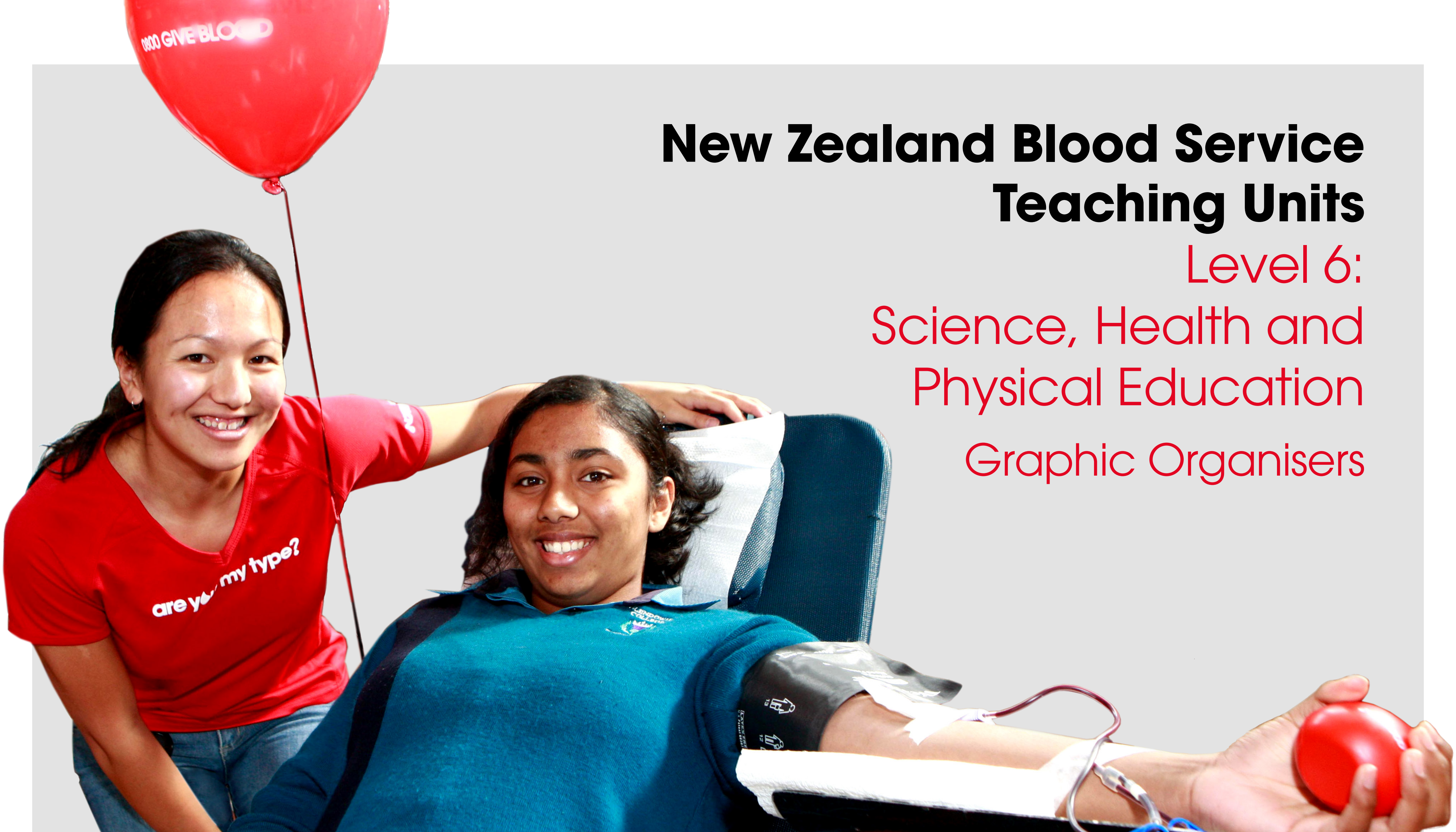


New Zealand Blood Service Teaching Units

Level 6: Science, Health and Physical Education

Graphic Organisers

nzblood.co.nz

NZBLOOD
Te Ratonga Toto O Aotearoa

107I39803

Teacher factsheet 1A

Functions of blood

Blood is a red fluid that has liquid and cellular components. It is pumped around the body in the circulatory system, so that it can meet the body's needs as a transport system for the following:

- oxygen
- nutrients
- waste products – it carries them to the organs that get rid of them
- immune cells (white blood cells) – to fight infection where needed
- blood-clotting materials – to prevent bleeding if blood vessels are cut
- hormones
- heat – flowing liquid helps to maintain a correct body temperature.

