
DIABETES AND YOU

One cell or lots of cells

A unicellular (single celled) organism is able to obtain necessary nutrients from its surrounds directly and is able to get rid of any waste products also directly to its surrounds. With multicellular (or many-celled) organisms, these basic functions of a cell (requirement of nutrients, disposal of wastes) don't change, however the environment around them is quite different. Cells within a multicellular organism now have other cells immediately neighbouring them, and this poses problems in terms of access to nutrients and disposal of wastes.

Glucose is a nutrient that can be readily used by cells as a "fuel" - a source of energy to drive the other processes and functions of the cell. With a single cell, glucose is transported across the cell membrane and into the cytoplasm. A multicellular organism still has this need, but the challenge is being able to get the glucose there. A single cell does not have control over the availability of glucose (or other nutrients) it is at the mercy of the surrounding environment. A multicellular organism has the opportunity to provide a more stable supply of glucose.

Differences between unicellular and multicellular organisms

Refer to the diagrams on the following page, showing a unicellular organism (a *Paramecium*), and a multicellular organism (the human body). Use these diagrams as a guide to make the following comparisons between unicellular and multicellular organisms in the way they perform different processes necessary for life.

PROCESS	UNICELLULAR	MULTICELLULAR
Obtaining nutrients		
Disposal of wastes		
Transport of nutrients		
Reproduction		
Control		
Obtaining oxygen		

- What conclusion can you make?

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One cell or lots of cells

Diagram 1: Paramecium

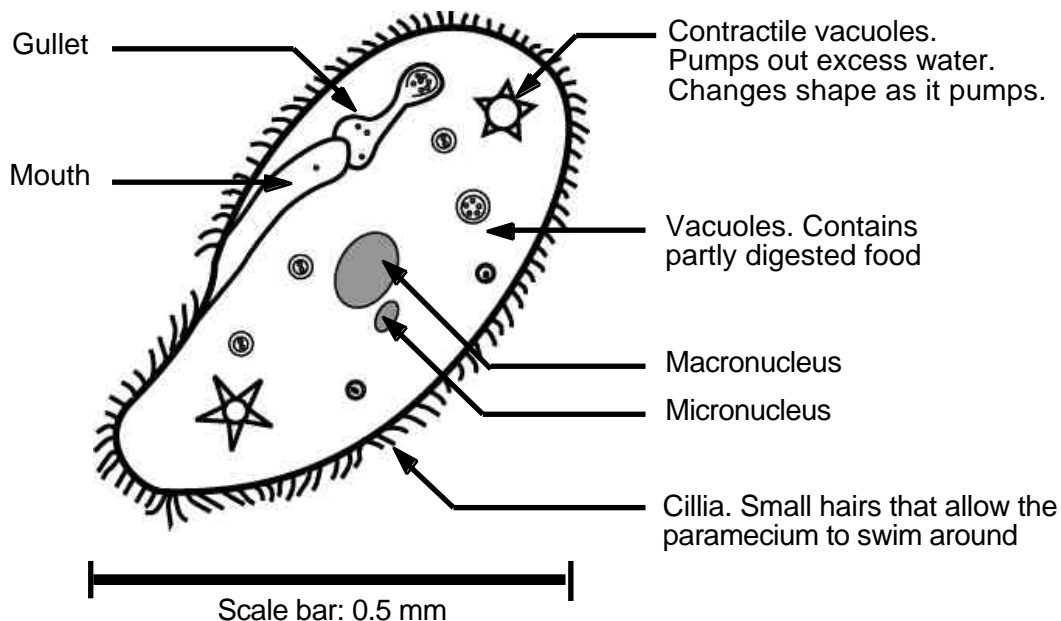
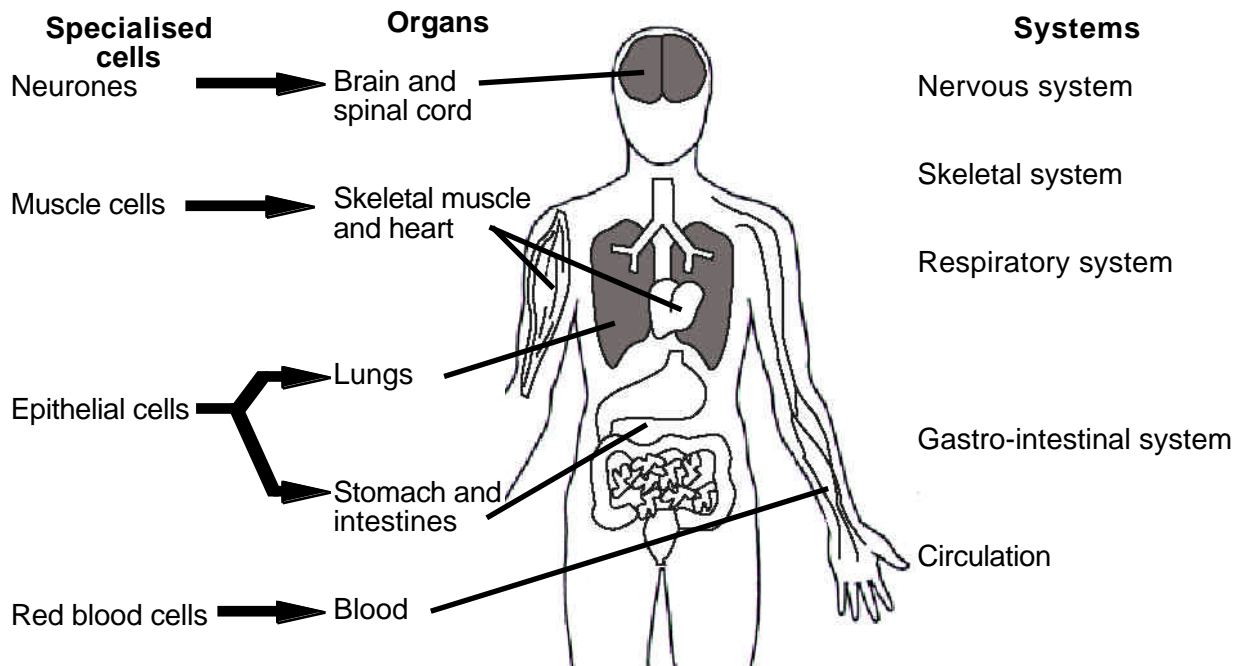
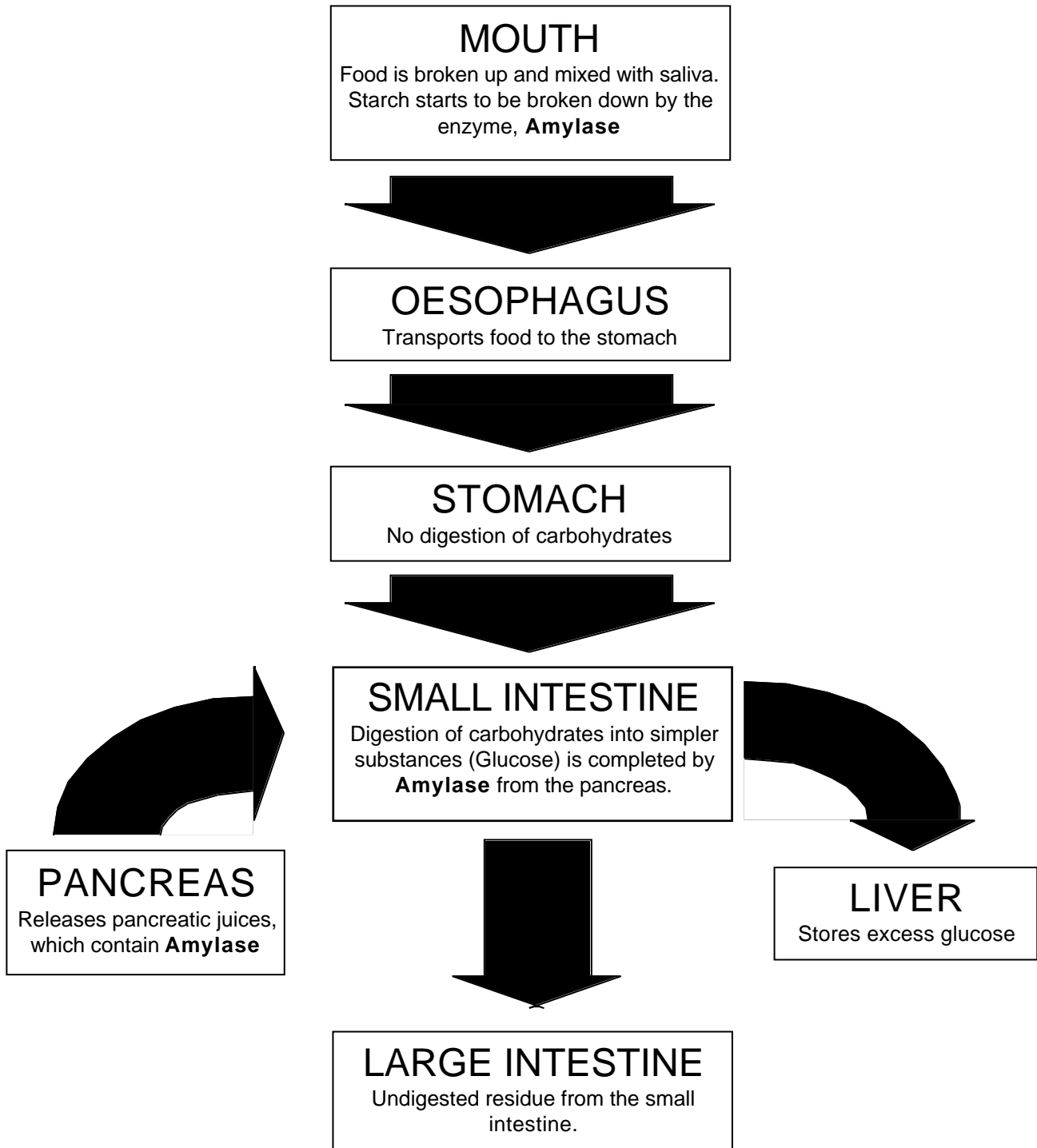


