KS3 Forensic Science

F15.2506

Year 9 Scheme with *How Science Works*

Update v1.4, December 2023

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Introduction

The end of year 9 has always proved to be a difficult period of time for us to fill in a productive way. As a department, we have tried beginning GCSE work, extended project work or investigations; however none of these approaches seemed to enthuse pupils.

This scheme of work was written in response to these difficulties. My aim was to introduce some of the new, and reinforce some of the existing, aspects of 'How Science Works' ideas, which are so pivotal to the new KS4 curriculum, in a contemporary and exciting context. Like it or not, Forensic Science is an area of science that has mass appeal, for pupils and adults alike, and it became clear to us very quickly that the pupils were captivated by the science of it all and the opportunity to see how it's all done.

The scheme itself can be followed step-by-step. Most of the lessons have PowerPoint and worksheet support, and all are cross referenced to the appropriate 'How Science Works' target. Additional resources, such as lesson guidance for teachers (identified by the use of the word 'Overview' in the title), handouts and online activities and are also clearly referenced.

The material has been broken down into seven main areas, each with its own PowerPoint presentation (Introduction to Forensic Science, Hair Analysis, Footprints, Anthropology, Blood Analysis, Blood Patterns and Blood Typing). These are included on the CD-ROM and provide an introduction to each topic for the students. Also on the CD-ROM is also a copy of all the pages designed for laminating as reusable resources, allowing them to easily be printed in colour as required.

Additionally, there is also a bonus section on fingerprinting, should you or the pupils wish to explore this aspect of forensic science in more depth. This is, of course, one of many opportunities to go off on a tangent, with something that interests you or the pupils, and this is probably the only curriculum time that we have to do this. We have had in outside speakers – many local police forces will come in and talk to the pupils about Scenes of Crime work, and there is a wealth of information online for other branches – such as entomology, toxicology etc. As with all schemes the teacher should assess what is appropriate for their own class, and adjust the material used accordingly.

It was my hope, when I wrote this, that the pupils would finish Year 9 with a good grounding in those HSW skills and a good degree of interest in and enthusiasm for Science. I know our pupils have thoroughly enjoyed the course; this year was our third 'run-through' and pupils, across the school, talk about it and ask when they will get to do it.

I hope you and your pupils get as much out of it as we have.

November 2007

Update v1.1, 10 June 2008 – Updated instructions for preparing and storing phenolphthalein solution.

Update v1.3, 23 April 2010 – Added alternative methods for preparing phenolphthalein solution.

Update v1.4, 1 December 2023 – Lessons 17-19 removed as link is no longer active.

Scheme of Work

Lesson Number	Learning Objectives	Teaching Ideas	Resources
Who are forensic scientists and what do they do?			
1	• [illegible] people involved in [illegible] forensic evidence • [illegible] of evidence/branches of science involved	Elicit ideas from pupils about what forensic science is all about. Lead to idea of vast number of disciplines involved. Look at types of crimes and disputes that may be investigated. Provide pupils with case studies of problems and ask them to decide which disciplines would be involved and what kind of tests/research could be carried out to [illegible]	PowerPoint (**introduction.ppt**) Case study of Holly [illegible] Chapman – literacy [illegible] (**How Forensic Scie** Word search availab [illegible] (**What is Forensic S** Forensic science car [illegible] **http://www.planet- InfoPage_37.html** Homework – assign [illegible] branches of forensic Ask them to researc [illegible] information and res [illegible] an informational po [illegible] presentation about t Suggest : ballistics, a [illegible] entomology, print e [illegible] pathology etc.
2–3	• Types of evidence/branches of science involved in forensics • How to select information from appropriate secondary sou[illegible] • How to present inf[illegible] to an audien[illegible]	In groups, pupils re[illegible] ar[illegible] information posters about their branch of forensic science. Each group to deliver a 2 minute presentation about what their branch involves.	Poster tray, fake blo[illegible] (**p.26**), ink pads for [illegible] Could also allow th[illegible] folders in which the[illegible] fingerprints etc.

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Lesson Number	Learning Objectives	Teaching Ideas	Resources
What types of evidence can be collected?			
4	• About properties of hair and other animal hair • Make accurate observations using microscope and record them • Draw a conclusion from evidence provided	Ask pupils to suggest what kinds of trace evidence are left at the majority of crime scenes. Establish hair/fibres can be viewed under a microscope for unique properties to provide information about suspects/victims etc. Provide pupils with samples of human and other animal hair, and ask them to use the microscope to observe and identify differences between them. Compare different samples of human hair and look for differences in the medulla etc. Pupils may like to pull a hair of their own and observe the stretching of the root which often indicates forcible removal, and the skin cells around the root.	Samples of human hair samples of animal hair Microscope, video microscope PowerPoint (**hair.ppt**) Pictures and info on hair can be found at: **http://www.fbi.gov/hq/lab/july2004/research/2...**
5	• Observe some of the properties of different fibres • Make accurate observations and record them • Draw a conclusion from evidence provided	Analysis of fibres, e.g. wool, cotton etc. Discuss with pupils what kind of information these could give. Ask pupils to analyse 4/5 known substances and create a key. Give them an unknown fibre end to identify using their key. Explain natural fibres burn, leaving little ash or mess, synthetic fibres tend to melt/smoke and give off a strong smell.	Worksheet (**Analysing Fibre Ev...**) Video clip and pictures Materials' CD-Rom...

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Lesson Number	Learning Objectives	Teaching Ideas	Resources
6	• How to collect evidence without disturbing it • What types of information can be gained from shoe wear patterns etc.	Cast footprints using plaster of Paris. Spray with hairspray if casting from soil – helps retain pattern. Ask pupils to make sketches of the shoe tread, and suggest other important information they may give e.g. is the tread worn evenly, are there any logos etc.? How might this evidence be any use? Pupils can also prepare rubbings of their own patterns using crayons for comparison.	PowerPoint (**footprints.ppt**) Digital camera for p Trays of sand to pri soil.
Is there a connection between stride length and height?			
7–8	• To plan a method with sufficient data to decide if there is a relationship • To distinguish between acc and precise measur • To appreci re s improve y	Ask pupils if they any information could be gained from l stride in footprints left at a and discuss ways in which this could be investigated. Reinforce **accurate** measurements and **precise** measurements and distinguish between them – HSW Discuss plans, and then allow pupils to carry out practical work, presenting results graphically and establishing any patterns found. Discuss the v bili of the concl s pe ps pool class results with individual conclusions.	1m rulers, chalk ma

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Lesson Number	Learning Objectives	Teaching Ideas	Resources
What is anthropology and what information can be gained from bones?			
9	• About the work of a anthropologist • About the bones of the body • About the mathematical relationship between bone measurements and height.	Pupils can measure foot length – from heel to tip of longest toe – and height to determine relationship. Results can be pooled and graphed, or just pooled within the group to work out relationship between foot length and height. Relationship is approx. Foot length = 15% height Another opportunity to reinforce accurate and precise measurements.	Worksheets (**Foot Measurements** **Is there a relationship** **height? p.22, The Hu** Rulers, chalk, calcu PowerPoint (**anthropology.ppt**) Literacy and numer (**Finding the Roma** Research opportuni
How is blood evidence collected and what can it tell us			
10	• About the chemical basis of two simple tests for blood evidence • To evaluate the scope and reliability of these tests • About the importance of controls in scientific tests	Ascertain that stains found at a scene must be checked to see if they are blood. Explain the basis of catalase reaction, bubbles when peroxide is added indicates the **possibility** of blood. Provide pupils with fabric/filter paper samples stained with blood, ketchup, beet juice, etc. and ask them to carry out their tests and record findings. Demonstrate phenolphthalein test and allow pupils to carry out tests. Discuss the value of controls – positive and negative. Discuss problems/limitations – e.g. not conclusive, does not indicate human blood or what type.	PowerPoint (**bloodanalysis.ppt**) Fabric swatches wit animal blood, fresh Worksheets (**Blood stain Analys** **The Phenolphthale** **Extension** Ask pupils to resea tests e.g. precipitin, findings in the form Emphasise use of p controls.

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Lesson Number	Learning Objectives	Teaching Ideas	Resources
11	• How blood spatter patterns can give information about crime • To investigate factors which affect blood • Process evidence collected in form of a graph and be able to read off it	Show pupils information on spatter patterns. Ask them to suggest what information could be gained. Ask them to investigate: Effect of height on spatter Effect of surface on patterns Effect of direction on spatter	Fake blood – recipe PowerPoint (**bloodpatterns.ppt**) Worksheet for inves and diameter. (**Blood Patterns p.2** Graph paper. Homework – Ask p their blood type for
What other information can be derived from blood?			
12–13	• About the ABO blood grouping and its distribution in the population • How to perform a test to determine blood type • Discussions of this evidence – i.e. can eliminate people from enquiries, but cannot conclusively prove guilt	Introduce the ABO blood group system, antigens and antibodies in blood group. Discuss transfusion reactions. Introduce Rh factor. Explain basis for tests for them – e.g. presence of Anti-B antibodies in blood group A.	PowerPoint (**bloodtype.ppt**) Laminated blood gr Worksheets (**Blood Groups p.33 Typing Blood Sam** Blood typing kit Interactive 'blood ty **http://nobelprize.o landsteiner/index.h** Blood typing kits av science suppliers.

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Lesson Number	Learning Objectives	Teaching Ideas	Resources
What is DNA & how can we extract it?			
14–15	• About the struct… fu… n c… • …me …s in blood contain …id therefore genetic information • About the way in which that information is extracted • To extract some DNA from their own cells	Ask pupils about work in 9A and ascertain that DNA is unique to all individuals and that this is found in all nucleated cells. Build a DNA model and explain what DNA does – small sections are genes. Establish which cells in the blood contain nuclei and explain how this can be extracted. Extract DNA from onion, …i fruit, or cheek cells. D… …NA database and possible …buse of this kind of information.	Laminated DNA ba…
What can we do with DNA now that we have extracted it?			
16	• That DNA can be cut into sections, which can then be separated to give a pattern unique to each individual • To describe how electrophoresis works • To use an interactive model of genetic fingerprints to solve a 'crime'	Explain how DNA can be cut into sections using enzymes which can then be separated. Introduce term 'Genetic Fingerprint', and demo techniques or show animation from W… …w on Life CD-Rom.	IT room for interact… **http://www.biotech…** **popups/int_dnapro…** Text ref Biology for … Worksheet 'bar cod… (**Applications of D…** **Extension** Ask pupils to resear… prove paternity. As… results are never giv…

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Lesson Number	Learning Objectives	Teaching Ideas	Resources
How do various pieces of evidence fit toget[illegible]er[illegible]ated in court?			
17–19 ISA , 1 lesson for practica[illegible] 1 [illegible]on for tables/charts/graphs, 1 lesson for supervised assessment			

	Additional websites
CHIN – Interactive Investigator An interactive investigation, where pupils have to process a 'scene', collect evidence and decide its importance. Lots of information to read.	http://www.virtuali
Quiz – Basic Forensic Science	http://www.funtrivi
Quiz – Basic Forensic Science 2	http://www.funtrivi

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Holly Wells and Jessica Chapma
How Forensic Science Caught their

On August 4th 2002, Holly Wells and Jessica Chapman went missing after
house in Soham. There was a nationwide hunt for the girls, which ended 1
discovery of their bodies in a six foot ditch in local woodland.

During the hunt for the girls, investigators had become suspicious of a loca
claimed to have seen the girls walk past the home he shared with his girlfr
searched Soham College, where Huntley worked, and found the partly bur
girls were last seen in – Manchester United shirts and tracksuit bottoms – i

Huntley was arrested and his home searched. He denied all involvement w
It was now up to the scientists from the Forensic Science Service (FSS) to e
determine Huntley's guilt or innocence. Most Forensic Scientists are not p
examine the evidence collected and present their findings to police and in

Forensic analysis

Teams of scientists spent the next 14 months painstakingly examining evid
the bin containing the remains of the girls' clothes and shoes and the wood
were found.

Tens of thousands of fibres were recovered from Ian Huntley's car, carpets
bathroom mat. Each one of these fibres was examined under a microscope
some of them to fibres found on the girls' Manchester United football shirts
In addition, scientists were able to match fibres from the girls' shirts to fibr
and on his clothes.

Altogether, scientists examined over 40,000 fibres, and were able to prove
addition to fibres, scientists also examined hairs found on the girls' clothes
and reconstructed the cuts found on the girls shirts.

Ian Huntley was found guilty at the Old Bailey in December 2003 of the m
Jessica Chapman and received two life sentences.

