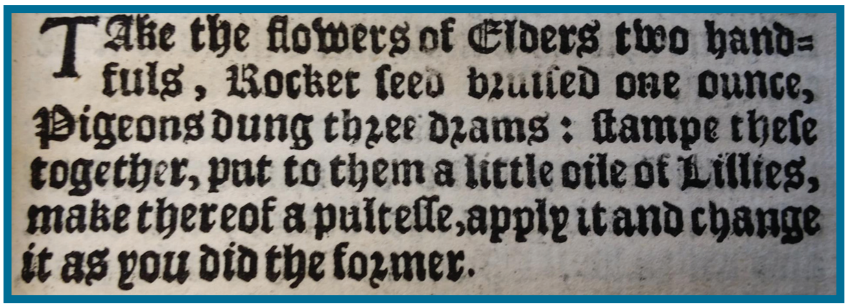
Some remedies included:

- Fig cordial
- Blood letting
- Inducing vomiting.

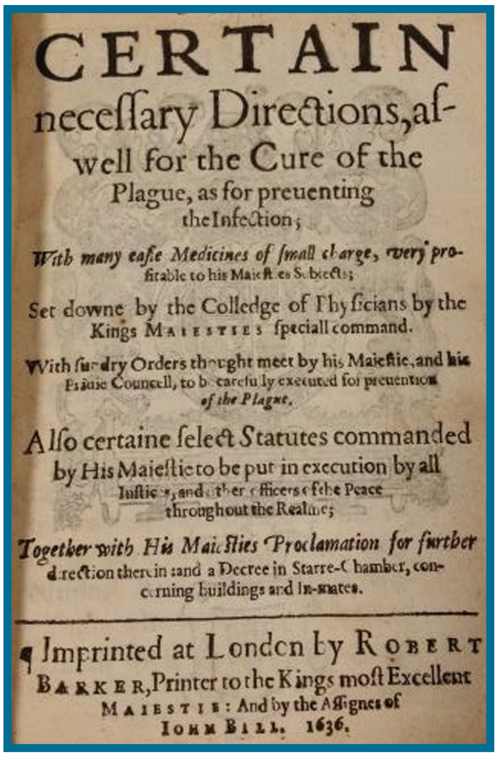
Venetian Plague Doctor

The following was also suggested as cure:

Take the flowers of elders two handfuls, rocket seed bruised one ounce, pigeon dung three drams: stamp these together, put to them a little oil of lillies, make thereof a pultesse, apply it and change it as you did the former.



Take the flowers of Elders two handfuls, Rocket ſeed bruiſed one ounce, Pigeons dung three drams: ſtampe theſe together, put to them a little oile of Lillies, make thereof a pulteſſe, apply it and change it as you did the former.



CERTAIN
neceſſary Directions, as-
well for the Cure of the
Plague, as for preuenting
the Infection;
With many eaſie Medicines of ſmall charge, very profitable to his Maieſties Subiects;
Set downe by the Colledge of Phyſicians by the Kings Maiesties ſpeciall command.
With ſundry Orders thought meet by his Maieſtie, and his Priuie Councell, to be carefully executed for preuention of the Plague.
Alſo certaine ſelect Statutes commanded by His Maieſtie to be put in execution by all Iuſtices, and other officers of the Peace throughout the Realme;
Together with His Maieſties Proclamation for further direction therein: and a Decree in Starre-Chamber, concerning buildings and In-mates.
Imprinted at London by Robert Barker, Printer to the Kings moſt Excellent Maiestie: And by the Aſſignes of Iohn Bill. 1636.