Diagram 2: The Human Body



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Absorption of glucose in the digestive system



Activity: One cell or lots of cells

Teacher notes and suggestions

- Read the passage on unicellular and multicellular organisms.
- Briefly discuss diagrams of a *single cell* and the *human body*.
- Complete table (in groups). Have additional texts available if students need help.

Discuss answers as a class.

Formulate conclusion: That the systems in a multicellular organism serve the needs of individual cells in the body.

Activity: Absorption of glucose in the digestive system

Teacher notes and suggestions

Resources needed:

Pictures of the digestive and circulatory systems, books/handouts detailing the digestive and circulatory systems.

Through a class discussion, list the systems and their function.

Circle the digestive and circulatory systems and tell the students that you or the class will be concentrating on these two for this activity.

Formulate another list of nutrients humans need and why.

On over heads, posters or handouts show diagrams of the digestive and circulatory systems.

Ask students (in groups) to trace the path of absorption of glucose in the digestive system- from eating to storage in the liver. They should record it as a table or flow chart and include the following:

- Part of the digestive systems involved
- Any changes that occur
- Any enzymes involved.

Revise why we need glucose. In particular, emphasise that the brain relies on glucose as it's sole source of energy. Other tissues are able to use other sources of energy, for example muscles are able to use fats as an energy source.

Ask students to suggest how the glucose is distributed around the body (ie. the circulatory system).

Look at the diagram of the circulatory system and ask students to suggest the pathway of glucose from the liver to another part of the body (eg. the brain).

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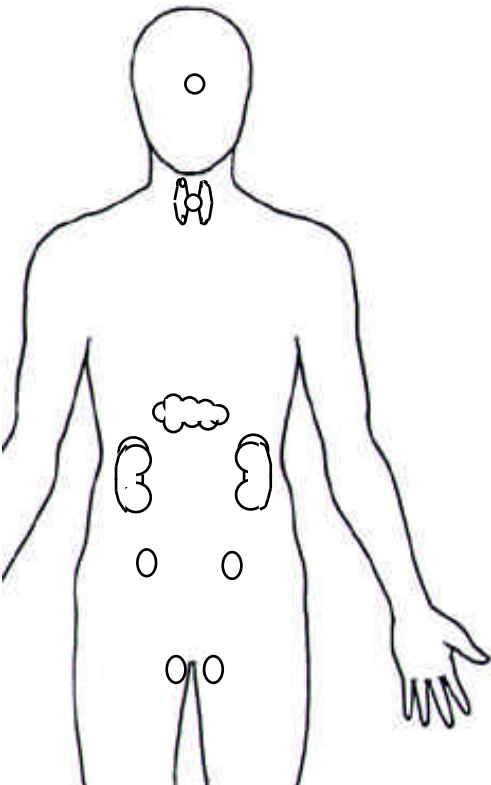
Keeping glucose on the straight and narrow

Homeostasis

The ability of a living thing to maintain a stable internal environment is called **homeostasis**. You can think of it as an internal 'climate control system' for the body. Homeostasis is maintained within the body by a number of processes that rely upon an interaction between the **nervous** and **endocrine systems**. The nervous system describes the network of interconnected nerve cells that coordinate activity within the body. The endocrine system is composed of a number of **glands** that produce chemicals or **hormones** that regulate activity via the blood stream. The two systems operate together to achieve homeostasis within the body. The link between these two systems is the **hypothalamus** located at the base of the brain which acts as the "gateway" between the brain and the master endocrine gland called the **pituitary gland** located directly beneath it.

The endocrine glands

Draw a line linking the name of each endocrine gland with its location in the body.