The fact that blood is "pumped" around the circulatory system by the heart requires it to adapt to changes in body needs, for example, when exercising, the heart pumps stronger (a larger volume is pumped with each beat) and faster to deliver more blood – and more oxygen – to the muscles.

Teacher factsheet 1B

Examples of blood calculations

For a person weighing 70 kg

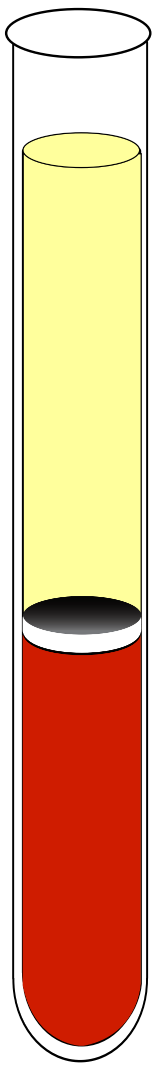
Volume of blood in average* body:	65 mL/kg (females) 70 mL/kg (males)	4a) Blood volume = 65 x 70 kg = 4550 mL = 4.55 L (females) 70 x 70 kg = 5460 mL = 5.46 L (males)
% volume of red blood cells:	40% (F) 45% (M)	4b) Red blood cell volume = 40% x 4.55 L = 1.82 L (females) 45% x 5.46 L = 2.46 L (males)
% volume of plasma:	60% (F) 55% (M)	4c) Plasma volume = 60% x 4.55 L = 2.73 L (females) 55% x 5.46 L = 3.00 L (males)

* average refers to a person with an average normal amount of muscle and fat. Increased body muscle will increase the amount of blood while increased body fat will reduce the amount of blood.

Graphic organiser 1

If a test tube of blood is left to stand for half an hour, it starts to separate into three layers as the denser components sink to the bottom.

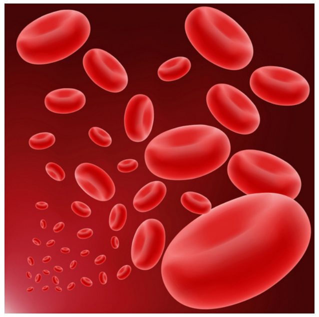
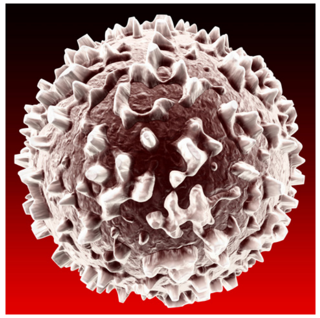
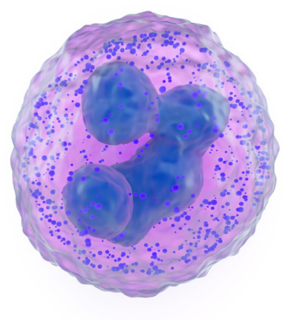
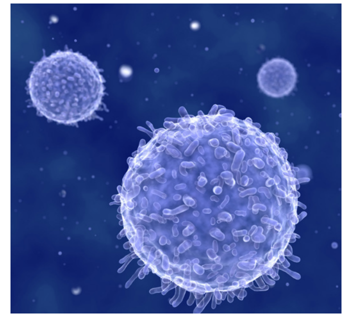
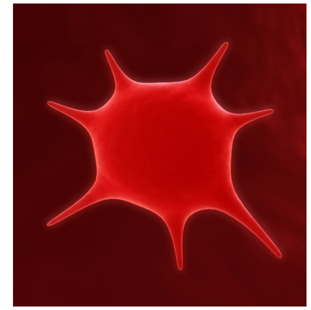
Label the test tube appropriately.



WHITE BLOOD CELLS	This is mainly water and forms about 60% of blood, but it also contains vital substances, such as sugars, fats (carried by special proteins to make them soluble), proteins (antibodies, enzymes, and clotting factors) and hormones that need transporting around the body.
RED BLOOD CELLS	These come in many different shapes and sizes. They form part of the immune system and they each have different functions to play in fighting and preventing infections getting into the body.
PLATELETS	These are flattened disc shaped particles that circulate in blood. When activated, they clump together. They also help to form the beginnings of a blood clot in order to stop bleeding.
PLASMA	These are the most common cells in the blood (4–6 million/L blood). They contain haemoglobin (Hb) molecules, which carry oxygen and also give the cells their red colour.

Graphic organiser 2

This table can be printed, and then the photos and descriptions cut up, so they can be mixed up and then matched correctly. Match the description with the correct cell. Pay attention to the description of the cell shape and nucleus to help you.