Questions

1. Why do you think it is important that 'Most forensic scientists are not p
2. The evidence in this case was collected from 4 major sites – name them
3. How long did it take the Forensic Science Service to process all the evid
4. What do you think the term 'two way transfer' means?
5. Imagine you are a reporter for a newspaper. Write an article for re
   how forensic science helped to solve it (or not). Present your article
   a newspaper and include illustrations if you wish.

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What is Forensic Science all abo

X	T	W	Y	Q	J	Z	I	R	I	B	G	Y	F
C	Y	O	I	G	K	U	Y	Z	A	C	G	U	Y
R	P	T	X	H	O	G	P	L	Z	[illegible]	F	E	E
I	O	Q	J	I	O	L	L	Z	[illegible]	R	I	M	M
F	F	S	U	L	C	I	[illegible]	O	I	B	P	Y	N
V	Y	E	C	[illegible]	S	O	P	H	M	T	G	M	P
P	Q	[illegible]	I	T	Z	O	L	F	T	N	P	Q	E
C	E	Z	I	O	R	L	V	O	P	A	P	D	C
S	Z	C	W	H	T	A	H	P	G	S	P	A	N
I	S	S	T	T	A	H	O	H	N	Y	E	Q	E
D	L	N	O	T	Y	G	O	L	O	T	N	O	D
O	A	C	V	Q	P	W	E	C	A	P	T	L	I
C	I	N	S	E	C	T	S	T	W	N	O	E	V
S	B	O	J	A	I	K	C	G	N	H	M	F	E
P	T	E	O	U	O	Y	B	H	M	A	O	J	I
P	C	W	F	F	I	D	W	J	Y	[illegible]	L	Q	L
U	C	T	A	W	X	T	G	V	[illegible]	G	O	L	E
I	R	R	N	S	T	[illegible]	[illegible]	G	X	M	G	F	I
F	I	N	C	[illegible]	K	P	R	I	N	T	Y	M	U
V	A	[illegible]	T	J	T	L	T	V	D	D	E	I	L

Anthropology
Ballistics
Crime
Entomology
Evidence
Fibres
Trace
Fingerprint
Odontology
Insects
Serology
Toxicology
Pathology

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Analysing Fibres (Lesson Overvi

Resources
Analysing fibre worksheet (**p.12**)
Science of Materials CD-ROM
Prepared, labelled slides of various natural and synt[illegible] fibres, 1 'unknow

Objectives
Pupils should learn:
- How to make and [illegible]d accurate observations with a microscope
- About s[illegible]roperties of everyday fibres

Key words
synthetic, natural, nylon, fibre, polyester

Overview
Provide pupils with samples of known fibres and ask them to examine the
a microscope, and prepare an information sheet on typical fibres either on
on pupil worksheet. When this is complete, provide them with an 'unknow
different colour of those already examined, and ask them to determine wh
It's useful to point out that pupils should try to look at individual fibres w

Demonstrate that natural fibres burn, synthetic fibres melt and sometimes

Cotton is a flat and twisted ribbon-like fib[illegible]e; [illegible]ar[illegible]ars to be thick and rou
because each fibre is a long and t[illegible]d [illegible]be.

Linen looks li[illegible] a [illegible]h walls thick enough that it does not collapse, u
ribbon-like[illegible] for frequent small knobs. A narrow line in the centre is a

Silk is solid like a thread of solid glass. Its diameter is the same all the wa

Wool is different from any other natural fibre; it looks broken or scaly unc

Polyester has borders that aren't regular or smooth but have a granular lo
sticking out from the fibres cause bits to pull together after a while and sn

Nylon is pretty similar to silk but nylon is twisted in a spiral, unlike the st

Apparatus
Microscopes
Hand lenses
4/5 known fibres, 1 labelled '[illegible]kn[illegible]'

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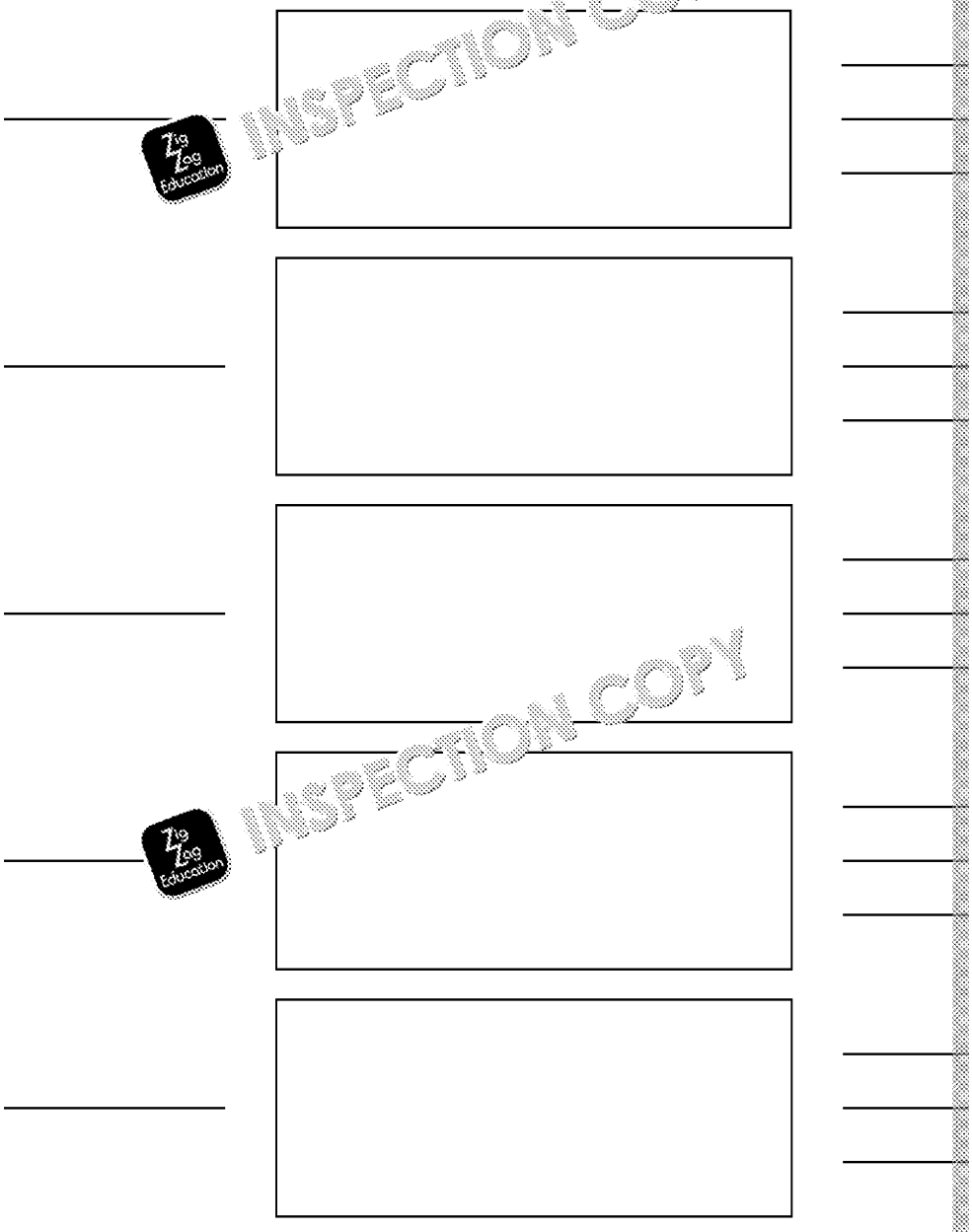
Analysing Fibre Evidence

Analyse each of the fibres you have been given carefully using the microsc
drawing of what you see in the boxes provided, and describe each fibre in

Fibre Name



What type of fibre was the unknown?.....

How do you know?.....

Explain the major physical and chemical differences between natural and

.....

.....

.....

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Hair Structure (Lesson Overvie

Resources
PowerPoint (**hair.ppt**)
Prepared slides of hairs of various types

Objectives
Pupils should learn:
- About the basic structu[illegible] hai[illegible]and how this can vary among humans
- To make careful [illegible]ations using a microscope and record those deta
- To com[illegible]n unknown with known standards to reach a conclusion

Key words
medulla, cortex, cuticle

Overview
Pupils will probably know little about hair structure and in order to appre human types and different species, will need to know basic structure. Hai where the medulla is the lead, the cortex the wood, and the cuticle the pai medulla may be fragmented or absent altogether, the main structure is the keratin, which determines its properties such as elasticity and curl. Within granules. These can be smooth and dark, which tend to be evenly distribut and less evenly distributed. The cuticle is made up of 6-10 overlapping lay easily managed hair has smooth cuticles; when th[illegible]cle is damaged, hai may have 'split ends'.

Human hair can be broad[illegible]into 3 categories – Caucasian, Asian and Explain basi[illegible]ru[illegible]rovide pupils with hair samples to look at. Pupil observatio[illegible]he slides they look at. Have them pull out a hair and show Pre-prepare[illegible]slides are useful but pupils can also make their own hair slid adding a drop of water and a cover slip.

Provide them with some hairs from different animals. Ask them to record worksheet.

Apparatus
Prepared slides of hair samples, human and animal
Empty slides to make up own hair slides if needed
Pipettes
Microscopes
Hand lenses

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Footprints (Lesson Overview)

Resources
PowerPoint (**footprints.ppt**)

Objectives
Pupils should learn:
- To make and record accurate observations
- How to make a permanent cast of footprints
- What kind of information can be derived from prints at a crime scene

Key words
impression, tread, gait

Overview
Footprints can be cast using plaster of Paris. Pupils can work in groups to make a tray of soil/sand, and then swap trays with other groups. Alternatively, prepare soft soil, and allow groups to cast those. If pre-preparing, use some shoes with patterns. If casting outside, a cardboard or wood frame around the print will help the plaster is poured in. Spraying the soil with hairspray also helps preserve.

Ask all members of group to make an accurate sketch of the print (to scale) information they can glean – logos, wear patterns etc. Could use digital camera casting.

Latent prints can also be found at crime scenes using dusting, and electrostatic lifting.

Plaster of Paris can be mixed in bowls and poured in, or mixed in large Ziplock piping bags and left for at least 15–20 minutes to set. Casts should be left to dry attempting to brush or wash off any soil.

Tip – insert 2 cocktail sticks into plaster as it sets, this will help lift it out.

Apparatus
Trays of soil, shoes for prints, or ask pupils to bring their own.
Cocktail sticks, plaster of Paris.
Mixing bowls or bags, stirrers.

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Fingerprints (Lesson Overview

Resources
Fingerprint classification handout (**p.18**)
Index cards (**p.16**)
Pupil worksheet for lifting techniques (**p.17**)

Objectives
Pupils should learn:
- How fingerprints ar[illegible] – loop, arch, whorl etc.
- How to [illegible]his [illegible]n to classify their own and others' prints
- About w[illegible] reveal latent prints

Key words
loop, arch, whorl, latent, fuming, visible, impression

Overview
Discuss unique quality of fingerprints – even identical twins do not have i
develop in the womb between 12 and 16 weeks of life, and remain the sam
Show classification system, and allow pupils to produce their own fingerp
pads and index cards. Have them divide card into five squares, make a pri
underneath.

At crime scenes there are 3 types of prints – visible, impression and latent.
made on surfaces – they are the combination of oil a[illegible]veat on surfaces.
revealed by dusting and then lifted using tap[illegible]o[illegible] pupils to carry this
white tile, microscope slide/beaker
Demonstrate superglue and [illegible]odine fuming to reveal prints that cannot
prints.

Points to n
Tell pupils to run their hands through their hair or down the side of the n
dusting, as this increases the oils on the fingers, and will therefore give a b

Fuming with iodine will make visible latent prints on rough surfaces e.g. p
rectangle of filter paper using tweezers. They should fold it, put their initi
put a single print on the inside. Fume the whole class in tanks with a benc

Superglue is good for latent prints on smooth non porous surfaces. The ga
acids, fatty acids and proteins in prints. Recommend as demo only – put s
foil in a sealed jar with a little glue on some tin foil. Add a cup of hot wate
developing process. Leave to develop – print will appea[illegible] white. Jar can be
lamp, but if left to develop in a warm room wil[illegible] o[illegible] just as well – about

Apparatus
Ink pads, index cards, br[illegible]aphite powder, white tiles, beakers, rolls
Rectangle of [illegible]er [illegible]or each pupil, demonstration surface for supergl

For fuming:
Iodine crystals, watch glass, glass trough and lid.
Superglue, tin foil squares, sealable jar.