Quote taken from this book

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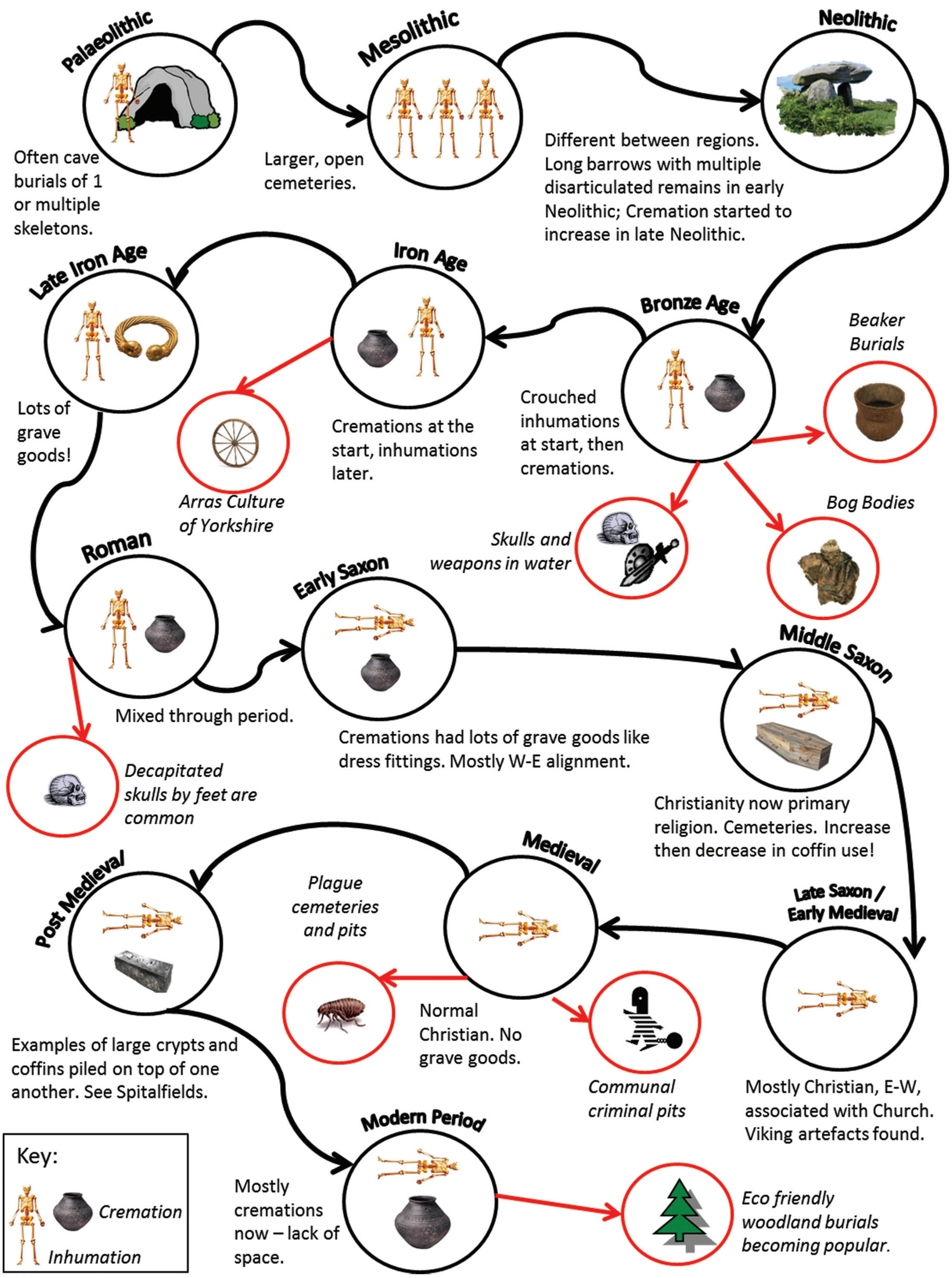
Disposing of the Dead