				
RED BLOOD CELLS	MACROPHAGES (White Blood Cell)	NEUTROPHILS (White Blood Cell)	LYMPHOCYTES (White Blood Cell)	PLATELETS
They are the most common blood cell. They are disc shaped and flexible so they can pass through very small blood vessels. They have no nucleus. They are packed with a molecule called haemoglobin, which gives them their red colour and allows them to take up, carry, and release oxygen very efficiently.	These cells can migrate out of the blood and into the tissues. They actively change shape and surround foreign bodies, such as bacteria, and "eat them" – a process called PHAGOCYTOSIS. They are usually the first blood cells to mount the defence against infection.	Each cell has an irregular shaped nucleus, which has many lobes to it. Their cytoplasm is "spotty", as it contains granules of enzymes that help to break down invading organisms like bacteria.	Round cells that contain a single, large round nucleus. There are two main types: B cells, which produce antibodies, and T cells, which secrete chemicals to attract other immune cells to the area to fight off infection.	Small fragments of cells. They circulate for about 9 days. If they encounter a damaged blood vessel, they clump together to plug the hole and stimulate the forming of a blood clot.

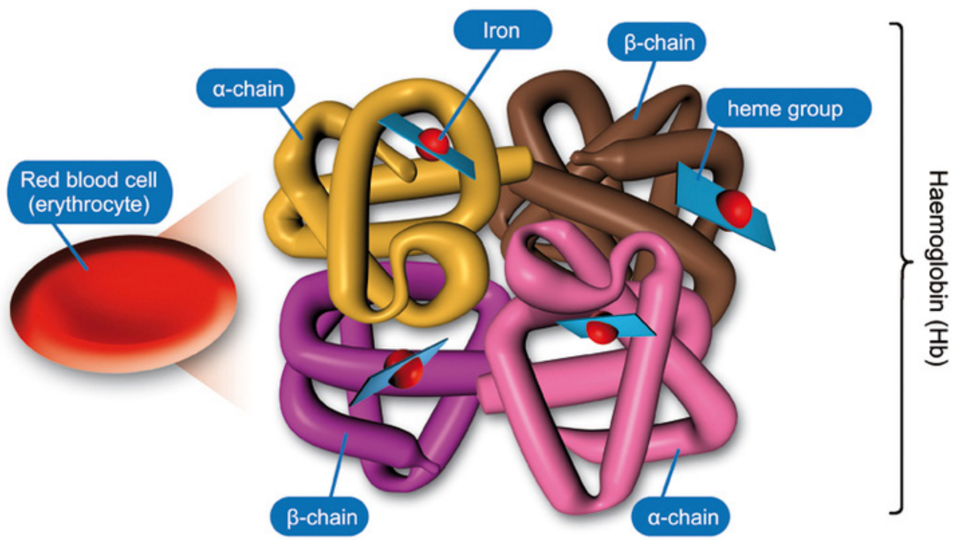
Teacher factsheet 2

Haemoglobin (Hb) is the oxygen-carrying protein found within all red blood cells at very high concentration. It is an efficient carrier of oxygen because of the iron atoms that each Hb molecule contains. This means it picks up oxygen when the oxygen levels are high (for example, in the lungs) and drops off oxygen when the levels are low (for example, when it reaches tissues or organs that are working and need oxygen to be delivered to their cells). When we are at rest, the red cells unload only about 25% of the oxygen carried, but during maximal exercise, the amount unloaded and taken up in the tissues is considerably increased.

Each Hb molecule is made up of four globin chains (globins are proteins) and each globin chain has a Haem molecule attached to it where the iron (Fe) atom sits. It is the Fe atom that attracts and binds the O_2 molecule. As each Hb molecule has four globin chains attached to four haem molecules (each with an Fe atom in the middle), this means that each Hb molecule can carry four molecules of O_2. Oxygenated haemoglobin is bright red in colour, while deoxygenated haemoglobin is a much darker, bluish red. Doctors use this colour difference to look for warning signs that the uptake of oxygen in the lungs is not working normally. Look at the colour of your veins where they are close to the surface on the back of your hand to see the bluish colour. Compare it with the colour of the blood vessels on the inside of your lip or a friend's lower eyelid.

Try and make a Hb molecule using this picture as a guide and see how amazing it is that something so complex can fit into a tiny cell – many times over!

Structure of haemoglobin



Each erythrocyte (RBC) contains ~270 million haemoglobin molecules

You will need:

- 4 strips of long, flexible card in 2 different colours (globin chains)
- 4 square shaped cards (haem molecule)
- 4 small balls (iron atom)
- Sellotape® or Blu Tack®

Can you construct it so that it stays together?

Is the iron atom exposed so that an O_2 molecule could attach?