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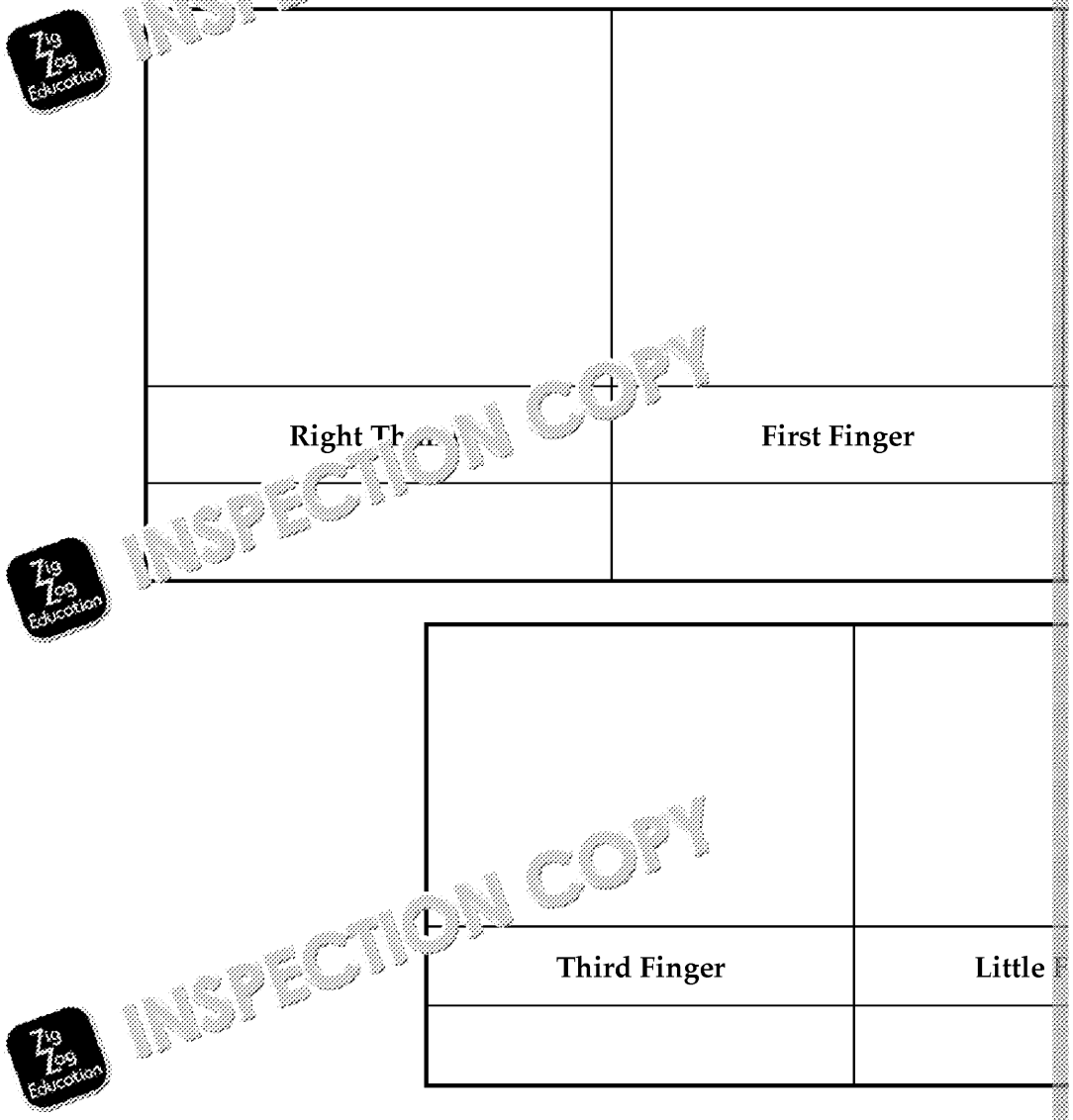
Fingerprint Card

Carefully roll your right thumb on the ink pad, then roll your inked thumb onto the card b
provided to classify your prints as arch, whorl, etc.



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Fingerprint Lifting Techniques

1. What causes a fingerprint?

.....

.....

2. What are the three types of finger prints found at a crime scene?

.....

.....

.....

3. What does the term 'latent' mean?

.....

.....

.....

4. In the squares below, fix two prints lifted by dusting. State the surface t

Surface:	Surface:

3. Fix your iodine print below:

4. Why does running your hand through your hair help give a better print

.....

.....

.....

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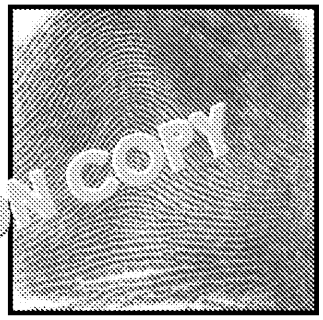
Fingerprint Classification

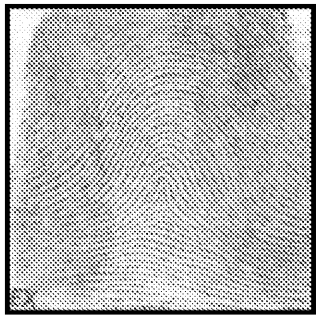
Arch



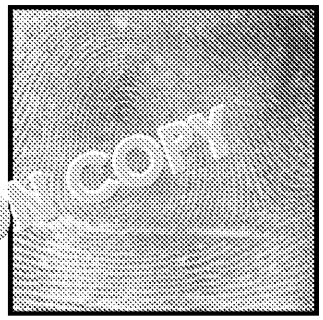
Right loop

Left loop

Tented arch



Whorl



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Forensic Anthropology (Lesson Ove

Resources
PowerPoint (**anthropology.ppt**)
Skeleton Worksheet (**p.25**)
Worksheet – Finding the Romanovs (**pp.23-24**)
Worksheet – Determining height from footprints (**pp.21-22**)

Objectives
Pupils should learn:
- About s[illegible] f the major bones in the body
- How a m[illegible]ematical formula can be used to deduce height from bone l
- About other information that anthropologists can collect from bones

Key words
tibia, fibula, femur, humerus, radius

Overview
Forensic anthropology is the study of skeletal and other human remains to i
determine the circumstances involved in someone's death. Forensic anthro
the age, sex, ancestry, stature, and unique features of a skeleton. At times,
descendants to provide information about the deceased.

Osteology (the study of bones) is very important w[illegible]ensic scientists w
crime scene. When forensic scientists arriv[illegible]a[illegible]e scene area, they are
decomposed remains, along wit[illegible]h[illegible]ther types of physical evidence.

Forensic inv[illegible]ga[illegible]t be able to distinguish human bone from anim
bones are [illegible]. Because humans are bipedal (walk on two feet), our bon
valgus knee and the femur do not line up exactly with the tibia, which hel
gravity. Humans have a large calcaneus (heel bone) and a big toe bone, as
feet when walking.

The human body has 206 bones. The average male skeleton weighs about
and the average female skeleton weighs about 3.5 kilograms (about 7.7 po

Investigators can often determine the following basic identifying factors fr

- **Gender:** Many gender differences are visible when the skull is examine
foreheads, while females have straighter foreheads[illegible]ales have extrem
females have slight ridges, with sharp orbi[illegible]o[illegible]rs. Males have area
attachment visible on the cheek bo[illegible]d large canines. Females have
of males are squarer. The M[illegible]is is narrower than that of the fema

- **Age:** A[illegible]y b[illegible]esumated from *calcifications* (stages at which the bone
changes[illegible] pelvis, evidence of bone disease such as arthritis, and th

- **Previous trauma:** Evidence of a once broken or fractured bone indicate
lead to a victim's identity through comparisons with medical records.

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- **Height:** If the skeleton is incomplete, forensic scientists are able to appr individual by measuring the length of the foot. The length of a person's cent of his or her height.

  15/100 = Length of Foot/x (person's height)

  Formulas applied to the length of the femur, tibia or fibula will also ap The ratio of body parts is slightly diff nt in growing children.

Use skeleton worksh t to find some of major bones in the body.

Ask what i ation bones may yield. Investigate can bone length tell us In groups, measure from heel of left foot to tip of longest toe. Record meas Use ratio to work out the heights of other 'victims'.

Extension
Use literacy and numeracy activity on Romanov family to show mathema other bone lengths and height. Complete research for homework.

Alternative
Cut Styrofoam plates into 6 equal pieces and give two to each pupil. Cut o end and ask pupils to stack the two remaining pieces and put them in thei this will give teeth impressions, label top and bottom. Could ask some pup mix up samples and ask if groups can identify who they came from.

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Foot Measurements and Shoe S

Use the chart below to convert foot measurements to

Foot in centimetres	UK Women's Size	UK Men'
22.07	3.5	-
22.38	4	-
22.86	4.5	-
23.34	5	-
23.65	5.5	5
24.13	6	5.5
24.61	6.5	6
24.92	7	6.5
25.4	7.5	7
25.88	8	7.5
26.19	8.5	8
26.67	9	8.5
27.15	9.5	9
27.46	10	9.5
27.94	10.5	10
28.42	11	10.5
28.73	11.5	11
29.2	12	11.5
29.69	–	12
30.48	–	13
31.27	–	14
32.23	–	15
33.02	–	16

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Is there a relationship between foot size a

1. To measure foot size – place the heel of the left foot against a wall. Mea
   (from where heel touches wall to tip of toe), in centimetres. Record you
2. Measure the height of each individual in centimetres. Record measuren
   data table.
3. Divide the length of the foot by the height of e[illegible] individual, and mult

Relationship between foot length and heig

Name	Foot length (cm)	Height (cm)	

Questions

1. Is there a relati[illegible]etween foot length and height? Describe it.
2. Use you[illegible]h to predict the height of:
   a. A vi[illegible]n with a foot length of 27.5cm
   b. A suspect who left a footprint measuring 35.2cm
3. What other information can be gathered from bones?

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Finding the Romanovs

It is believed that on the night of July 16, 1918, Czar Nicholas II, his wife Czarina Alexandra, their four daughters, Olga, Tatyana, Maria, and Anastasia, and their only son Alexei, were taken into the cellar of the house where they were being held prisoner. They were told they were going to have their picture taken. Also taken were three of their servants, Anna Demidova, Kharitonov and footman Trupp, and the family doctor Dr Botkin. They were all shot by a Bolshevik firing squad.

Not all of the family died immediately. The girls had sewn diamonds into their clothes to carry them undetected, and some of the bullets bounced off them. After the shooting, they stabbed those who were still alive and placed the bodies onto a truck with the intention of dumping them down a mine shaft. However, the truck broke down during the trip to the mine. They reportedly stripped the bodies and burned them with gasoline. To make identification even harder, they doused the bodies with sulphuric acid. The remains were then buried.

A report found in 1989 gave clues to the location of the grave, and, in 1991, a site was found that they thought might be the burial site. The Russian government authorized a dig, which was coordinated by the Chief Forensic Medical Examiner of the Russian Federation.

The grave consisted of a shallow pit (less than a metre deep), and contained nine skeletons. Many of the bones were badly damaged. All the skeletons showed evidence of trauma, some subsequent to it. For instance, some skulls had bullet entry points. Areas of the face were missing, which made facial identification difficult.

Scientists in England worked with the Russian scientists to examine the bones.

The location of the grave, the condition of the bones, the finding of gold and platinum fillings (only available to the rich), the relationships of the DNA samples from the bones to those of the descendants of the Imperial family, and other evidence strengthen the belief that the Romanovs had been found.

It is believed that 11 individuals were killed by the Bolsheviks (the Romanovs and their doctor).

Analyse the evidence and answer the questions on the following page, to identify those buried in the grave.

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Formulas for Determining Height from Bone Length (measured in centi

- Femur 2.38 x (femur length) + 61.41 = height
- Humerus 3.08 x (humerus length) + 70.45 = height
- Radius 3.78 x (radius length) + 79.01 = height

Determining height from bone length

Skeleton	Tandem repeats	Sex (M/F)	Femur length (cm)	Humerus length (cm)	Radius length (cm)	Height (cm)
1	9, 10		44.79	31.5		
2		M	37.64	26.15		
3 (child)	8, 10	F	38.9	27.1		
4	7, 10	M	42.5	30.0		
5 (child)	7, 8	F	38.9	27.21	20.34	
6 (child)	8, 10	F	37.6	26.2	23.0	
7	8, 8	F	39.4	27.4		
8	6, 9	M	38.32	26.68		
9	6, 6	M	37.3	25.92		

Tandem re

Normal ge contain many extremely variable regions. We can often t sequence to his or her parents by comparing the number of copies of a gen every chromosome we have, we get one copy of that chromosome from ou our father. Therefore, we expect that, given any two specific variable regio chromosomes will have the same number of repeats as our father and one repeats as our mother.