Name of Gland

Hormone secreted

A. Pituitary

B. Ovaries (female)

C. Thyroid

D. Pancreas

E. Parathyroid

F. Testes (male)

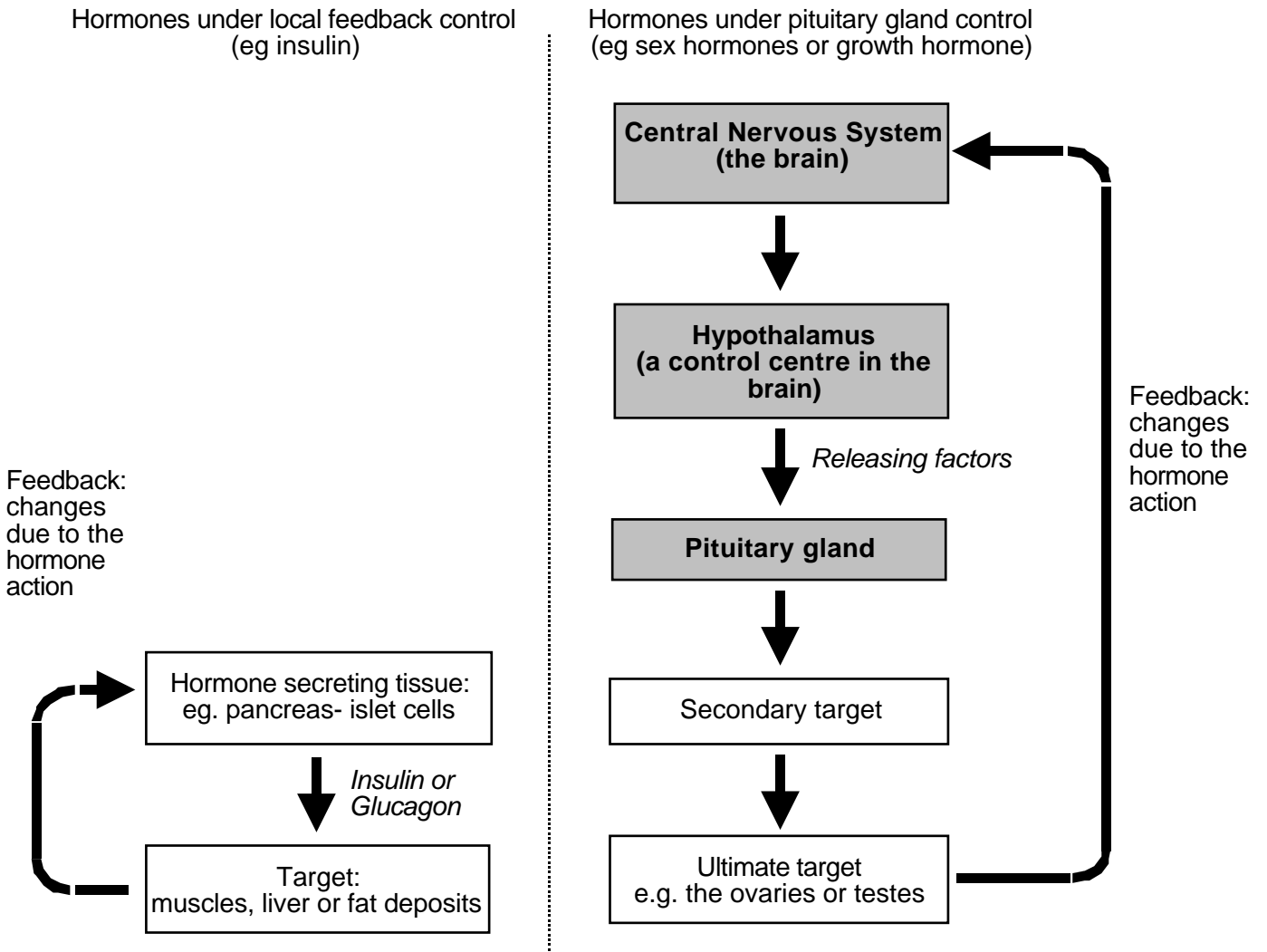
G. Adrenal

DIABETES AND YOU

Keeping glucose on the straight and narrow

Control of hormones

All hormone actions are controlled by a combination of hormone secreting tissues (or **glands**) and what is known as **feedback loops**. These feedback loops are necessary to inform the hormone secreting tissues how well the hormone is doing its action. This means the hormone secreting tissue doesn't keep producing the hormone when it isn't needed. There are two types of feedback loop, and the one used depends on whether the hormone comes under the control of the Pituitary gland, or whether the hormone is controlled locally by the hormone secreting tissue or gland. Glucose is controlled by a **local feedback loop**, meaning the absorption of glucose is managed by the **Islet cells** in the **pancreas**.



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Keeping glucose on the straight and narrow

The endocrine system

Gland	Function of the hormones
Pituitary	Has a major function in the control of growth, via growth hormone Secretes hormones that control the other glands
Adrenal	Assists the body in dealing with emergencies, via adrenaline Regulation of salts and water levels in the blood Assists in the development of sexual characteristics
Parathyroid	Regulates the use of calcium and phosphates within the body
Thyroid	Important in controlling the use of energy by the body (metabolism) Influences the development and growth of the body
Pancreas- Islets of Langerhans	Regulates the use and storage of sugars in the body via insulin and glucagon
Ovaries (female)	Controls the development of adult female sex characteristics Controls the formation of mature eggs
Testes (male)	Controls the development of adult male sex characteristics Controls the formation of sperm

Use the information in the table above to complete each of the following statements.

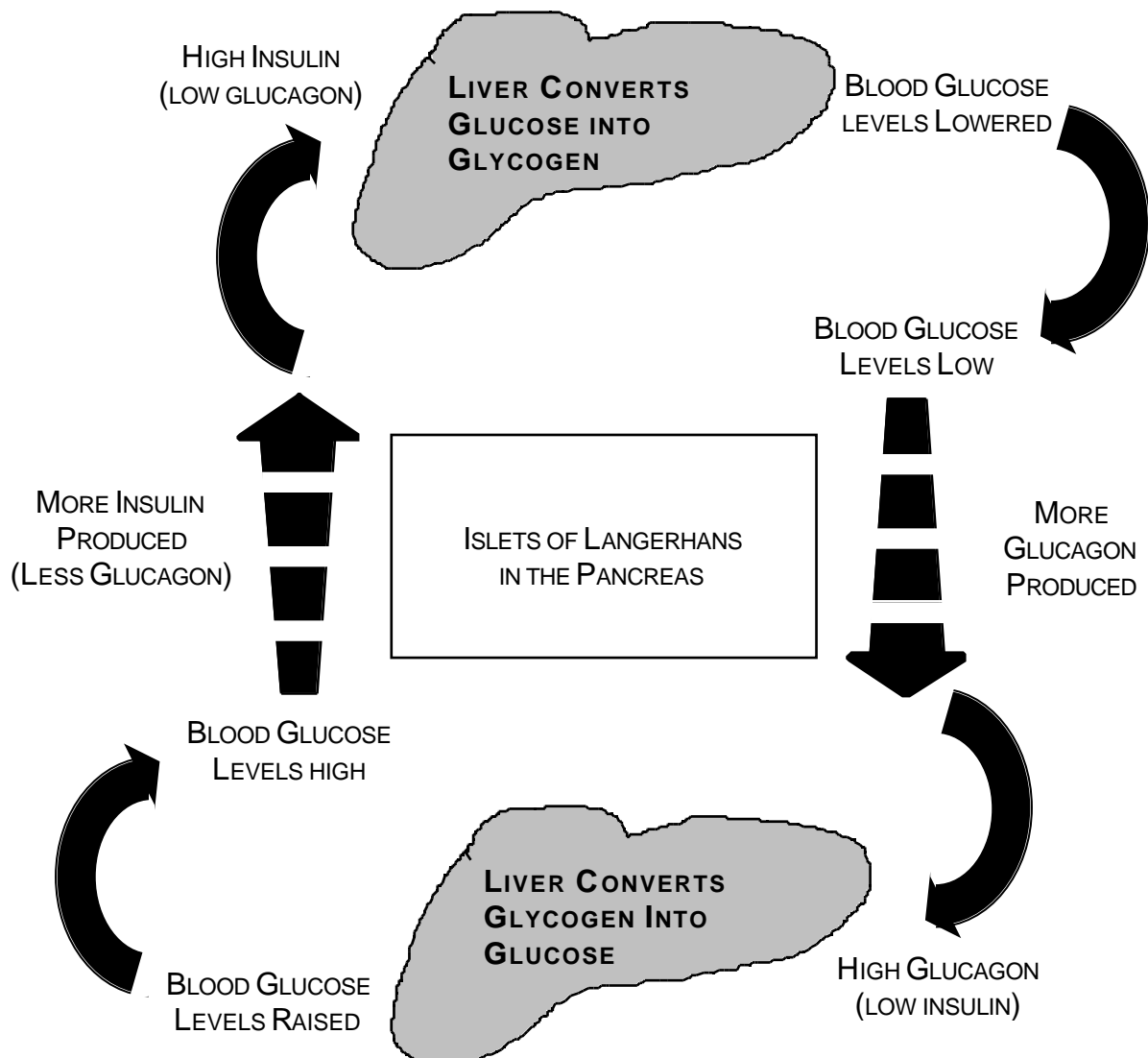
1. The hormone _____ is released from the _____ gland when the body is faced with a fright or an emergency and helps the body in dealing with the situation.
2. The sex hormones secreted from the _____ influence the development of adult sex characteristics of young women.
3. The levels of calcium and phosphate in the blood and their use by the body is controlled by secretions from the _____ gland.
4. The some endocrine glands of the body are under the control of the _____ gland.
5. Insulin and glucagon secreted from the _____ regulate glucose levels in the blood.
6. The development of sex characteristics in young men is influenced by hormones from the _____.
7. Hormones from the _____ gland control the rate of energy use by the body (metabolism).