Graphic organiser 3

Reasons why people I know have had a blood transfusion	**Other possible uses for donated blood** (Use your knowledge of blood and its contents.)	**What blood donated in New Zealand is used for** https://www.nzblood.co.nz/about-blood/what-blood-is-used-for/

Graphic organiser 4

Reason blood product is needed	Name of blood product(s) which may be used https://www.nzblood.co.nz/knowledge-hub/posters-and-brochures/	What part of blood does this product come from? (For example, plasma or red blood cells.)
Surgery (operations)		
Trauma (accidents)		
A person with severe burns		
A person with severe bleeding		
A person with haemophilia (a clotting disorder) who has an injury *(Remember, even a small bleed becomes dangerous if you can't stop the bleeding.)*		
A mother, who is blood group Rh(D) negative, gives birth to a baby who is Rh(D) positive		
A newborn baby who is affected by a blood group antibody from its mother		

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Graphic organiser 5A

DONOR

RECIPIENT

Type	O–	O+	B–	B+	A–	A+	AB–	AB+
AB+	●	●	●	●	●	●	●	●
AB–	●		●		●		●	
A+	●	●			●	●		
A–	●				●			
B+	●	●	●	●				
B–	●		●					
O+	●	●						
O–	●							

Divide into pairs. Take turns and randomly pick up a blood group card. Compare it with your partner's card and use this chart from New Zealand Blood Service to see if your blood groups would be compatible.

- Make sure you understand the terms "donor", "recipient", and "compatible".
- What patterns do you see emerging?
- Which blood type do you think could be the most useful to the Blood Service? Why?

Questions

- Which blood group is the most common in the New Zealand population?
- Is this blood group the most common group in all parts of the world – or does the frequency of blood groups vary between cultures?
- Can blood components (i.e., red cells, fresh frozen plasma, and platelets) be stored for when needed? If so, how, and for how long?

Blood group cards

A +	**B +**	**AB +**	**O +**	**A -**	**B -**	**AB -**	**O -**

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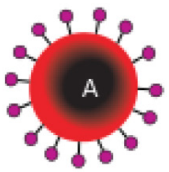
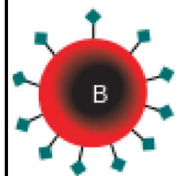
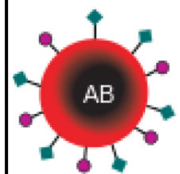
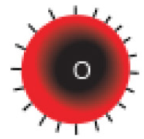
Teacher factsheet 3

For those students who have some prior knowledge of antibody/antigen interaction, or those who need extension, an alternative to the above activity is to ask them to complete their own blood group compatibility table in graphic organiser 5B, using the scaffolding questions and/or the chart below to help them.

	Group A	Group B	Group AB	Group O
Red blood cell				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
A and B antigens in red blood cell	A antigen	B antigen	 A and B antigens	None

Look at this chart and note the **antibodies** and **antigens** that are present on each blood group. The antigens in your red blood cells determine your blood group (see chart).

Remember, the first principle of transfusing blood is that the donor blood must not be destroyed by antibodies that are present in the recipient's blood.

Use these questions and the chart to help you complete your own blood group compatibility chart from graphic organiser 5B.

1. Which ANTIGENS does the DONOR have on their red blood cells? (The antigens determine their blood group, i.e., A antigens = Blood Group A)
2. Which ANTIBODIES could the RECIPIENT have in their blood?
3. Are these ANTIBODIES going to attack the ANTIGENS on the DONOR RED BLOOD CELLS?

If YES ↓ **Blood INCOMPATIBLE**

If NO ↓ **Blood COMPATIBLE**

Play the NOBEL PRIZE GAME and check you can save your patient's life by giving them the correct blood.

https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/

Graphic organiser 5B

DONOR

RECIPIENT

Type	O–	O+	B–	B+	A–	A+	AB–	AB+
AB+								
AB–								
A+								
A–								
B+								
B–								
O+								
O–								

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Graphic organiser 6

Am I eligible to give blood?

Use https://www.nzblood.co.nz/become-a-donor/am-i-eligible/detailed-eligibility-criteria/

Potential donor	**Nurse assessment of eligibilty** *Can this donor give blood – according to NZBS guidelines? Give an explanation.*	**What tests might the Blood Service arrange?**
I have a cold		
I am taking antibiotics		
I have been anaemic and have taken iron tablets		
I smoke		
I have lived in the UK between 1998–2001		
I had an operation a year ago		
I have taken drugs not prescribed by a doctor		
I have haemochromatosis (*A genetic condition that means I absorb too much iron*.)		
I am pregnant		
I have my period		
I have had my ears pierced		
I have tattoos		