Questions

1. Use the genomic evidence (tandem repeats) to determine the possible p Czar and Czarina).
2. Which individuals could not possibly be parents of the children? Explai
3. Anastasia was about 164 cm (5′ 4 ¾″) tall. Could her skeleton be one of Explain.
4. Which skeleton do you think is that of the Czar? The Czarina? Explain
5. Research to find more information on the Romanov family. In your own were, when they were killed, and who scientists think the missing bodies

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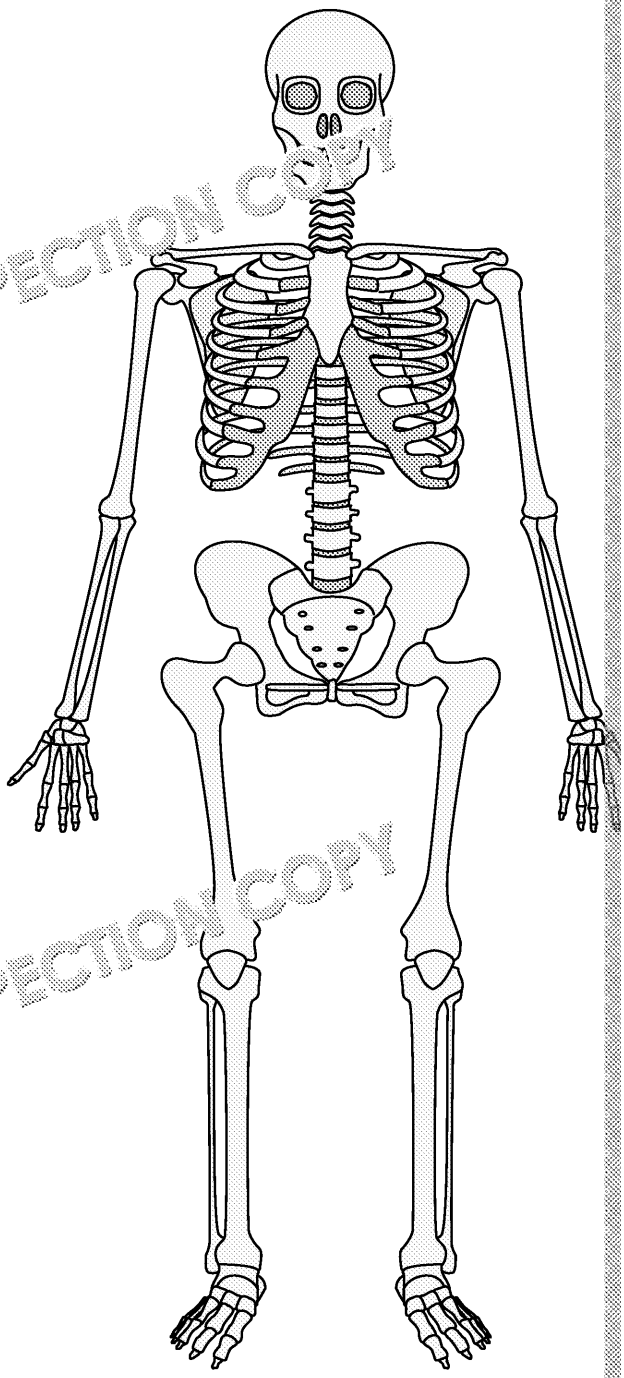
The Human Skeleton



Label: Tibia, fibula, radius, ulna, hu... u..., enur, patella (knee

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Blood Patterns (Lesson Overvie

Resources
PowerPoint (**bloodpatterns.ppt**)
Worksheet to support investigation (**p.27**)

Objectives
Pupils should learn:
- Blood patterns can give [illegible] crimes officer information about wea
- How to carry [illegible] investigation to collect sufficient precise and reliab
- To proc[illegible]graph of results and use it to provide information on a dr scene

Key words
precise, reliable, passive, transfer, projected

Suggestions
Show pupils pictures of blood patterns and discuss types of information th
Elicit main factors – height blood drops from, direction, force of blows etc

Show PowerPoint to show 3 main categories of bloodstain.

Demonstrate droplets from above always give uniform spot which can be
Discuss plan to investigate – does the diameter of the spot tell us anything

Prepare an 'unknown' spot before the lesson for them to read off their unk

Suggest heights of 1m, 1.5m, 2m, 2.5m and 3m. Discuss variables to
If you drop on graph paper they may be easier to measure.
This is an opportunity to discuss precise measurement.
Which units will they use to measure in – cm or mm?
Discuss reliability also – the value of repeated readings and similarity.

Apparatus
100 ml beaker for 'blood'
Plastic pipettes
Metre rulers
30 cm rulers
Fake blood (recipe opposite)
graph paper, A3 and A4

Fake blood recipe:
175 g cornflour
100ml water
175 ml gol[illegible]ru
4 teaspoon[illegible]ood colouring
These are approximate – you may want to thin it a little more or add more

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Blood Patterns

Bloodstains at a crime scene can yield a lot of information about the crime, perpetrators. Bloodstains would always be photographed to keep a perma being tested, typed and analysed for DNA.

List the three main categories of blood patterns:

- .....
- .....
- .....

Your task

In groups carry out an investigation to see if the height of a drop of blood a

Height (m)	Size of drop (mm)	Size of drop(mm)
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

Questions

1. Name one variable that you kept the same during your investigation.
2. How did you make your results precise?
3. Are your results reliable?
4. How do you know?
5. Draw a graph of your results.
6. A droplet measures 18mm. What height would it have dropped from?
7. What droplet size would be produced from a height of 25 cm?

Diameter (mm)

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Blood Stain Analysis (Lesson Overview: 1

Resources
PowerPoint (**bloodanalysis.ppt**)
Blood Stain Analysis – Worksheets 1 & 2 (**pp.30-31**)

Objectives
Pupils should learn:
- About the chemical basis of 2 simple tests for blood presence
- To carry out the tests and make conclusions
- To evaluate the scope and reliability of the test
- About the purpose of controls in experiments

Key words
catalase, hydrogen peroxide, phenolphthalein, luminescence, haemoglobin

Overview
Catalase speeds up the breakdown of hydrogen peroxide into water and o
peroxide is added to anything containing catalase. Many plant cells contai
common. Catalase is not used at crime scenes for this reason.

Provide pupils with samples of red/brown substances on fabric swatches.
peroxide on the whole stain? Why not – contamination etc. Ask them to m
before carrying out the tests.

Swatches can be placed on the tile and a few drops of the phenolphthalein
of drops of hydrogen peroxide. A bright pink colour indicates a positive re

The phenolphthalein test is more commonly used at crime scenes and repl
when benzidine was shown to be a carcinogen.
The presence of haemoglobin produces a deep pink colour in the solution.
The test is non-destructive.

Introduce the idea of a 'control'. Test the fabric on its own (negative contro
(positive control) before having pupils testing unknowns.

Discuss limitations
False positives with catalase – plant materials etc.
Any animal blood will react with either, so it would not prove presence of
indication of type etc.

Apparatus – Hydrogen Peroxide Tes
Hydrogen peroxide dropper bottles or pipettes
White tiles
Fabric swatches with stains on – labelled A, B & C
Gloves

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Apparatus – Phenolphthalein Test
Phenolphthalein working solution in brown dropper bottles
Hydrogen peroxide
White tiles
Fabric swatches with various stains
Fabric without stains as control
Dropper bottles or pipettes
Positive and negative control
Unknowns, one of which is blood

Phenolphthalein stock solution:
2 g phenolphthalein
20g potassium hydroxide
100 ml water

1. Mix thoroughly and then add 20g powdered zinc
2. Leaving the zinc powder to completely settle to the bottom, make sure t
   of the litre beaker.
3. After 24-48 hours, the solution should be colourless.
4. Decant the clear solution carefully into an amber tinted bottle. Do not a
   around whilst this is done.
5. If the solution turns pink again, allow the zinc powder to settle until th
6. Storage must be in a brown bottle.

Working solution:
20 ml stock solution in
80 ml ethanol

Stains:
Fabric with
Red paint
Beet juice
Barbecue sauce
Ketchup
Fresh tomato
Blood – liver in blender
Spaghetti sauce

Extension
Pupils could research other blood tests.
Precipitin – uses the reaction to human antibodies to determine if blood is
Luminol – glows when in contact with blood, even at very dilute concentra
Luminol can detect the presence of blood the eye can no longer see.

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Alternative methds for making the Phenolphthalein solution:

1. Mix the following reagents in a 250 cm^3 round-bottomed flask:

   - Phenolphthalein 2.0 g
   - Potassium Hydroxide 20.0g
   - Deionised Water 100 cm^3
   - Zinc Dust 20.0 g
   - A few anti-bumping granules

   Boil under reflux for 2 hours until the solution has lost its pink colour
   containi[illegible] keep in the reduced form. Stored in a fridge, in
   months.

2. The preparation can be scaled-up and the low-concentration solution w
   step:

   - Phenolphthalein 4 g
   - Sodium Hydroxide pellets 40 g
   - Zinc dust 20 g
   - Deionised water 1000 cm^3
   - Ethanol to bring the total volume up to 1200 cm^3

   Reflux in a 5000 cm^3 round-bottomed flask. After reflux, restore to 1200

3. Another method uses similar proportions but across refluxing. In a 1 d

   - Phenolphthalein 1 g
   - Sodium Hydroxide pelle[illegible]
   - Zinc dust 5 g
   - Deio[illegible] w[illegible] 250 cm^3

   Using a [illegible]ng hot plate, mix and heat until the solution loses its pink
   process may take 2 to 3 hours.

   Decant the liquid into a 500 cm^3 measuring cylinder. Add ethanol to ma

   Add a small amount of zinc powder to a brown bottle, and pour the ph
   this bottle. Label, date, and store the bottle in a refrigerator.

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Blood Stain Analysis

Investigators often find blood stains at the scene of a crime. They also ofte
be blood or some other substance – e.g. paint. All stains need to be tested f

The Catalase Test
Catalase is an enzyme found inside most living cells, including plant cells
of hydrogen peroxide, which can be toxic if allowed to accumulate.

Hydrogen peroxide → Water + Oxygen

If hydrogen peroxide is added to anything containing catalase, bubbles of
are seen, the substance is said to test positive for catalase.

Which of the following do you think will test positive? Make a prediction,
Then carry out the tests.

N.B. Although you will not be using real human blood, gloves should be w

Substance	Prediction – Positive or negative?	Explain why you thi

Questions
1. Which of your stains gave a positive result?
2. What are the limitations of this test?

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The Phenolphthalein Test

Phenolphthalein is a clear, colourless liquid, but it will react with haemoglobin in the presence of hydrogen peroxide to produce a deep pink colour.

It is commonly used at crime scenes to test stains for the presence of blood and is also known as the 'Kastle-Meyer' test.

Method

- Test your sample by adding a few drops of the phenolphthalein solution.
- Then add one or two drops of hydrogen peroxide.
- Record your observations in the table below.

Sample	Result with ph
Filter paper (negative control)	
Known blood sample (positive control)	
Unknown (1)	
Unknown (2)	
Unknown (3)	

Questions

1. What do you think the term 'destructive' means?
2. What was the purpose of the negative control?
3. What was the purpose of the positive control?
4. Can you think of any limitations of this test?

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Blood Typing (Lesson Overview: 2 L

Resources
PowerPoint available (**bloodtype.ppt**)
Blood Groups – write on worksheet (**p.33**)
Typing blood samples – write on worksheet (**p.34**)
Blood Typing handout – laminated (**p.35**)
Red blood cells with different anti[illegible]s, [illegible] accompanying antibodies – la
http://nobelprize.org/medi[illegible]/educational/landsteiner/index.html

Objectives
Students sh[illegible] learn:
- The basis for the division of blood groups
- Blood can be further subdivided into RH positive or negative
- Antibodies present in the plasma can cause a reaction with mismatched transfusion
- This reaction is utilised to type blood in many situations, including blo

Key words
antigens, antibodies, Rhesus, agglutination, transfusion

Overview
1st lesson – Introduce the 4 blood groups, distribution.
Use models on the board to show proteins on mem[illegible]and antibodies in
Explain antigen/antibody reaction causes clot in[illegible]relate back to work in 8
Ask why A people would not pr[illegible]nti-A antibodies (own blood wou
Invite pupils to 'donate' B [illegible]to A person. Allow them to move the b
antigen/anti[illegible]would form and cause clotting.
Explain in[illegible]ons – fatal blood clots, organ rejection etc.
Discuss importance of matching blood for transfusions.
Introduce Rh factor as a second molecule – either present or not. Ask – wo
positive people to make antibodies to Rh protein?
Play interactive blood typing game – asks pupils to type a patient's blood
to give them a transfusion. Find at: **http://nobelprize.org/medicine/educa**

2nd lesson – Recap incompatibility. Explain how this reaction can be used
The Anti A and Anti B antibody are manufactured and added to the samp
both or neither sample tells us blood group.
Clumping with Anti Rh shows positive, no clumping negative.