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Keeping glucose on the straight and narrow

Control of blood sugar in the body

The **local feedback mechanism** which is involved in the control of blood glucose levels, requires the interaction of two hormones and the detection of the levels of glucose in the blood by the Islets of Langerhans in the pancreas. These hormone systems interact by two feedback loops working together to control blood sugar. This is demonstrated in the diagram below.



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Keeping glucose on the straight and narrow - Revision

1. What is homeostasis?

2. Why is homeostasis important to the body?

3. Draw a general diagram to illustrate a feedback system that could be used to describe any homeostatic feedback loop.

4. Why is the regulation of blood sugar important?

Activity: Keeping glucose on the straight and narrow

Teachers notes and suggestions

Resources needed: books/ handouts on the endocrine system.

- Discuss what a hormone is and complete sheets on the endocrine system.
- Explain that *homeostasis* as a process that maintains internal stability (balance). Brainstorm what needs to be kept in balance in the body. eg. temperature, water, glucose etc.
- Explain why it is important that glucose is regulated. Highlight how glucose is the only fuel that the brain is able to utilise. If there is insufficient glucose available for the brain, then the brain can have difficulty in functioning and may go into a coma due to this stress.
- Allow students a few minutes to think about how insulin helps to balance the glucose levels in the body. The following are some points that could assist them

Insulin is produced in the *islets of Langerhans* found in the Pancreas.

More insulin is produced when blood glucose levels are high.

Less insulin is produced when blood levels of glucose are low.

The liver can convert glucose into glycogen and vice- versa.

Glucose is stored as glycogen when it is not needed.

The circulatory system transports glucose around the body.

The circulatory system transports the hormones insulin and glucagon around the body to the target organs of the liver and muscle.

- Students can represent their thoughts as a flow diagram.
- Students then discuss their ideas in groups and present them on paper to be put around the room.
- Through questioning elicit the idea of a feedback model. Draw this progressively on the board.
- Discuss the idea of negative feedback. In the case of glucose regulation, an increase in the amount of glucose sets into motion processes that decrease it. Conversely a decrease in glucose levels sets into motion processes which increase it. In other words, a change in the glucose content in the blood automatically brings about the opposite effect. In both cases the result is that the level of glucose is kept reasonably constant.
- It may be useful to use the analogy of a thermostat and how it regulates the temperature in a room by providing 'feedback' about what the temperature is in the room. If the temperature is too hot (above a set point) then, say the airconditioning system will turn on to cool the room down. Once the room temperature has returned to below the set temperature, the airconditioning turns off again.

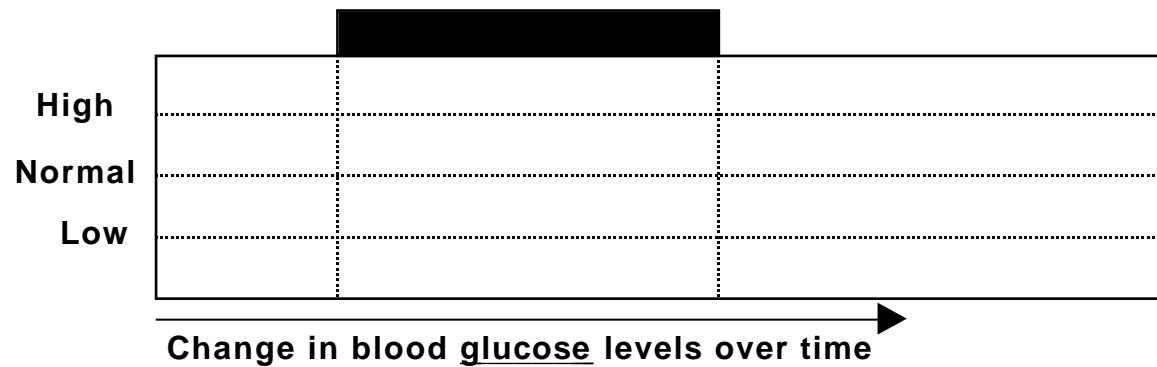
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How systems interact

To see how the levels of glucose in the blood are maintained in response to the normal daily activities of the body, we need to look at two different situations.

The first is the response to having something to eat. Most foods contain carbohydrates of some kind, which are broken down to simple sugars like glucose. On the graphs below, plot the changes in glucose and insulin levels you would expect to see in the blood of someone who has just eaten breakfast.

If you need to, refer back to the diagram showing the feedback loop for the control of glucose.

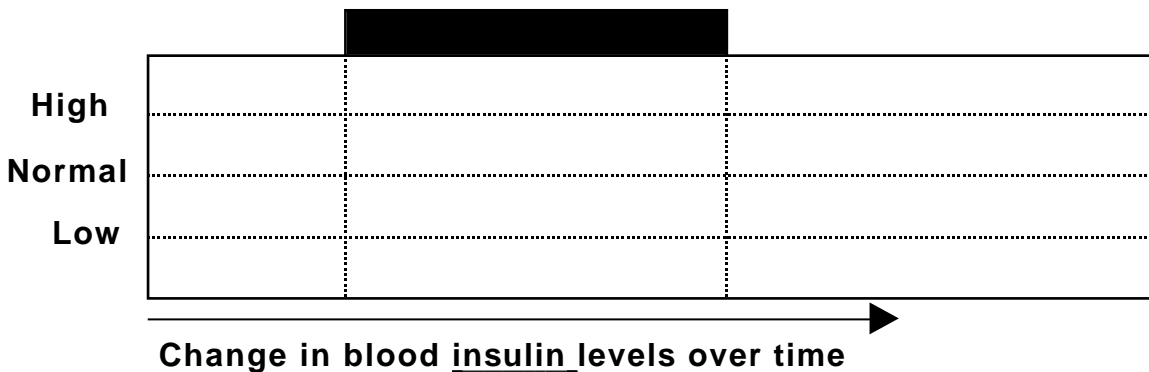
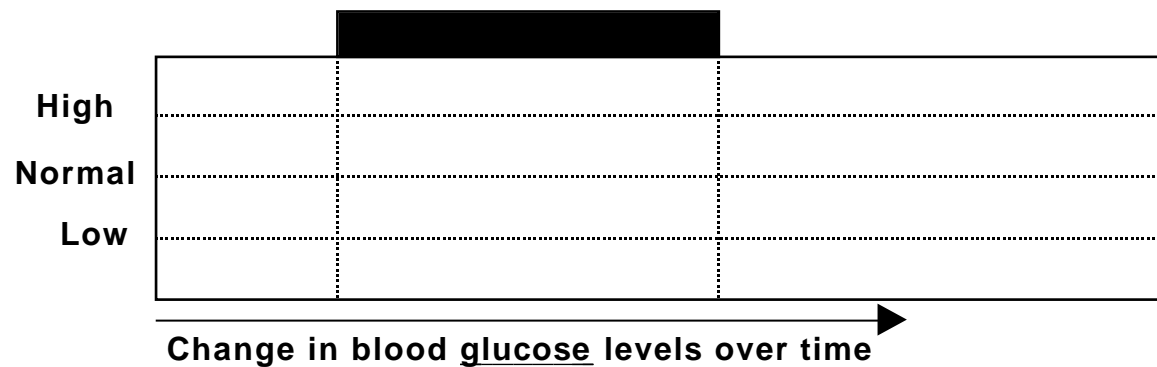


- What would happen to glucose levels if there were no insulin released in response to eating some food?