Teacher factsheet 4

Facts about iron

- Iron is an essential element that is needed for the body to function, but iron levels need to be maintained carefully. Too much iron and it is deposited in tissues and damages the cells. Too little iron and we become anaemic, tired, pale, and out of breath after exertion, and can experience impairment of mental and physical functioning.
- Iron is found mainly in the blood – in haemoglobin molecules inside red blood cells. It is also found in enzymes that are involved in energy-transforming metabolic pathways. Stores of iron are also found in the liver and bone marrow, where the iron is locked up inside a storage protein called Ferritin. Ferritin is like a hollow ball and each molecule can hold 6000 atoms of iron.
- The main use of iron is to enable the haemoglobin molecule to carry O_2 efficiently and in a way that adapts to the body's needs. It picks up O_2 when O_2 levels are high (for example, in the lungs) and releases it when O_2 levels are low (for example, in active muscles). This is due to the way in which Fe binds to haem and to O_2. Iron is also used in enzymes of metabolism. This type of iron is very important for handling energy. Iron deficiency leads to fatigue but this symptom is quite non-specific. There are many different causes for this symptom.
- Iron is absorbed into our bodies from the food we eat. Some foods contain high amounts of iron, for example, red meat. Haem iron from meat, particularly the red meats, is the most easily absorbed. We can also obtain iron from non-haem iron, such as that found in vegetables (beans, lentils, and broccoli) – but this is less readily absorbed. The body can vary the amount of iron it absorbs from our diet to a certain extent. For example, if a person has lost blood for any reason (including from giving a blood donation), then iron absorption can increase. Vitamin C from foods will also increase the absorption of iron from a meal.
- However, foods containing large amounts of phytates (some cereals and rice) and polyphenols (such as tea and coffee) can inhibit iron absorption. For this reason vegetarians, who will be eating only foods with medium iron content at most, are advised to avoid drinking tea or coffee with meals.
- Iron is lost from the body any time we bleed. Large bleeds mean large iron loss. The body will mobilise its iron stores so that new Hb molecules and red blood cells can be made to compensate. The body will also start to absorb more iron from our food; so it is important to eat high iron foods in these situations. Women who are menstruating have higher iron requirements than men. Small amounts of iron are also lost each day in normal cell replacement in our skin and gut, so we always need to be replacing this iron. In times of rapid growth, such as pregnancy and puberty, more iron is needed because we are making more tissue cells and red blood cells for the new tissues. Care with our diet is required to ensure iron demand is matched with intake, particularly in the case of young females who are also starting to menstruate. At ages 13–16 years, young women need to absorb as much iron each day as a pregnant woman.
- Normally our body can sense when enough iron is present in ferritin stores and will reduce iron absorption. In Haemochromatosis, the cells lining the bowel that absorb foods cannot reduce iron absorption as much as is needed. High iron levels are toxic to cells. This condition is often managed by regular blood donations if blood tests suggest iron levels are too high (if an affected person is eligible to donate blood), or by regular bleeding into a bag and discarding the blood. These people should never take iron supplements. One in seven European people in New Zealand are carriers for this gene (they have one copy of the gene) and one in 300 have a double dose of the gene (one gene inherited from each parent) and are at risk of increased iron absorption. Because there are multiple factors affecting iron absorption, only some people with a double dose of the gene actually develop severe iron overload. Severe problems occur mostly in men and may be apparent in their twenties and thirties. This is because women menstruate, pregnancy results in transfer of a large amount of iron to the foetus, meal sizes are smaller, more women eat lower-iron or vegetarian diets, and men tend to eat larger amounts of meat in proportion. When women are affected, the increased iron stores are apparent much later in life (in their fifties and sixties).