41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 51

Credits

Page	Credit
2	Crouched burial at the Anglo-Saxon Bowl Hole Cemetery at Bamburgh Castle, Northumberland. Courtesy of the Bamburgh Research Project.
15	All images from Private Collection, Bridgeman Education.
17	Photographs of skulls and pelves courtesy of Charlotte Roberts, Department of Archaeology, Durham University.
18	Image of developing femurs courtesy of Charlotte Roberts Department of Archaeology, Durham University.
19	Typical Collagen Isotope Values courtesy of Andrew Millard, Department of Archaeology, Durham University.
20	The Oetzi Iceman, photograph, South Tyrol Museum of Archaeology, Bolzano, Italy, Bridgeman Education.
24	Photographs of pathology on teeth courtesy of Charlotte Roberts, Department of Archaeology, Durham University.
25	Set of four canopic jars belonging to Djedbastetefankh, from his tomb at Hawara, Late Period, c.380-342 BC (limestone), Egyptian 30th Dynasty (380 BC - 100), Ashmolean Museum, University of Oxford, UK, Bridgeman Education.
	Anubis and a Mummy, from the Tomb of Sennedjem, The Workers' Village, New Kingdom, Egyptian 19th Dynasty (1297 BC - 1185), mural, Deir el-Medina, Thebes, Egypt, Bridgeman Education.
27	Image of Egyptian mummy and radiograph courtesy of Oriental Museum, Durham University.
29	Cross section and image of full bone courtesy of Charlotte Roberts, Department of Archaeology, Durham University.
30	Photographs of pathology on teeth and bones courtesy of Charlotte Roberts, Department of Archaeology, Durham University.
32	Africa, Sierra Leone, Funeral procession. 1880, Coloured engraving, Bridgeman Education.
32	Funeral procession for Queen Victoria, Cowes, 1901, (b/w photo), German Photographer, Bridgeman Education.
34	The Body of a Murderer Exposed in the Theatre of the Surgeons' Hall, Old Bailey, London, engraved by White, c18th, original was engraving – this is a b/w photo, Bridgeman Education.
35	Image photographed from modern reprint, 1926, of Anatomies de Mondino dei Luzzi et de Guido de Vigevano, 1326.
	Image photographed from modern reprint, 1930, of The kalendar & compost of shepherds, 1493.
	Image photographed from facsimile reprint, 1926, of Vesalius, Andreas, 1514-1564,De humani corporis fabrica libri septem.
	Image photographed from modern reprint, 1965, of Estienne, Charles, De dissectione partium corporis humani libri tres, 1545.
	All images courtesy of Palace Green Library, Special Collections, Durham University.
36	Andreae Vesalii from Andreae Vesalii de humani corporis fabrica libri s Joannis Oporini: Basile: 1543, British Library, London, UK, Bridgeman Education.

Page	Credit
37	Image photographed from facsimile reprint, 1926, of Vesalius, Andreas, 1514-1564,De humani corporis fabrica libri septem. Courtesy of Palace Green Special Collections, Durham University.
38	Portrait of Wilhelm Konrad Roentgen (1845-1923), c.1896, b/w photo, Musee du Centre Antoine Beclere, Paris, France, Bridgeman Education.
	Radiograph of the left hand of Anna Bertha Ludwig, Röntgen's wife, 1895, b/w photo, Röntgen, Wilhelm (1845 - 1923), Private Collection, Bridgeman Education.
	Rontgen exploring a child with X-ray device by 1900, coloured engraving, Bridgeman Education.
39	Mobile X-ray Unit in France, c.1914-18, b/w photo, French Photographer, Bridgeman Education.
40	Sneezing Man - CDC Public Health Image library ID 11162.
	Image of worker with oxen courtesy of Charlotte Roberts, Department of Archaeology, Durham University.
	Key TB Facts courtesy of World Health Organisation.
41	Spine With TB and sanatorium courtesy of Charlotte Roberts, Department of Archaeology, Durham University.
42	Portrait of Koch, Robert, Bridgeman Education.
42	Scanning electron micrograph of Mycobacterium tuberculosis, Centers for Disease Control and Prevention's Public Health Image Library (PHIL), #8438.
43	Both images courtesy of Kirsty McCarrison, Durham University Library's Learning Team.
44	Autograph letter outlining the discovery of the structure and function of DNA, Cambridge, 19th March 1953, pen & ink on paper, Crick, Francis (1916 - 2004), Private Collection, Bridgeman Education.
45	Image courtesy of Carl Jones, Durham University.
46	Londoners fleeing to the country to avoid the Plague, 1630, woodcut, Private Collection, Bridgeman Education.
	Group of plague items (iron & wood), 17th Century, © Museum of London, UK, Bridgeman Education.
47 / 48	Image photographed from London's dreadful visitation: or, A collection of all the bills of mortality for this present year: beginning the 27th. of December 1664. and ending the 19th. of December following, the Company of Parish-Clerks of London, 1665. Courtesy of Palace Green Library, Special Collections, Durham University.
49	Venetian Doctor during the time of the plague, 19th century, pen & ink and w/c on paper, Grevenbroeck, Jan van (1731 - 1807), Bridgeman Education.
	Certain necessary directions, aswell for the cure of the plague, as for preuenting the infection, 1636. Courtesy of Palace Green Library Special Collections, Durham University.
50	Images courtesy of Kirsty McCarrison, Durham University Library's Learning Team.
Back image	Bone Structure of the Human Neck and Shoulder, facsimile copy (pen & ink on paper), Vinci, Leonardo da (1452 - 1519), Bibliotheque des Arts Decoratifs, Paris, France, Bridgeman Education.