DIABETES AND YOU

How systems interact

The second example is the response to exercise. Exercise requires energy, and one source of energy is glucose. Glucose that is in the blood will be used first, but is unlikely to be enough except for the shortest of exercise (less than a minute). Glucose that is normally stored in the liver and muscles as glycogen, is able to be released to maintain the level of glucose in the blood. On the graphs below, plot the changes in glucose and insulin levels in the blood that you expect in response to exercise.



- What would happen to blood glucose levels if there was no way of releasing stored glucose into the blood when needed, as in the case of exercising?

Activity: How systems interact

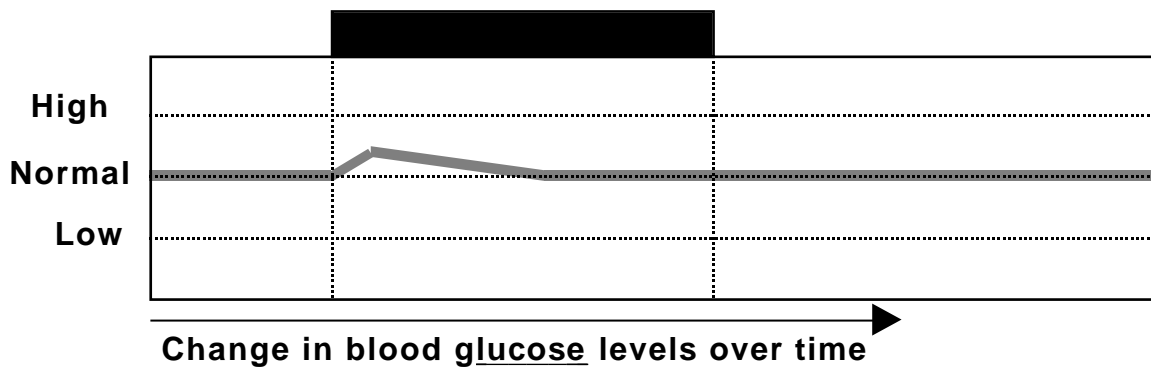
Teachers notes and suggestions

Resources needed: texts about body systems, and exercise.

- To explore the idea of systems interacting together use the examples of eating a meal and exercising.
- Ask students (in groups) to design an experiment which investigates what happens to blood glucose levels, insulin levels and glucagon levels during each of the two testing situations. Tell each group that they are able to measure each of these substances from a blood sample. For the purposes of this exercise it is not necessary for them to consider or understand how this might be done, just that it is possible. Things they might need to consider include the following:
 - exercise time and what type of exercise
 - how much and what food to eat
 - how many trials, how many subjects
 - Before and after measurements
- Groups present their design to the class, providing an opportunity for the class to discuss the proposed experiment and suggest modifications if necessary.
- Students return to their groups and consider, in light of what they know about glucose regulation, what they expect to happen during exercise and eating a meal. Give them about 30 minutes to “mind-map” what happens in the body during exercise and eating a meal. Include the systems such as circulatory, respiratory, nervous and endocrine.
- The main idea of this activity is that students develop an understanding of how the different systems of the body work together.
- Stick the mind maps around the room and develop a class “mind-map” up on the board. (See sample following)
- As an alternative for lower ability students, cut out the pieces for the “mind-map” and have them arrange them.
- Individually, they then complete the activity sheets where they plot out the expected changes in glucose levels and insulin levels.
- Ask what problems could occur if the pancreas did not function properly. (Revisit feedback model and mind-map). State when there is a malfunction in producing insulin it is a disease called diabetes.

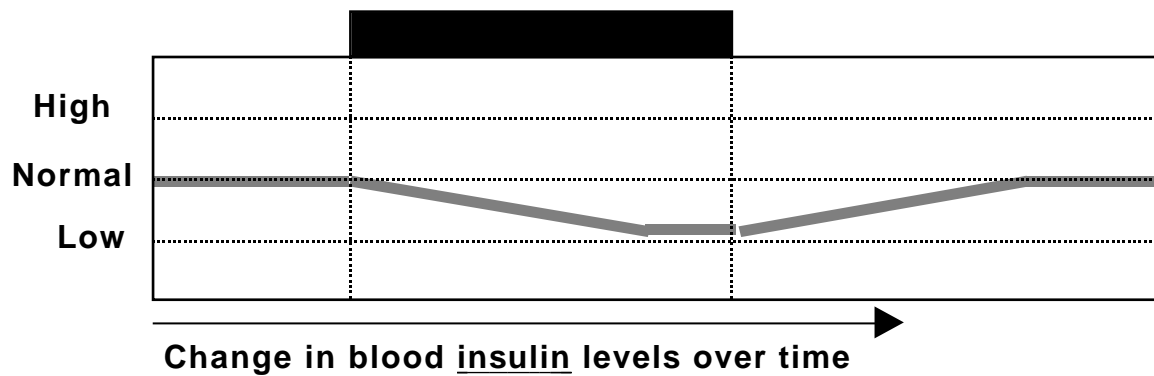
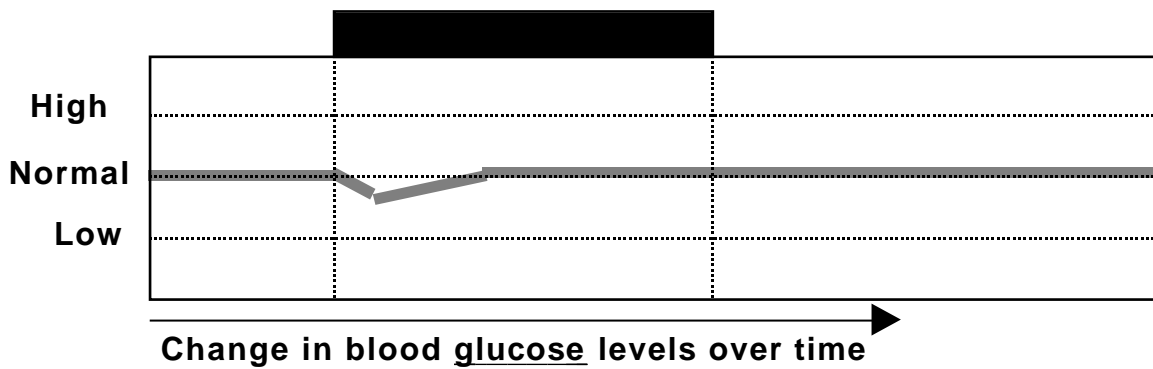
Activity: How systems interact
Teachers notes and suggestions