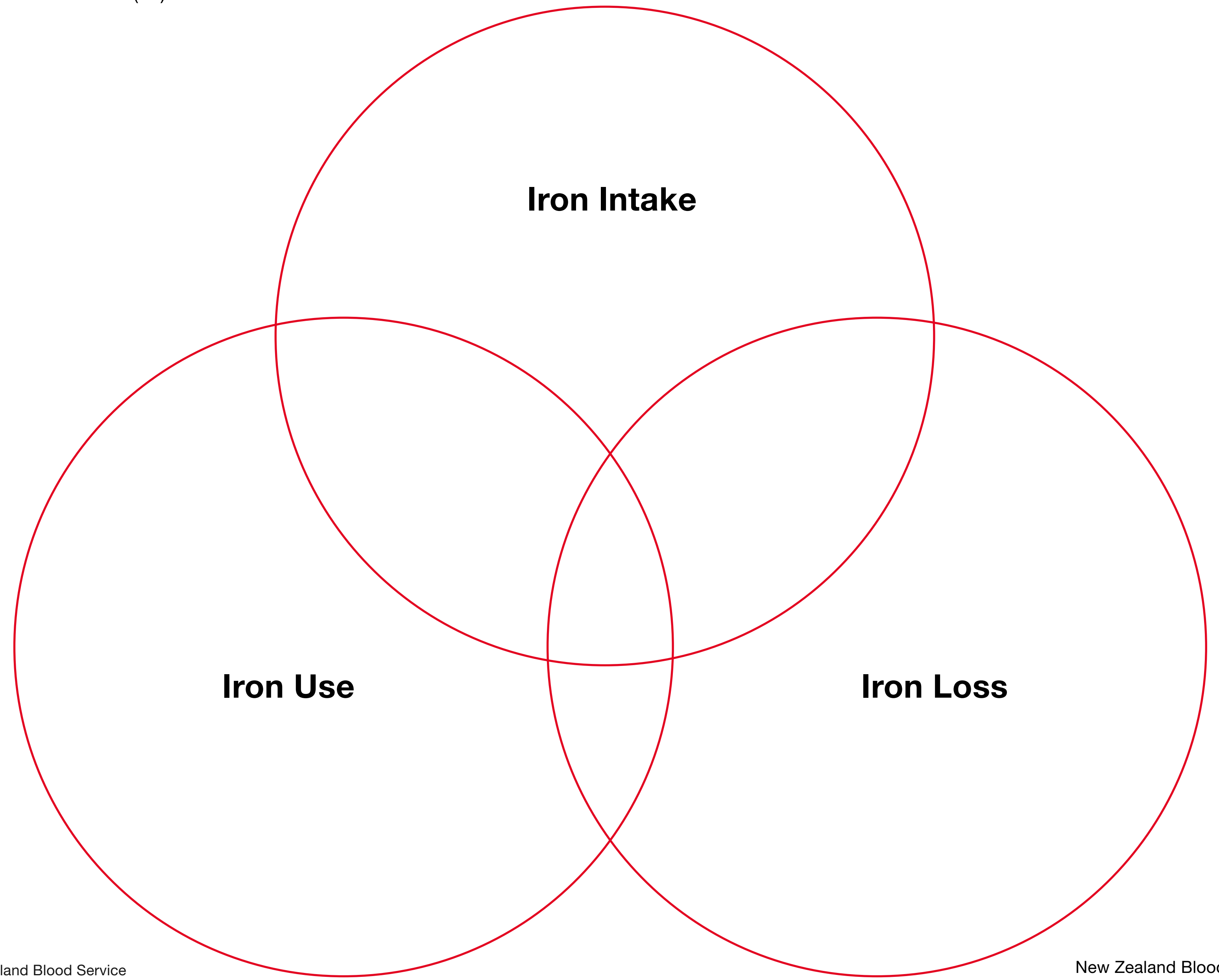
Graphic organiser 7

Website URL				
Date accessed				
Validity				
Is the personal author of the site identified? What are their credentials/qualifications?				
Is contact information provided? (The author should be accountable for her/his work.)				
Does the site allow messages and feedback to be posted?				
When was the site first created and last updated? (A site's longevity is a clue to its stability. A reliable site is frequently revised and improved.)				
Content				
What is the depth and breadth of the information offered?				
Are there links to other useful and reliable sites?				
Does the advertising overpower the content?				
Has the author referenced the sources used?				
Purpose				
What is the major domain of the URL? What might that imply? (**.com** = commercial, **.edu** = education, **.org** = non-profit organisation, **.gov(t)** = government). Is this site trying to persuade you? Educate you? Market a product?				
Are there any **biases** (only showing one side of an argument) being promoted, such as racial, gender, religious, or other types?				

(adapted from https://www.ercsd.org/cms/lib/NY02205564/Centricity/Domain/990/Website_Evaluation_Checklist.pdf*)*

Graphic organiser 8

After reading the "Maintaining Healthy Iron Levels" digital resource from NZ Blood, https://www.nzblood.co.nz/knowledge-hub/digital-resources/ fill in as many factors as you can think of that influence our iron (Fe) levels.



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Teacher answer guide: Graphic organiser 9

The following bar chart illustrates what happens to iron levels in our body if we gradually deplete our iron stores and eventually become anaemic. Notice how levels of iron in Hb and enzymes are maintained until iron stores are completely depleted. It is not until then that we actually become anaemic. Anaemia is the result of insufficient iron to make haemoglobin and red blood cells – they become fewer and smaller in number in iron deficiency anaemia. Increasing iron in our diet by eating more high-iron foods, such as meat, and vitamin C-containing foods, such as fruit and tomatoes, can help to improve our iron stores and may prevent us becoming anaemic.