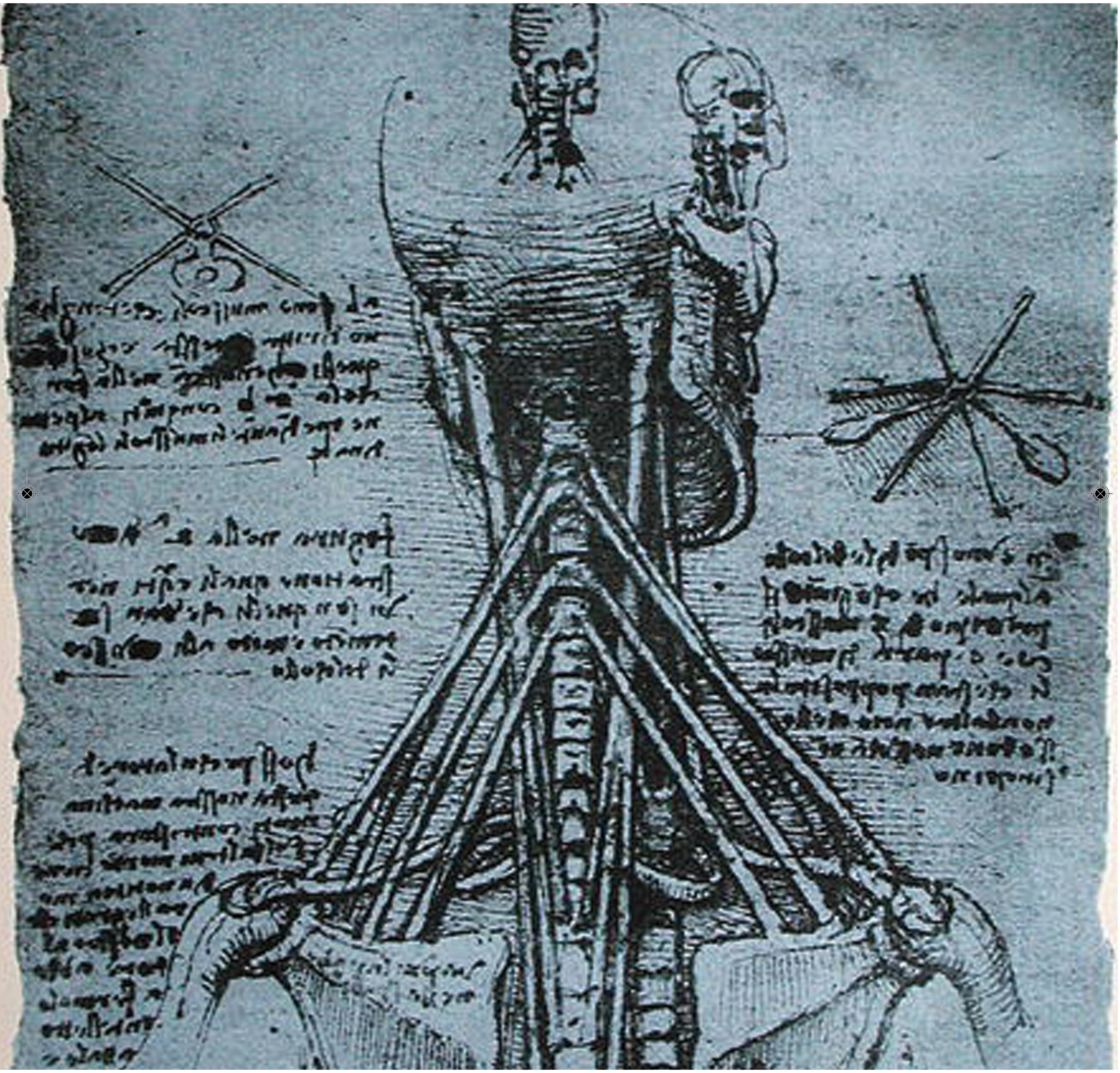
Thanks:

Thank you to the Department of Archaeology for their funding of this project and to individual members of the Department who supplied images and text. A useful bibliography for further reading can be found here: **www.durham.ac.uk/archaeology/staff/?id=163**

Thank you to the Library Learning Team and associated volunteers for their support and assistance with preparation of materials.

41300_LG_Resource_Booklet V3_37090_LG_Resource_Booklet 06/01/2015 15:41 Page 52

Durham University



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