Points to Note
- Blood type is the combination of g[illegible]nd Rh factor.

Apparatus
Kits for bl[illegible]pi[illegible], pupils should work in pairs.

Extension/Other ideas
Discuss the transmission of HIV, Hepatitis in blood supply – stress safety
Research efforts to remove surface proteins to allow universal donation.
Design a leaflet to encourage people to donate blood.

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Blood Groups

The most common way to type blood is the ABO system. There are four m

..... and ..... In the UK the most common are ..... and .....

They are grouped because of tiny ..... on the membrane of the red b
of protein – A and B.

Antibodies are spe... proteins in the plasma which help protect us from f
types of bl... oup antigens – Anti-A and Anti-B.

E.g. A person with blood group Type A has A proteins on their red blood
antibodies in their plasma.
Why do you think they don't carry Anti-A antibodies?

Complete the table below:

Blood Group	Proteins on membrane	A
A	A proteins	
B		
AB		
O		

Transfusions

Why is it essential to match blo... when giving a transfusion? Wha
getting the transfusion a... bodies that attack the donor cells?

Blood group	Can give blood to	Ca
A		
B		
AB		
O		

Questions

1. If you managed a blood bank, which blood type would you want to col
   be given to the most people?)
2. If you were in an accident and needed a large bl... ansfusion, which
   to have?

The Rhesus factor

The Rhesus f... or ... ther type of protein found on the membrane. If it
if it is abse... od is Rh negative.

Rh group	Protein on membrane	A
Rh positive	Yes – Rh present	
Rh negative		

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Typing Blood Samples

Forensic scientists use the reaction between antibodies and blood proteins t
found at crime scenes.

Samples are tested with 3 antibodies – Anti-A, Anti-B and Anti-Rh.
If the protein that the antibody attacks is present, the blood will clump tog

Complete the table – the first one is done for you. The blood collected reac
B, therefore must be blood group O. There is no reaction with the Rhesus a
Rhesus ne

Reacts with Anti-A Antibody	Reacts with Anti-B antibody	Reacts with Anti Rh antibody
No	No	No
No	No	Yes
Yes	No	No
Yes	No	Yes
No	Yes	No
No	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes

Questions

1. What o formation would you need in order for blood found at th
2. What are the limitations of this kind of evidence? Can it prove conclusi
   as you can.

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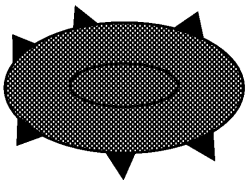
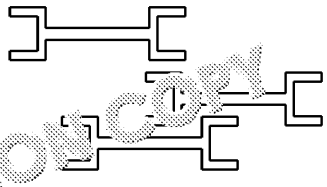
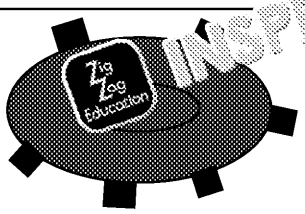
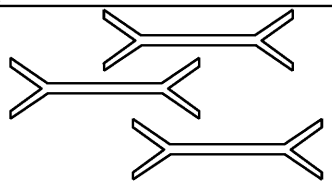
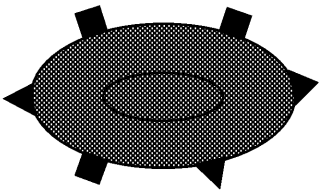
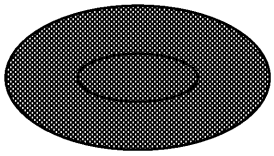
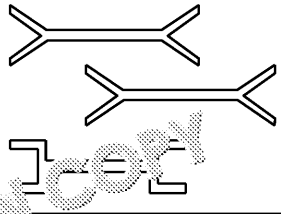
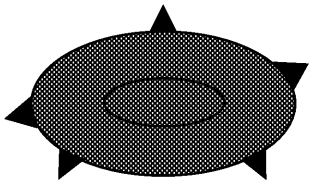
Blood Typing

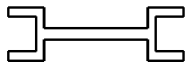
Antigens on red blood cells	Antibodies in plasma	
		**Blo** If y yo of an
		**Blo** If y yo of an
	**NONE**	**Blo** If y yo the and yo
		**Blo** If y yo on cel an

Blood T fu ons

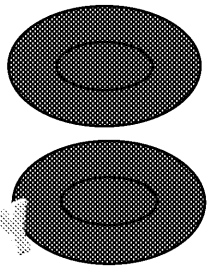
If you are g a blood transfusion that does not match your blood type, t
will react with the foreign blood antigens. For example, if a person with T
transfusion of Type B blood, the person's Anti-B antibodies will react with
donated blood. This causes the donated cells to clump together and cause



Group A person



Anti B antibodies



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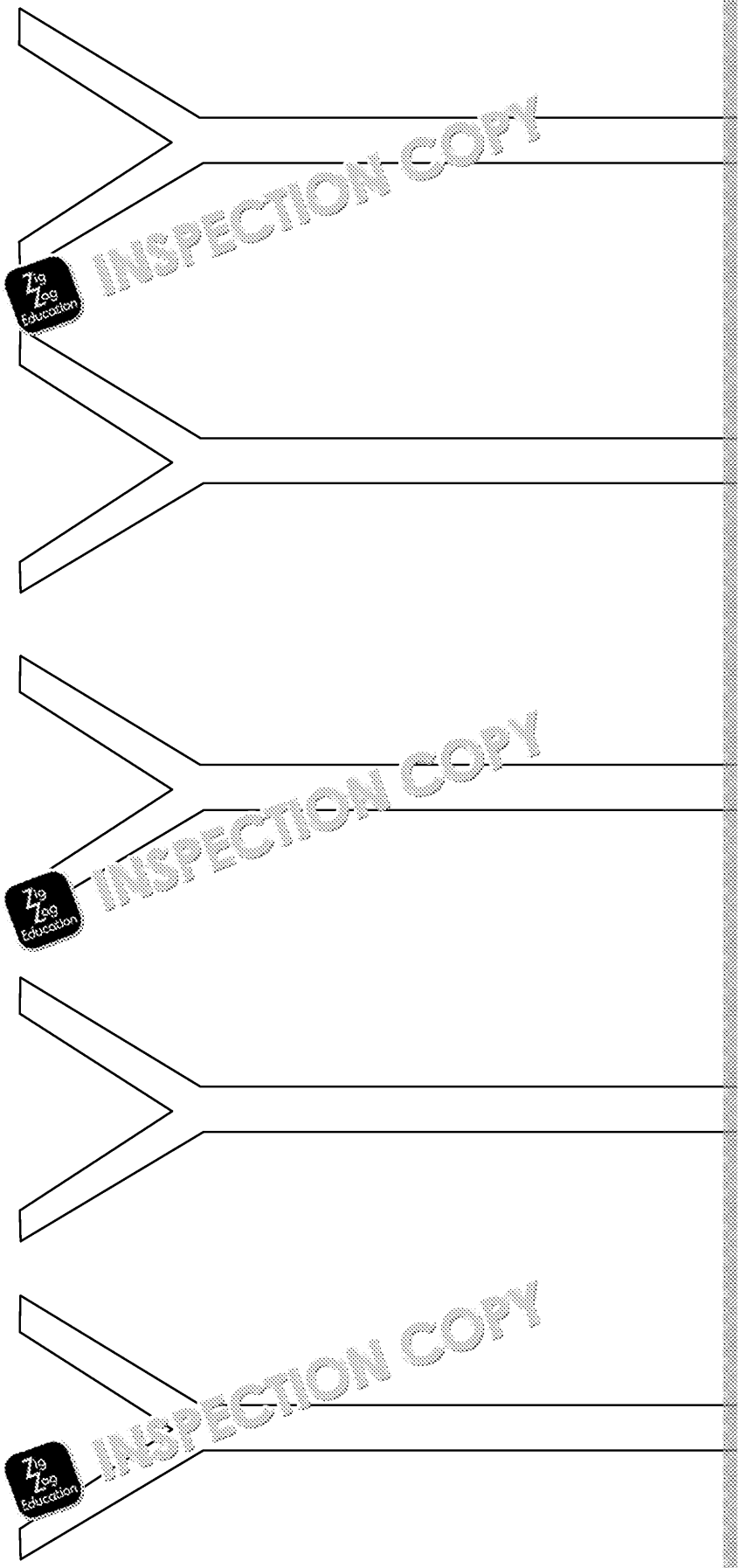
Anti-A Antibodies



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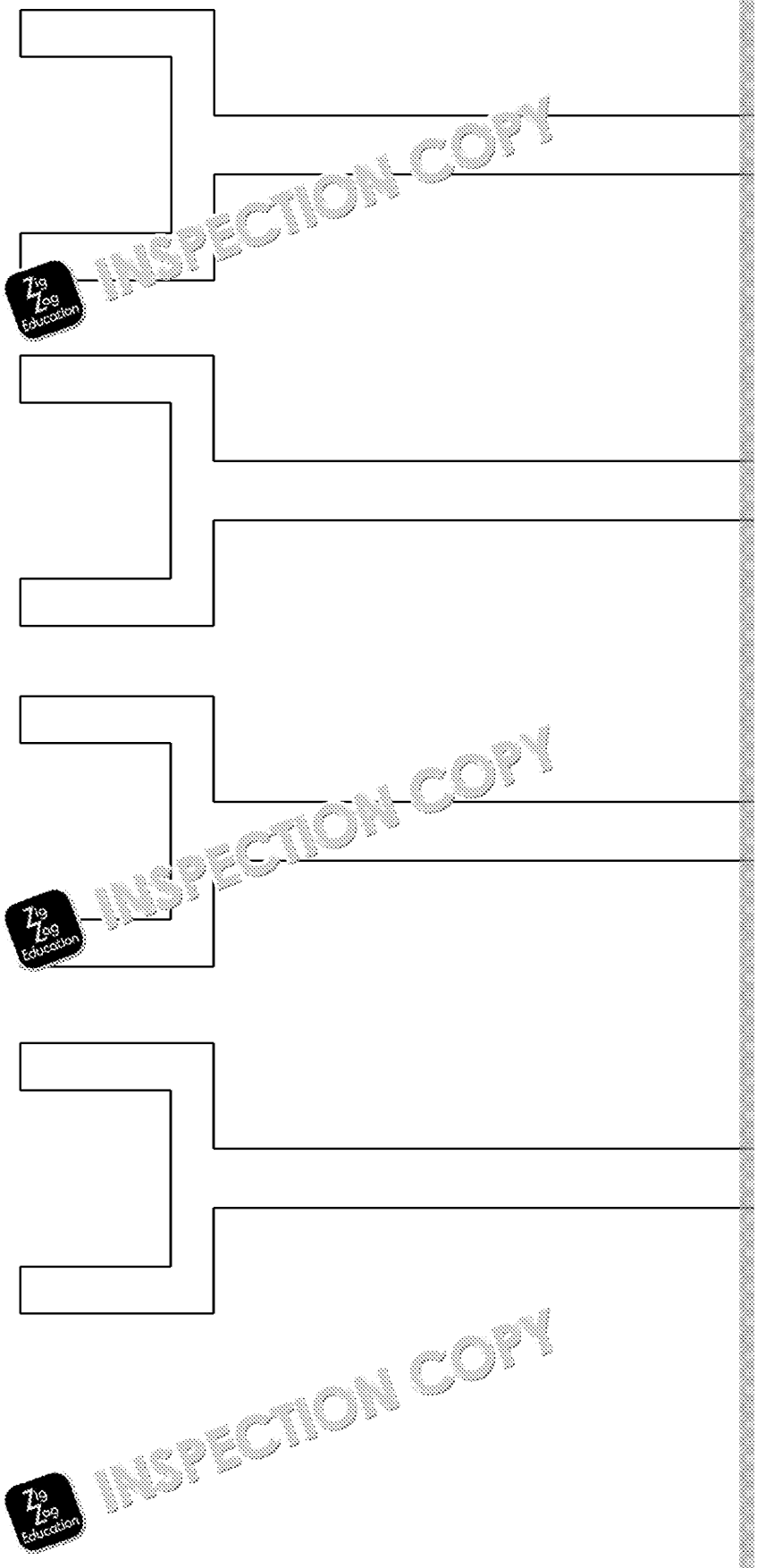
Anti-B Antibodies