For the scenarios posed in Section 3 Activity 3.3 (see graphic organiser 9), assume the following:

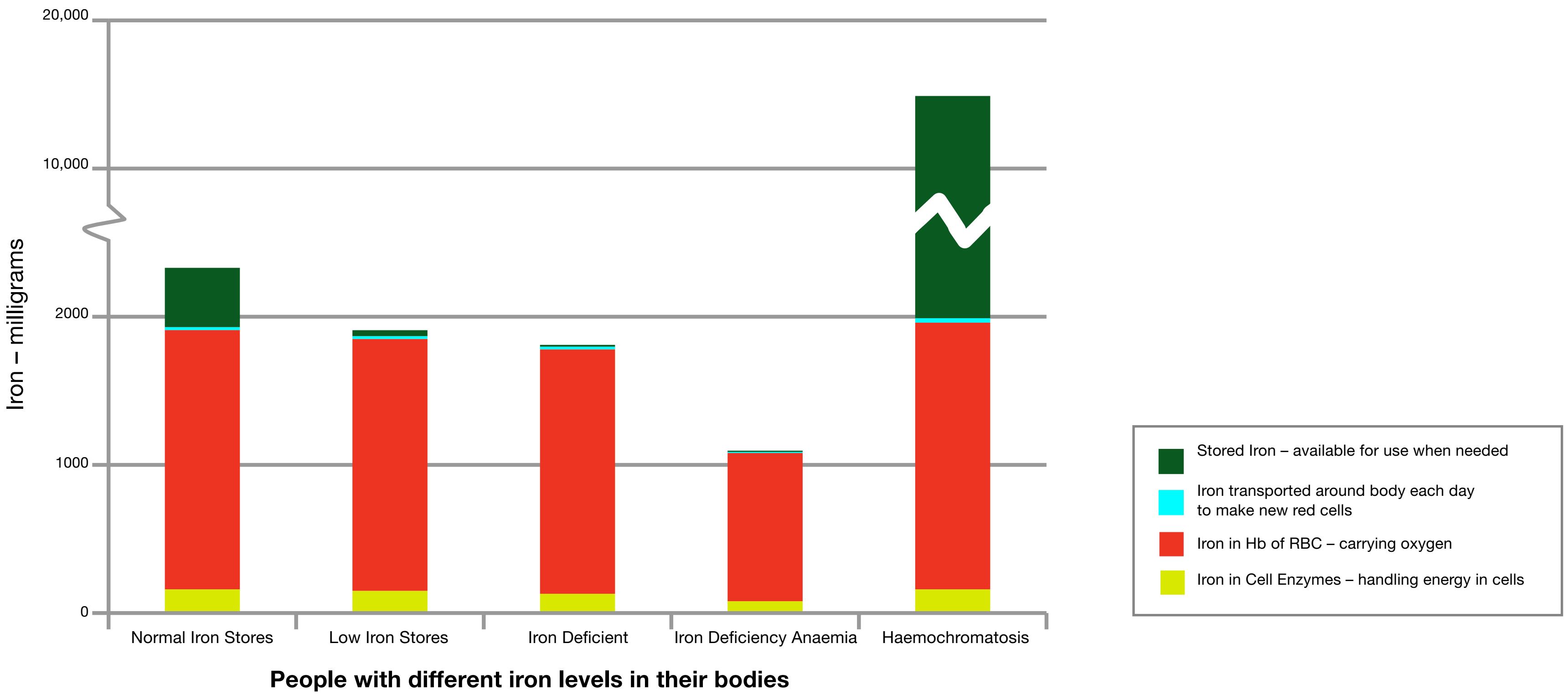
Person (i) = Low iron stores

Person (ii) = Low iron stores or iron deficient

Person (iii) = Iron deficiency anaemia

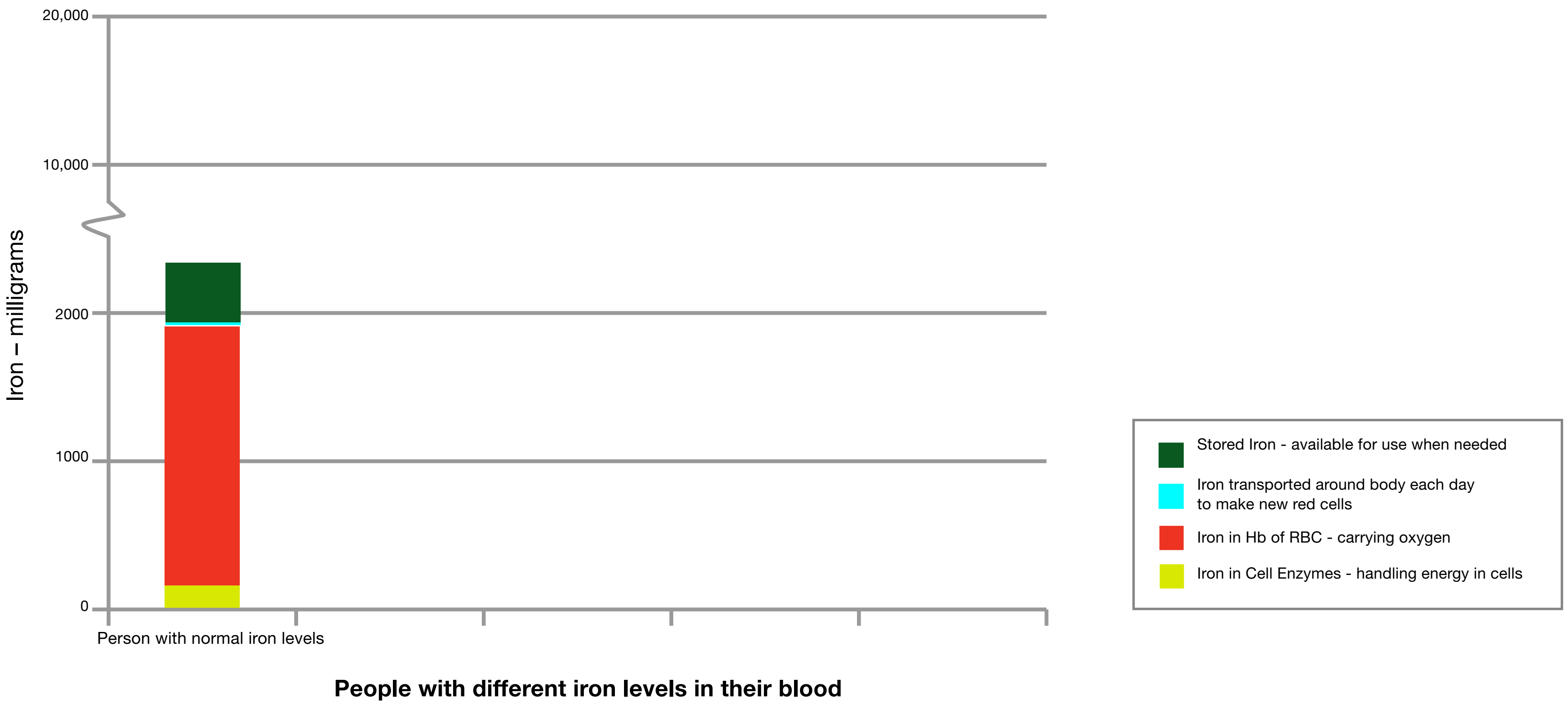
Person (iv) = Haemochromatosis

Observe the students' graphs to see if they make sensible extrapolations from the clinical information they are given to the iron levels of that person, and if they illustrate their interpretations appropriately in a bar chart format similar to that above. Exact replicas not needed.



Graphic organiser 9

Look at the bar chart and key below and see how it illustrates iron levels in a person with normal iron levels.



Add to the bar chart above to illustrate what you think could happen to the different iron levels in the following real-life situations.

- A person with inadequate iron in their diet
- A woman with low iron in her diet who also has frequent, heavy periods; OR a teenager with low iron in his diet who is going through a rapid growth spurt
- The same person in (ii) after 2–3 more months, who may have developed anaemia
- A person who has an untreated genetic condition, which means they absorb too much iron from their food.

Graphic organiser 10