Response to eating a meal



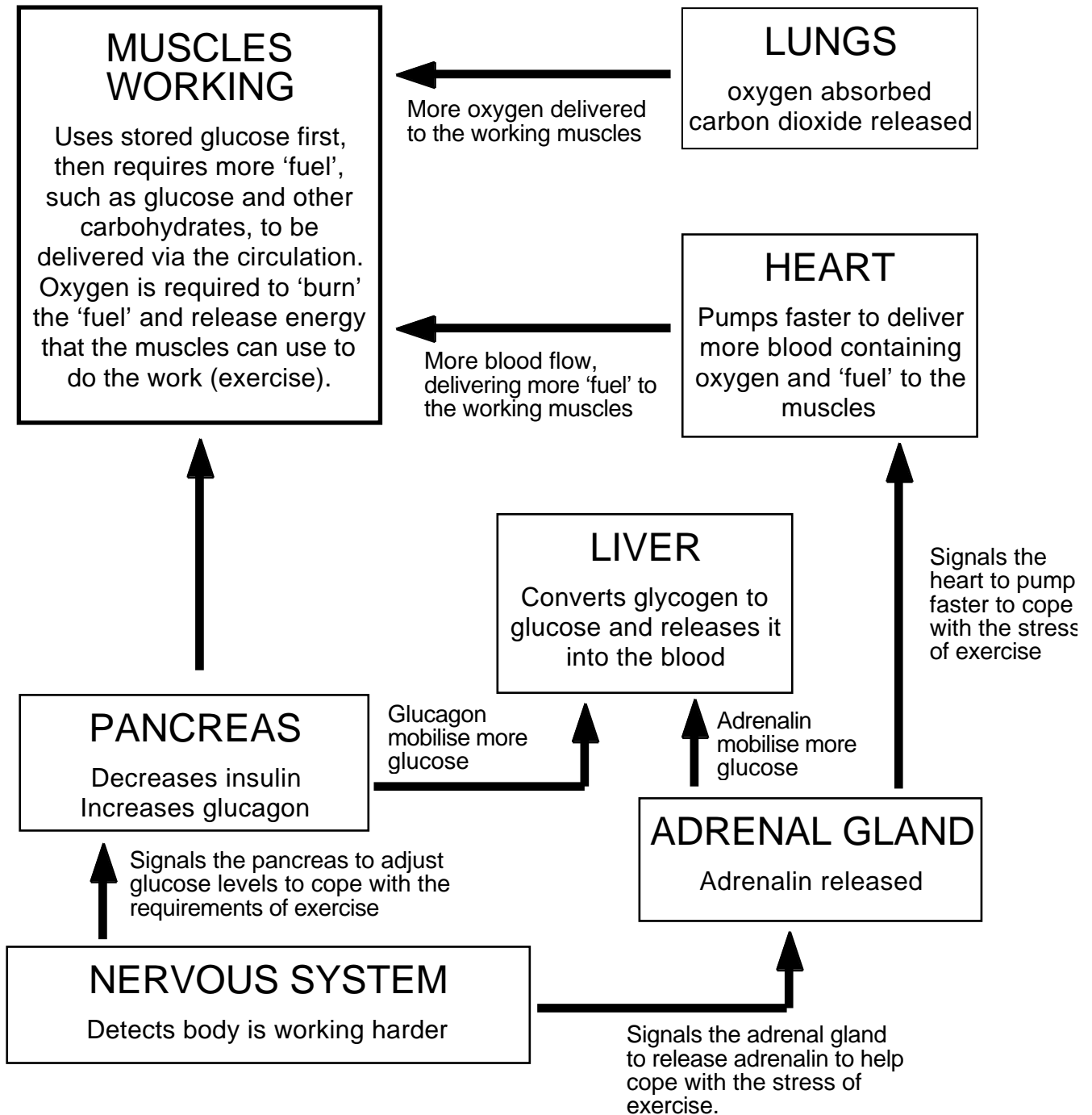
Activity: How systems interact
Teachers notes and suggestions

Response to exercising



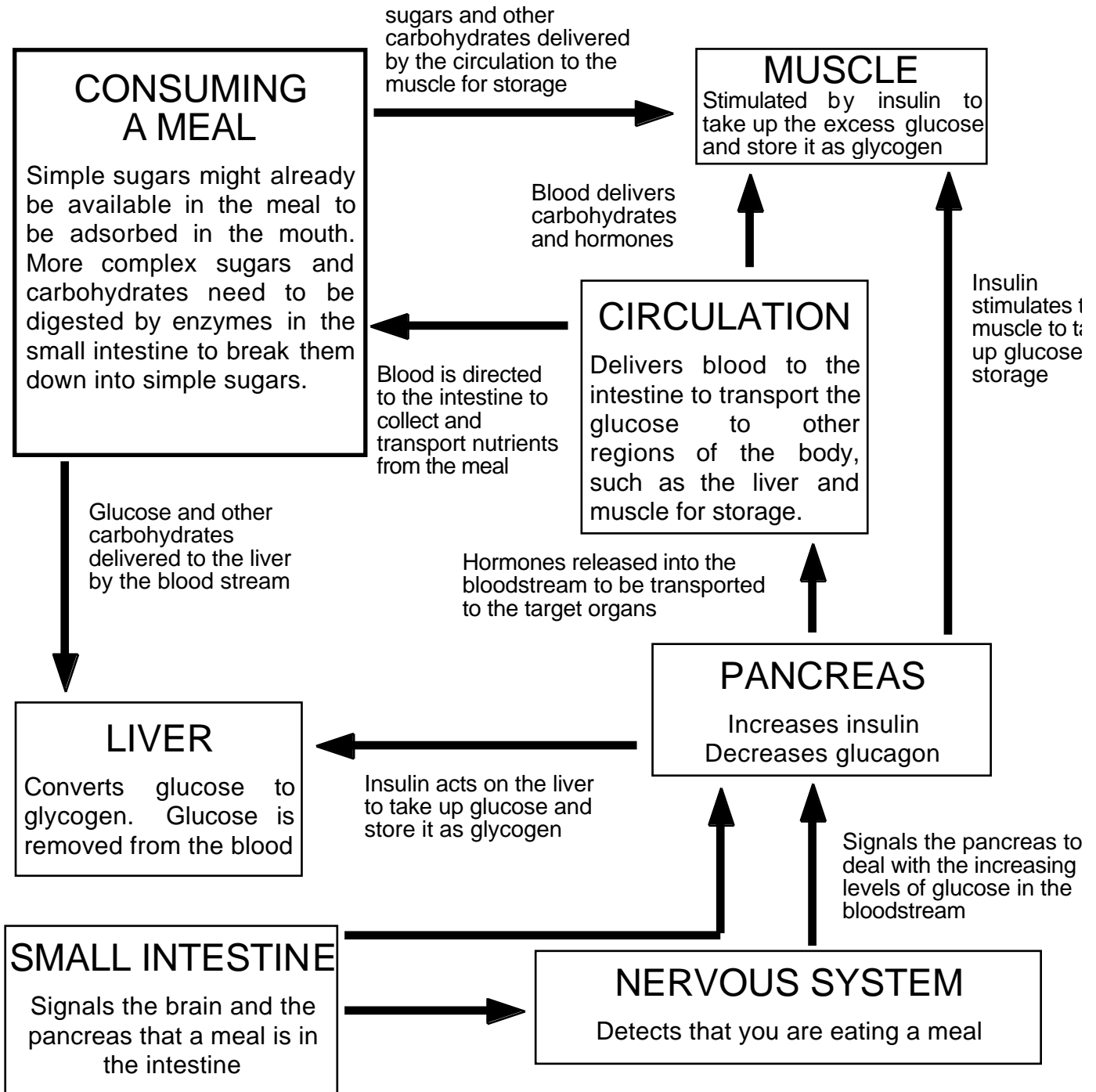
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How systems interact: An example of a mind-map



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How systems interact: An example of a mind-map (cont'd)



DIABETES AND YOU

The History of Diabetes Mellitus

What is diabetes?

Diabetes Mellitus the general name given to diseases associated with high levels of glucose in the blood. Glucose is a type of sugar and is an essential energy source for the body. The amount of glucose in the body is controlled by two hormones, **insulin** and **glucagon**, and these are produced in a cluster of cells in the pancreas called the **Islets of Langerhans**.