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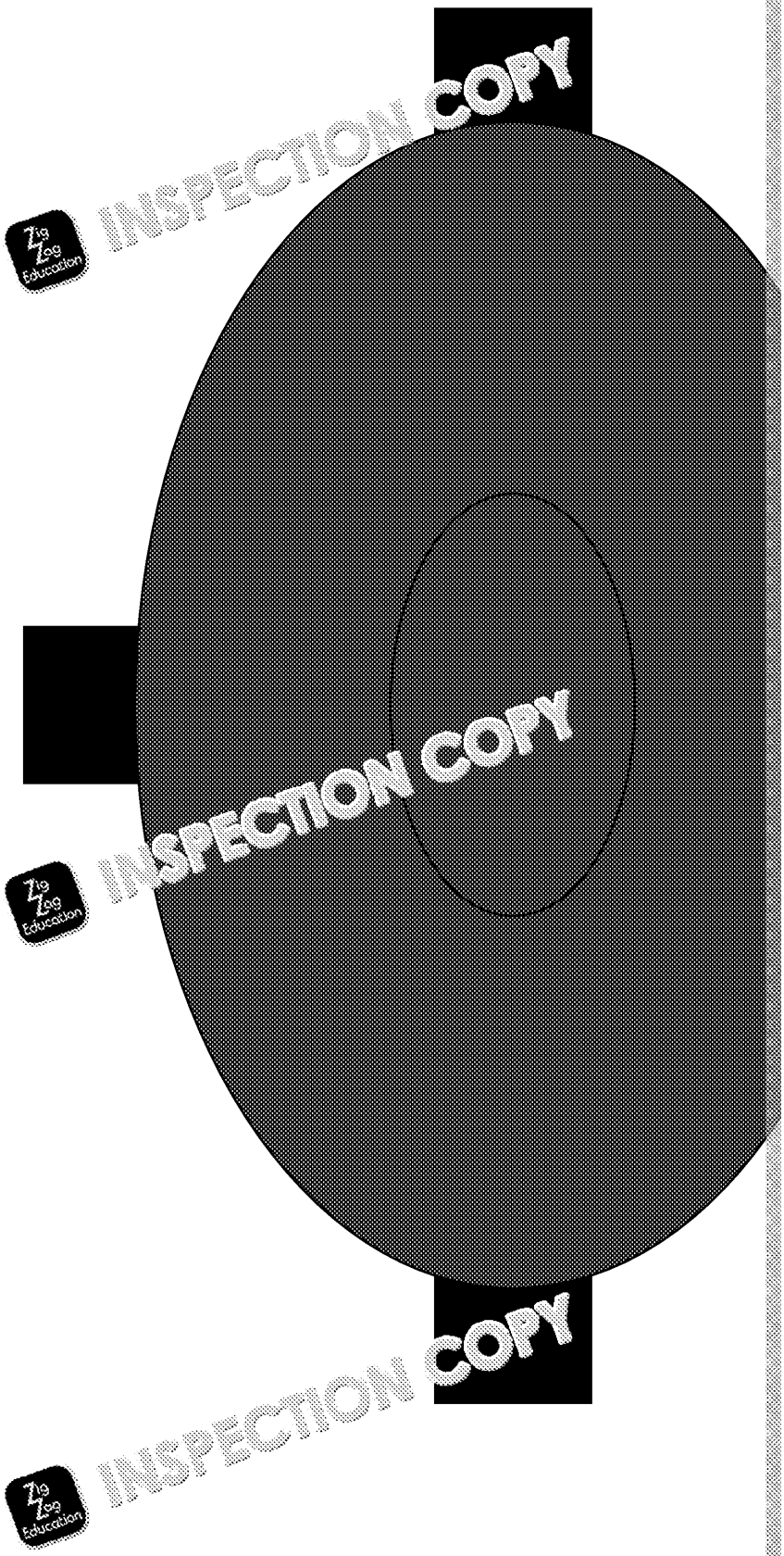
Type B Blood Cells



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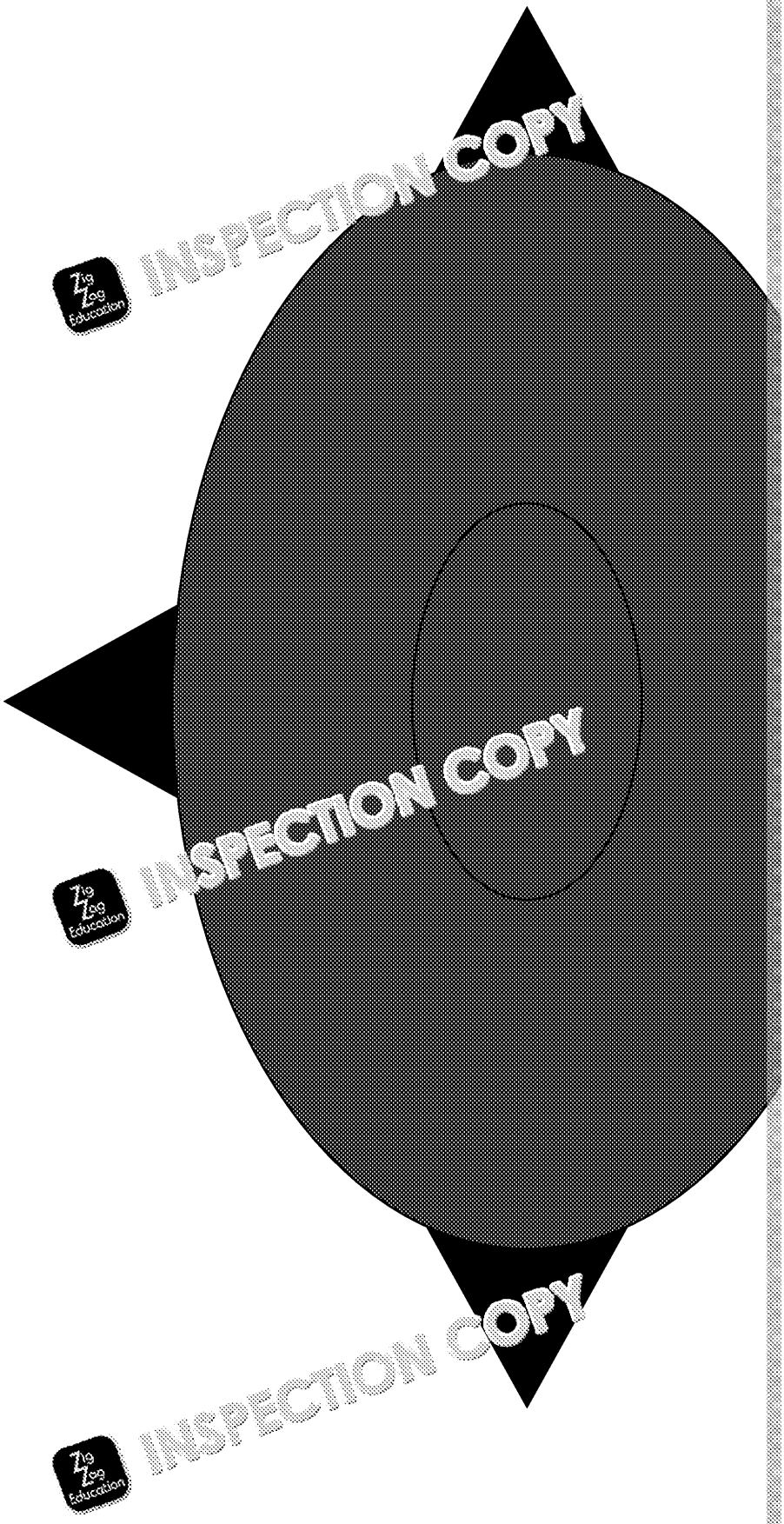
Type A Blood cells



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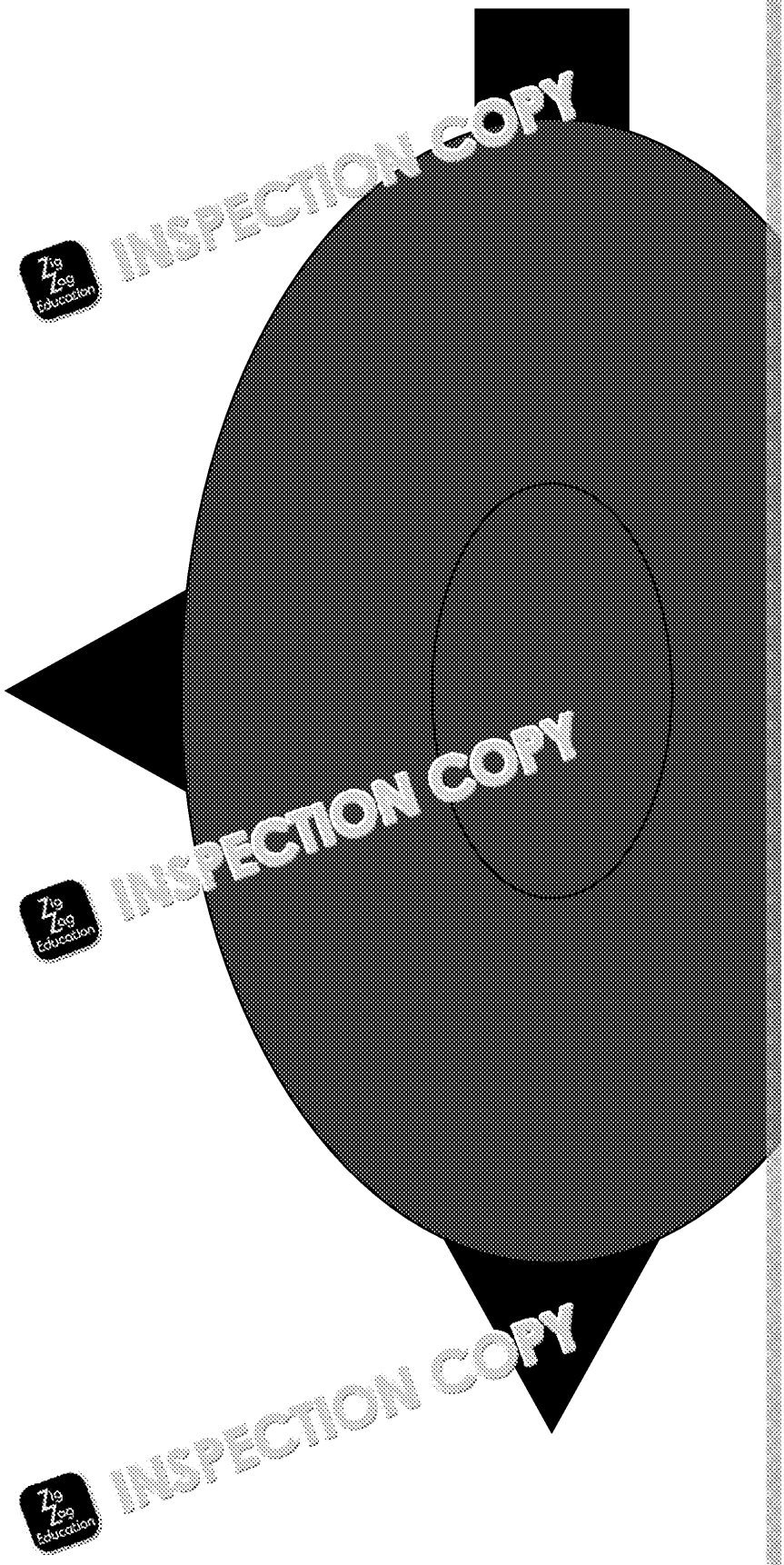
Type AB Blood cells