Have you had a blood test performed? Do you know what it was for? One of the most frequent blood tests is the "full blood count". Look back at your work on the components of blood and see what things you think a "full blood count" test might measure.

Considering what a full blood count might measure, can you think of some reasons a doctor might ask for a full blood count?

	Males	Females	Person with iron deficiency anaemia	Person with haemochromatosis (who absorbs too much iron)
Haemoglobin levels	130–170 g/L	120–165 g/L		
Red blood cell count	4.5–6.1 x 10^{12} /L	3.5–5.8 x 10^{12} /L		
Mean cell volume	80–100 fL (femtolitre = 10^{-15} L)			
Mean cell haemoglobin	25–30 pg (pictogram = 10^{-12} g)			
White blood count	4–11 x 10^{9} /L			
Platelet count	150–400 x 10^{9} /L			

Using your knowledge of iron, haemoglobin, and red blood cells, indicate with arrows if you think the normal values given on the left of the table would increase, decrease, or stay the same in each person on the right side of the table.

Graphic organiser 11

Rate the recipe

What recipe did you cook?

What high-iron foods did it contain?

What medium-iron foods did it contain?

What low-iron foods did it contain?

Did it contain any foods that enhance iron absorption? If so, what?

Did it contain any foods that inhibit iron absorption? If so, what?

How would you rate this recipe for:

	Poor	OK	Excellent
Taste			
Cost/Value for money			
Easy to cook			

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