When there is a change to the normal functioning of the gland the quantities of glucose in the blood stream become difficult to control. This results in diabetes, of which there are 2 main types. A person who has diabetes is called a diabetic.

Type 1 diabetes

This form of diabetes is sometimes known as **insulin dependent diabetes mellitus (IDDM)** because people with this type of diabetes need daily injections of the hormone insulin. This form of diabetes is caused by the body's own immune system attacking the Islets of Langerhans within the pancreas. This means that no insulin can be made, which in turn means that glucose in the blood isn't controlled. Type 1 diabetes can occur at any age, but most commonly starts in childhood. One of the ways it can be diagnosed is if glucose is detected in the urine.

Type 2 diabetes

This form of diabetes is also called **non-insulin dependent diabetes mellitus (NIDDM)** because people with this form of the disease rarely need to have insulin injections. It's sometimes referred to as maturity-onset or late-onset diabetes because it usually occurs later in life. In this case, insulin is produced normally but for various reasons the body doesn't recognise it. This means that even though the insulin is circulating around the bloodstream, it can't do its job of reducing blood glucose levels. Type 2 diabetes is often associated with being overweight, particularly around the stomach region.

The story of diabetes

The symptoms associated with diabetes have been recorded right through history. In as early as 1550BC, the ancient Egyptians described symptoms that resembled diabetes mellitus together with records of treatment that included a soup-like cure made from bones, wheat, grain, grit, green lead and earth. In 100AD, a Greek man by the name of Aretaeus used the term 'diabetes' which in Ionian Greek means "**to run through**". He wrote a general description of all the conditions that caused increased urine output and thought that the condition was due to a kidney problem rather than problem with high blood sugar.

In approximately 131-201AD, a Roman doctor called Galen wrote about a disease that caused excessive urine production and excessive thirst and drinking, which he called "**Diarrhea urinosa**" and "**dipsakos**". It was not until the 400AD and 500AD that two Indian doctors noted that the urine of people suffering the above symptoms was sweet tasting, sticky to touch and attracted ants. Descriptions began to distinguish the types of diabetes: one which tended to affect older people who were fatter and a second type that tended to affect thin people who did not live long. Chinese doctors at this time agreed with this, describing the sweetness of diabetic urine and the attraction of dogs to it. Arabic medical texts

during the 800AD-1100AD also recorded such observations, with a doctor called Avicenna also documenting that gangrene was a complication associated with the disease.

During the 1500AD a Swiss doctor, Von Hohenheim, reported that diabetic urine contained white powder after evaporation. He thought (mistakenly) that this substance was salt, which he decided must accumulate in the kidneys causing the 'thirst' of the kidneys resulting in the production of copious quantities of urine.

Thomas Willis (1621-75AD) separated out diabetes from other disorders that also resulted in excessive urine production. Thomas Sydenham (1624-89AD) speculated that diabetes was a disease related to blood, and decided that there were materials in the blood that weren't completely used and had to be excreted in the urine. This was further elaborated upon by Matthew Dobson (1735-84AD) an English scientist, who discovered that the blood taken from diabetics contained high levels of sugar. This confirmed that it was a blood disease rather than a kidney disease. John Rollo, another English doctor who lived at about the same time as Dobson, was the first person to call the disease diabetes mellitus and described other side effects such as diabetic cataracts and acetone odour of the breath in patients. In 1788, Thomas Cawley reported that the disease diabetes mellitus might be caused by damage to the pancreas.

More advances were made in the 1800's when Claude Bernard (1813-78) observed that sugar was stored in the liver in another form called glycogen, and then showed that the brain had some effect on blood sugar levels. Diabetic coma was first described during the middle of the 1800's, as was damage to the retina in the eyes.

Oskar Minkowski (1858-1931) and Josef von Mering (1849-1908) carried out experiments on diabetes in dogs where they removed the dog's pancreas and then showed that the dogs went on to develop the symptoms of diabetes. The actual source of the insulin still remained a mystery however, until Paul Langerhans (1847-1888) identified structures within the pancreas that were different. These were later named the islets of Langerhans by Edouard Laguesse (1861-1927) who proposed that they were endocrine glands and suspected them of producing a substance that controlled the production of glucose, later called 'insulin' by a Belgian physician Jean de Meyer in 1909.

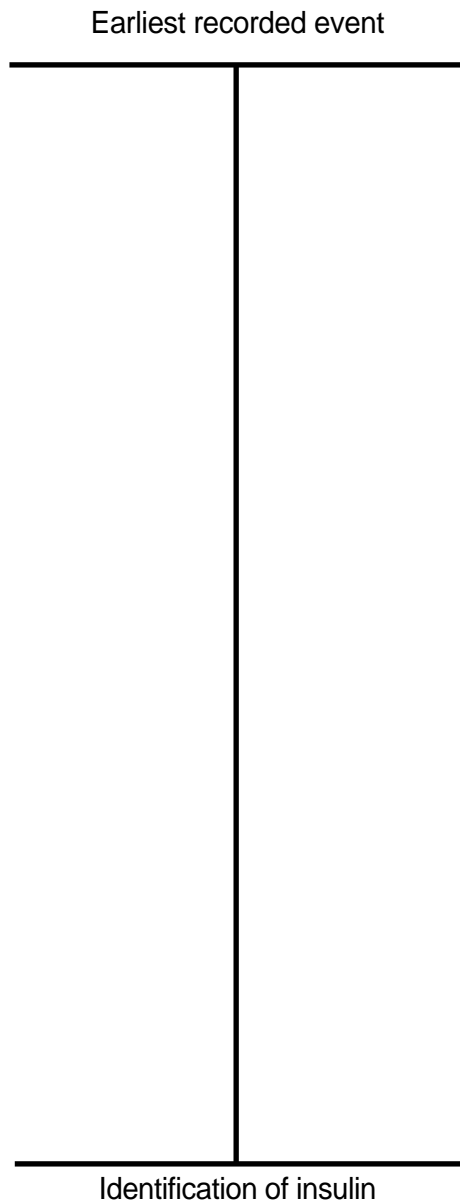
It was not until 1921 that the actual identification of insulin was made by two Canadian scientists called Banting and Best. The first clinical trials of injectable insulin began in Toronto in 1922. Banting also provided some of the first insulin he had isolated for the treatment of a diabetic child in Sydney at St. Vincent's Hospital. Without the insulin, like many other Type 1 diabetic children of the time, she would have died. With the availability of insulin for daily injections, she was able to lead a normal life and lived until the ripe age of 82.

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History of Diabetes

A timeline illustrates the sequence of related events. Construct a timeline to summarise the history of diabetes. Use the scaffold provided on this page.

- Read the passage on the history of diabetes carefully and underline the major events documented over time.
- Look at the timeline and decide on an appropriate scale to use, so that the events can be appropriately located.
- Place your events on the timeline.



DIABETES AND YOU

Treatment of diabetes

Research the major breakthroughs made in the treatment of diabetes in the 20th century.

Present a summary of these major events in the form of a time-line.

Some useful references:

<http://www.warner-lambert.com/info/basicfacts.html>

<http://www.niddk.nih.gov/health/diabetes/ndic.htm>

<http://www.niddk.nih.gov/health/diabetes/summary/altmed/altmed.htm>

<http://www.niddk.nih.gov/health/diabetes/pubs/esrd/esrd.htm>

DIABETES AND YOU

Should there be more research?

Write a newspaper article outlining the nature of diabetes and the need for continued research into the effects of the disease and its treatment.