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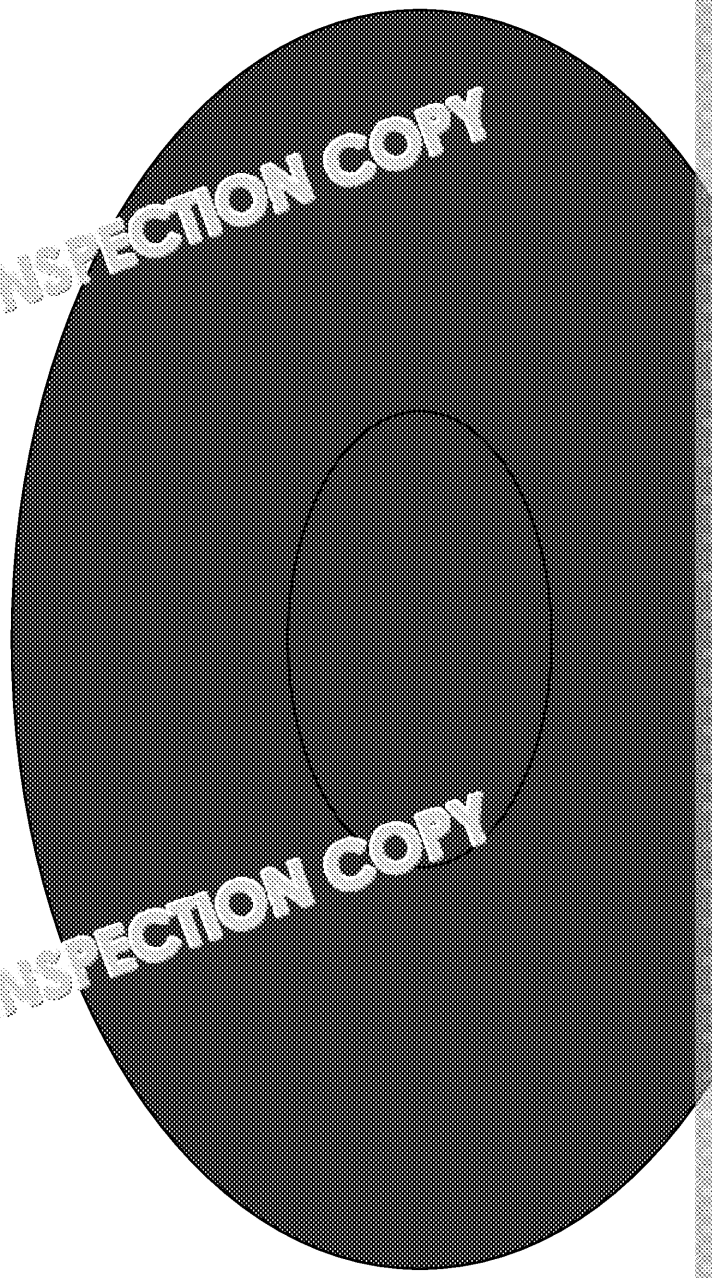
Type O Blood Cells



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DNA Structure & Function (Lesson O

Resources
Protocol for extraction from onion/kiwi if preferred
Stained cheek cell slides
DNA model
Laminated DNA bases, will need treasury tags for linking (**pp.45-46**)

Objectives
Students should le
- About the structure and function of DNA
- How genes code for certain features
- Some blood cells contain nuclei and within that is DNA
- How DNA can be extracted from cells

Key words
precipitation, genes, membrane, nucleus

Overview
1st Lesson – Print out base pair models onto coloured paper – suggest two colour for each base. Copy onto card or laminate. Punch holes in them.

Remind pupils of structure of blood, and that some cells contain nuclei. Re ask what can be found in the nucleus.

Show DNA model. Build a DNA model using the laminated bases A, G, T each pupil a base and ask them to find a suitable partner their base will fit Elicit the base pairings – A with T, C with G.

Split room in half and get each half to link their base pairs to form the 'lad using treasury tags. Stick both up. Show how the order of the pairs in one the order in the other half and perhaps different in length – this is essentia

Small sections of DNA are called genes. Genes can be likened to one line i recipe is unique, as there are over 30,000 instructions.

Cartoon face genes – pupils build a cartoon face using kits available, then sequence for each characteristic. Pupils can swap recipe sheets and build e permits.

2nd Lesson – Show cheek cell slide on video microscope. Pupils may also b swabbing for DNA samples from TV

Explain that DNA can be extracted from any nucleated cell, and as DNA i is extreme evidence in proving guilt/innocence. Elicit other areas establishing paternity.
Explain protocol.

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Apparatus Needed
Per pupil – boiling tube with bung, plastic cup, 10 ml measuring cylinder,
test-tube, tray of ethanol bottles.

Per table – 50 ml salt solution, 25 ml soap solution, cold ethanol (from free
disinfectant to dispose of cups and tubes.

Salt solution:
2 teaspoons salt in 1 litre of wa

Soap soluti
50 ml chea ing up liquid
150 ml water

Each pupil needs 5 ml soap solution and 10 ml salt solution. It is worthwh
DNA out using either a glass rod or pipette and re-suspending it in a little

Health & Safety
Pupils handle their own cups and tubes only. Pupils must rinse out all gla
disinfectant before the end of the lesson and dispose of their own pipettes

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See Your DNA

DNA contains the instructions for making you: How you look, what blood
tendency to get some diseases.

It is found inside the nucleus in just about every sing ll of your body.

In this activity, you'll break open th e membrane and the membrane su
you can see your very own DNA.

Method

1. Swill 10 salt water in your mouth for 30 seconds.
2. Spit the salt solution back into your cup. Transfer this into a boiling tub
   detergent.
3. Put a bung in the tube and *gently* rock it back and forth for 2–3 minutes
4. Open and slightly tilt the tube and pour 5 ml of the chilled ethanol dow
   forms a layer on the top of your soapy solution.
5. Allow tube to stand for 1 minute. DNA will begin to precipitate at the b
   and the soap solution. It will look like strands of cotton wool.
6. Place a thin acrylic or glass rod into the tube.
7. Stir using the rod in one direction to wind the DNA strands onto the ro
   mixing of the ethanol and soapy layers. If you mixed too vigorously, th
   short to wind up, and they may form clumps instead. You can try to sc
8. After you have wrapped as much DNA onto th d s you can, remov
   DNA into a small tube containing the r st f t 95 percent ethanol. Yo
   this solution.

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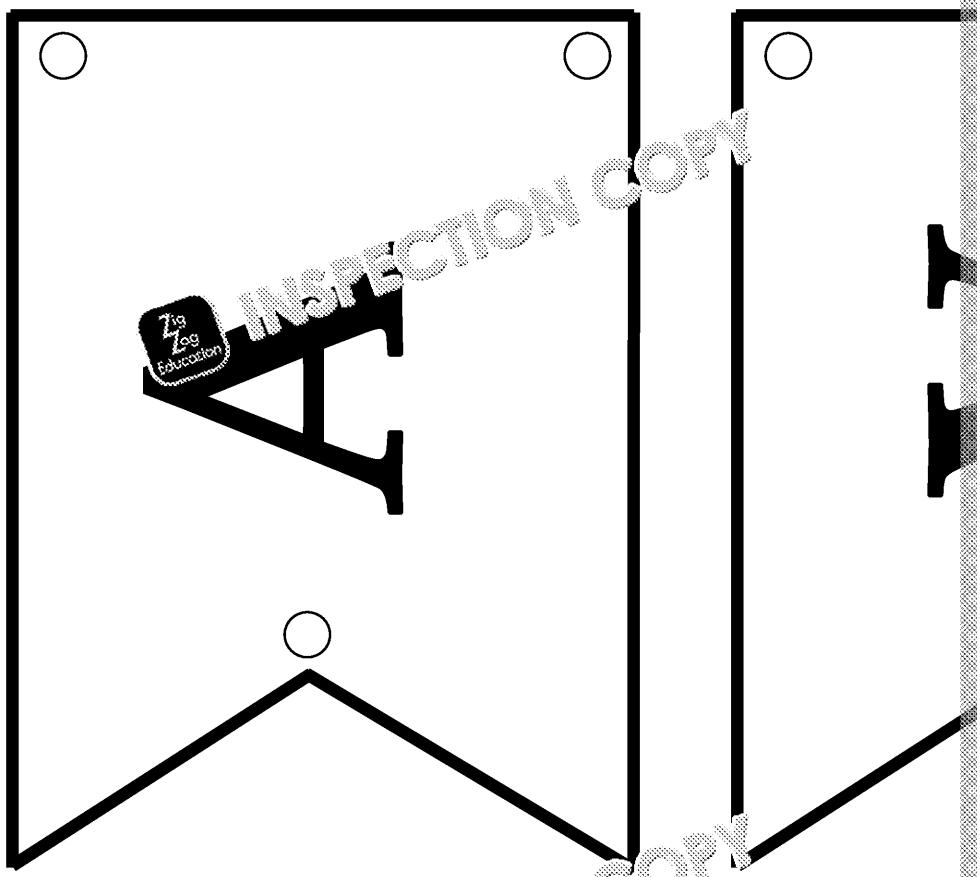
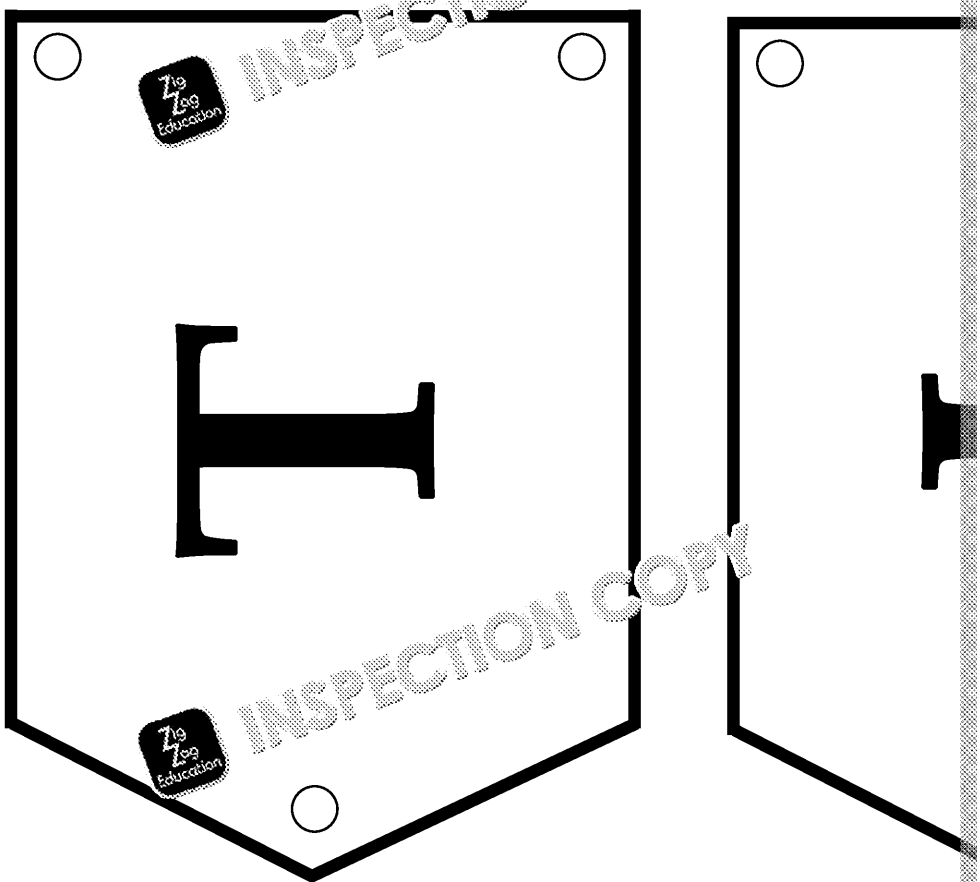
DNA Base Shapes





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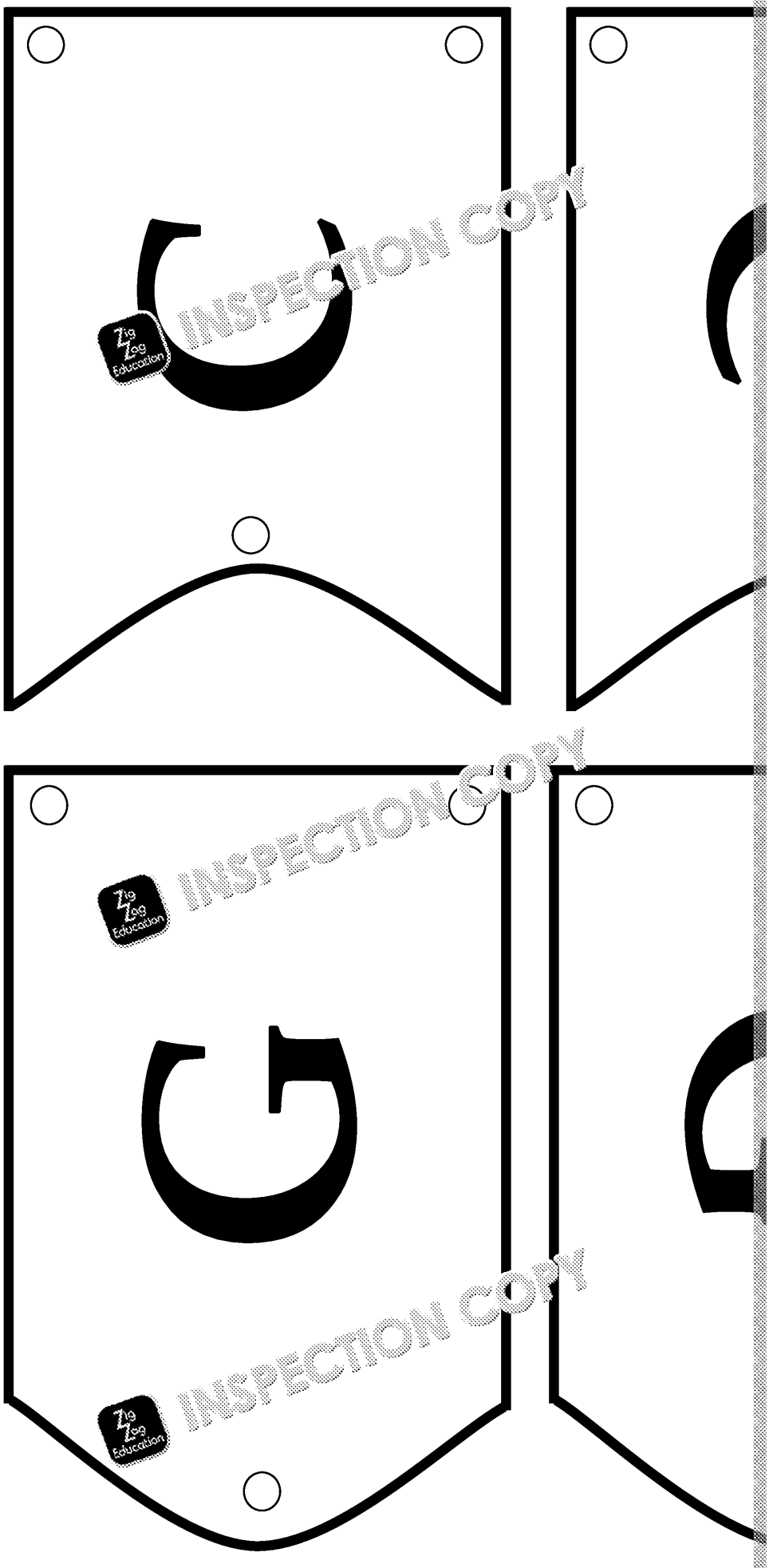

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DNA Fingerprinting (Lesson Over

Resources
Gel electrophoresis worksheet (**download from dnai.org**)
Paternity testing worksheet with questions (**p.48**)
Biology for You, p.292, pupil handout
Animation of DNA fingerprinting on 'Window on Life' CD-ROM

If using pupil worksheet, pupils need access to **www.dnai.org**
IT also needed for interactive crime solving
Animation of DNA fingerprinting at either **http://www.pbs.org/wgbh/nov**
www.biotechnologyonline.gov.au/popups/int_dnaprofiling.cfm

Objectives
Pupils should learn:
- That DNA can be cut, using enzymes, into fragments which are unique
- These fragments can then be separated using electrophoresis giving a 'fi
- How to interpret DNA evidence

Key words
electrophoresis, fragments, restriction enzymes, agarose

Overview
Although humans share a lot of the same DNA, there are certain sites whic high frequency. Once DNA is extracted, it can be 'chopped up' using restri fragments of varying length. These fragments can then be separated on the molecule using electrophoresis on an agarose gel. Radioactive probes are a varying fragments and X-Ray film is developed. The result is a pattern is unique to everyone.

Demonstrate gel electrophoresis or show animation from CD-Rom.

IT access to **www.dnai.org** shows principles of DNA fingerprinting, accor difficult, would need adapting for lower ability.

Then IT access to **www.biotechnologyonline.gov.au/popups/int_dnaprofi**
There are two cases to solve.
If unsuccessful go to homepage, click on resources, human uses and then D
Scroll down until 'Try solving a crime using DNA profiling – interactive'.

Extension/Other ideas
Debate the idea of the DNA database
Provide examples of people freed/convicted for crimes from many years a

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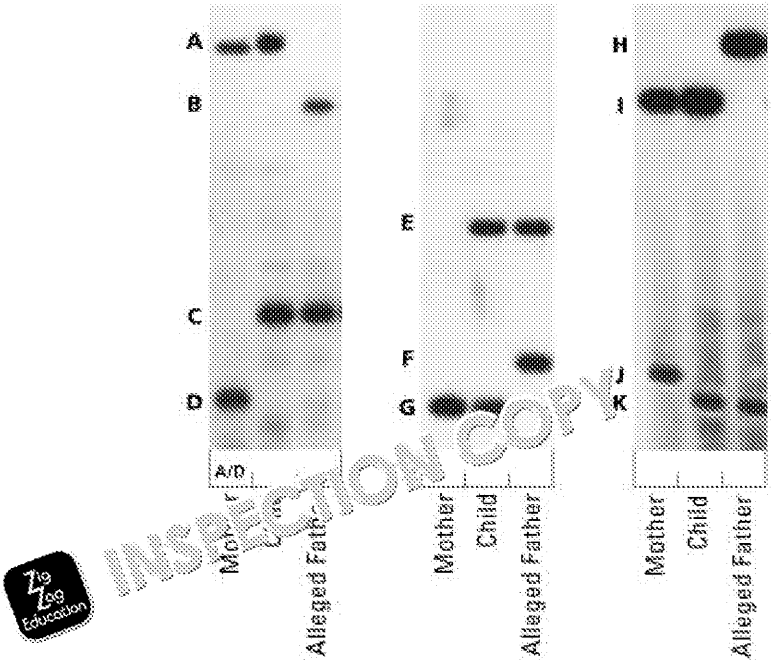
Applications of DNA Fingerprint

Paternity Testing

In this hypothetical paternity case, four autoradiographs show DNA "fing
individuals: a mother, her child, and the child's alleged father.

The two dark bands in each column represent one individual's DNA segm
that individual's biological mother and the other from the biological father
length from person to person. For this reason they are used as genetic mar
designated by a letter A through O.

The two letters associated with each segment indicate the individual's gen



AD	AC	BC

Instructions

1. Under each column in the autoradiograph, write the letters associated w
   For example, the genes of the mother in the first column are A/D. Then
   genotype that represents the gene inherited from the mother. The first
2. Which "letters" must the child have inherited from its father?
3. Is there evidence this is the child's father?

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How does the amount of catalase affect the breakdown of hydrogen perox

The investigation could involve any way of changing the amount of catala peroxide. The easiest source of catalase is potato cell [illegible] students have m of blood, they will need some background on the choice of source.

Pupils may need some help with the method, but should decide on their o take.

Suggested [illegible]me method

Using 10 ml 20% vol Hydrogen peroxide in 6 boiling tubes, vary the amou Pupils may either measure the height of the foam after a certain period of t reaction is complete, or measure the foam at completion of the reaction.

Pupils can work individually or in groups, but must produce their own ta

Tables and graphs must be produced under direct supervision. These shou back in the subsequent ISA.

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Internal Skills Assessment – Forensic

Pupil instructions

Your task is to investigate how the rate at which hydrogen peroxide is bro
amount of catalase present.

You will be using hydrogen peroxide, potato s (as your source of catalase),

Method

1. Measure out 10 [illegible] ydrogen peroxide and put it in a test tube.
2. Using t [illegible] r, cut out a cylinder of potato.
3. Measure the length of the potato chip, and trim it to required length.
4. Insert the potato into the hydrogen peroxide.
5. Measure the amount of foam given off after a set amount of time.
6. Carry out the experiment again using different lengths of potato.

Remember

You must decide:

1. How you will make this a fair test
2. How many different lengths you should try
3. How many repeats you should carry out

Before you start the practical work, you must draw up a table ready to rec

When you have finished

1. Make sure that you have prod [illegible] ar table of results.
2. Select the most appro [illegible] to display the results in the form of a g

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Part 1

These questions refer to your own investigation into the effect of catalase o
should use your own results, your graphs and what you remember about
answer these questions. Answer all questions in the spaces provided.

1. What were you trying to find out in your investigation?

   I was trying to find out if ...

   .....

   .....

   .....

   .....

2. Name one variable that you kept the same

   .....

3. Describe how this variable was controlled

   .....

   .....

   .....

4. In your investigation, which was:

   a) The independent variable .....

   b) The dependent variable .....

5. Describe how you measured your independent variable

   .....

   .....

   .....

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6. If you were to compare your results with others in your class, and all o
same, this would make your results:

More accurate	☐
More reliable	☐
More precise	☐
More valid	☐

7. Put a ci[illegible]ou[illegible]y results that do not seem to fit your pattern. You
table or [illegible]. If there are no anomalous results then say so here.

.....

8. Attach your table of results and your chart or graph to the paper.

9. Look back to question 1 where you wrote down what you were trying t
what you did find out from this experiment.

.....

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Part 2

These questions relate to a different investigation.

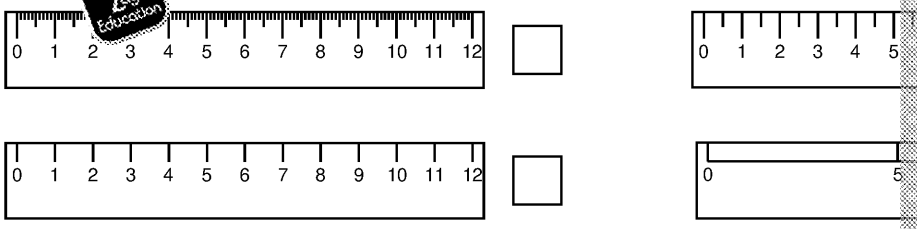
A group of pupils carried out an investigation to see if there was a link be
was released from, and the diameter of the bloodsta

They dropped drops of blood from se s of heights and measured the b
each measurement 3 times for each height. Their results are shown below:

Height (cm)	Diameter of stain (mm)	Diameter of stain (mm)	Diameter (m
10	4	3	2
20	6	4	5
30	7	7	7
40	4	9	8
50	9	11	1
60	11	11	1
70	14	16	1
80	19	16	1
90	20	18	1
100	23	21	1

1. Calculate the average diameter for each height and insert them in the

2. Which of the following rulers should they have used for this investiga



3. What is the range of values obtained for a drop from a height of 40 cm

.....

4. Height and diameter are examples of which type of variable:

Categoric ☐

Continuous ☐

Discrete ☐

Ordered ☐

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5. Which is the best way of representing these results?

Tick the box with the correct answer.

Bar chart ☐

Line graph ☐

Scatter graph ☐

Pie chart ☐

6. The p[illegible]ed later that the ruler used to measure the spatters w[illegible] rather [illegible]cm. What kind of error would this introduce?

Random ☐

Systematic ☐

Zero ☐

7. Write down one thing that would have to be kept the same during th[illegible]

.....

8. There is one anomalous result shown in the table. Draw a ring around

.....

9. If the tes[illegible]va[illegible]d, how should the results be treated?

The be[illegible]of results should be kept and the others discarded

The results of all tests should be averaged to find the mean

The results of all the tests should be added together

The first set of results should be used unless the others are very differ

10. Measuring the diameter in mm rather than cm makes the data more:

Accurate ☐

Precise ☐

Reliable ☐

Continuous ☐

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Mark scheme

Part 1

1. Rate of reaction or amount of foam/oxygen, or rate at which hydrogen peroxide is broken down, or any other suitable dependent variable
   Amount/surface area of catalase, or potato, or other suitable independent variable
2. Amount of peroxide, time left for, temperature of peroxide, type of pot, any suitable control variable
3. Measured with a ruler, all done at room temp etc.
4. a) Amount/surface area of potato/catalase
   b) Amount of foam/gas given off
5. With a ruler
6. More reliable
7. Anomalous results correctly identified or
   Correct statement that there are none
8. All relevant data included
   Columns and rows correctly labelled
   Units present and correct
   Correct choice of bar chart or graph
   Suitable scales chosen and labelled
   All points correctly plotted
9. Correct statement of relationship between independent and dependent variable.

Part 2

1. All averages correctly calculated and inserted into table
   Deduct 1 mark for 2 or more errors
   Answers: 5, 7, 7, 10, 12, 15, 17, 19, 21
2. First ruler (smallest scale)
3. 4–9 cm
4. Continuous
5. Scatter graph
6. Zero
7. Volume of drop, consistency of blood used, any suitable control variable
8. Anomalous result 40 cm height first column identified
9. The results of all tests should be averaged to find the mean
10. Precise.

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