Use the following scaffold to assist the planning and structure of your article.

Thesis

What is your point of view?

What major arguments are you going to elaborate in the body of your article?

Argument 1

What is this point about?

State the evidence that supports this point?

Argument 2

What is this point about?

State the evidence that supports this point?

Argument 3

What is this point about?

State the evidence that supports this point?

Argument

Restate the purpose of your article.

Provide a very brief summary of your arguments.

Do you have any recommendations to make?

DIABETES AND YOU

Diabetes in the news

Find a newspaper or magazine article that is about diabetes. To get you started, look in the daily newspapers, health magazines, and if you have access to the internet, the scientific news magazines such as Nature, Science, New Scientist or Scientific American. These can be found at-

<http://helix.nature.com/nsu> (Nature Science Updates)

<http://www.science.com/>

<http://www.newscientist.com/>

<http://www.sciam.com/>

Read through your article and evaluate it by considering the following points.

1. For what audience is the article written? For example, is it written for the general public, or is it a specialist research article?
2. What is the main point being made about diabetes?
3. Is the article accompanied by illustrations to help convey the main ideas?
4. Does the article explain how the main conclusion was determined? For example, does it describe the type of experiments or research conducted?
5. How does the main conclusion contribute to the body of knowledge about diabetes?
6. Is it possible that the main conclusion will help achieve either a better treatment or care for diabetic patients?

After having read and evaluated your own article, share your findings with other members of the class in a small group.

Using what you have learnt from evaluating your own article and those of other class members, write a short news article (a maximum of 200 words) about an aspect of diabetes that the general public should know about. For example, describe the symptoms of Type 1 and Type 2 diabetes, or identify ways in which we can minimise the risk of Type 2 diabetes. Make sure your article has a snappy title that will make people want to read it.

DIABETES AND YOU

Diabetes Awareness

In this activity, you take on the role of ‘science communicators’ working in groups to improve community awareness about diabetes. As a team, you will select **one** of the following suggested topics on which to research and collect information. Using this information, design a poster to effectively convey your message.

- Being aware of the symptoms of diabetes
- Being aware of how to control diabetes
- Being aware of the current treatments
- Being aware of the complications of diabetes
- Being aware of the research on diabetes
- Being aware of how to prevent diabetes (risk factors: role of diet and exercise)
- Being aware of the statistics (number of people who have diabetes in Australia)

What to do

Work in groups of 4 to 5. In your group, choose a leader then decide on who will be the:

- Researchers for the information
- Editor/s (editing the information and designing the format of the poster)
- Scribe/s (writing the information onto the poster)
- Illustrators (drawing or photocopying diagrams, graphs and pictures).

This activity is to be completed in 4 to 5 lessons, with the following suggested time-line:

- **First lesson** Selecting the topic, then researching background information
- **Second lesson** Discussing how to approach the topic; illustrations required writing and editing the collected information; any further research
- **Third lesson** Layout the design of the poster including the text and illustrations
- **Fourth lesson** Complete the poster for display and assessment.

DIABETES AND YOU

Symptoms

Type 1 diabetes

Also called **insulin dependent Diabetes Mellitus (IDDM)**, or **juvenile diabetes**.

- always feeling thirsty
- having to frequently go to the toilet to urinate
- weight loss
- lethargy / tiredness
- blurring of vision
-

Type 2 Diabetes

Also called **non-insulin dependent Diabetes Mellitus (NIDDM)**, or **mature-onset diabetes**.

- always feeling thirsty
- having to frequently go to the toilet to urinate
- lethargy / tiredness
- blurring of vision
- secondary infections
- often over-weight or obese

DIABETES AND YOU

Characteristics

Type 1 Diabetes

- includes 10% to 15% of all diabetics in Australia
- usually starts in children or young adults who are less than 30 years of age
- symptoms are often dramatic and obvious
- affected people are usually normal weight or underweight
- the amount of insulin found in the blood is low or completely absent
- affected people rely on the injection of insulin to control their blood glucose levels
- the injection of insulin continues for the rest of their lives, and is a treatment not a cure
- is described as an 'auto-immune disease', meaning that the body's immune system destroys the insulin-producing cells in the pancreas as if these cells were foreign invaders (ie. like bacteria)

Type 2 Diabetes

- includes 85% to 90% of all diabetics in Australia
- usually affects people who are older than 40 years of age
- symptoms usually appear gradually over time
- generally associated with over-weight people, but can also affect others
- the amount of insulin found in the blood is normal to high, but the insulin isn't able to control the blood glucose levels
- the disease is able to be controlled by careful diet, a regular exercise program or in some cases, medication
- is due to the body failing to use the insulin in the regular way; the body becomes resistant to insulin meaning the normal feedback control mechanisms don't respond to normal levels of insulin

Activity: Diabetes Awareness

Teacher notes and suggestions

The aim of the activity is for the students to convey in a meaningful way what they have learnt about one issue of diabetes. As a science communicator, their role is to take the information they have gathered and present it in an interesting way, thus conveying a message of awareness to the 'community'. Time could be set aside for a session where each group has five minutes to present the main message of the poster and then to answer any questions the other students might have. These posters could be displayed during Diabetes Awareness Week.

The posters can be used as a starting point to discuss other awareness campaigns, such as anti-smoking, drink-driving or osteoporosis. Issues to be discussed could include how the campaigns are used, what visual imagery is used, whether the campaign is perceived to be effective or not and discuss what the 'good' and 'bad' points are of the campaign.

Examples of posters from other awareness campaigns (obtainable from the group involved ie. anti-smoking posters from the Anti-cancer Foundation) should be available to show to the class. These could be used to stimulate the class with ideas of how to approach the activity as well as providing the discussion points at the conclusion of the activity.

Use the library or computer room for the research lessons. If these are not available use reference books, pamphlets from Diabetes Australia, photocopies of relevant information and/or printed information from various websites.

The criteria for class assessment can be determined by discussion between the teacher and the class in the first period. For example, the students in their groups could assess each poster by a number of criteria agreed on by the class at the beginning. An assessment sheet, something like that shown below, could be given to each group to make comments on each poster.

Name of Poster	Information	Presentation	Comments
	a) Does it make sense? b) Is it easy to understand? c) Does it have all the necessary information?	a) Visual impact b) Interesting layout c) Good use of diagrams or graphs to convey information	a) Good points b) Suggest any improvements

DIABETES AND YOU

Position is everything

Environmental factors influencing Type 2 diabetes

A diet high in saturated fats and a lifestyle with little exercise are the two largest environmental risk factors for developing Type 2 diabetes. The good thing is that both of these are able to be readily addressed in most people's situation.

There is a strong link between the development of Type 2 diabetes and obesity. A diet high in kilojoules (especially saturated fats) provides much more 'fuel' for energy than the body requires, particularly if the person doesn't exercise regularly. This excess of saturated fats is stored away in the body. It is the body's way of 'putting something away for a rainy day' - of storing energy in case there is a lean period in the future when food might not be so readily available. This is likely to have been a great advantage at different periods in our evolution, however our lifestyle today in Australia means that there is unlikely to be a shortage of food. Even if there is a local storm or draught that affects the production of food here, supermarkets are able to obtain food from elsewhere in the world. It is interesting to note that Type 2 diabetes is largely a disease of wealthy Western countries where there is good supply of foods, and also a large market for 'fast food' which tend to contain a high proportion of saturated fats.

Having all this excess energy stored away in the body's fat deposits is just the beginning. It is easy to see if someone has been eating lots of fatty food because they put on weight. It isn't as easy to see the effects of the extra fat deposits on how the body works. Research has shown that the accumulation of fat deposits, especially in the abdominal area, gradually changes the way in which the body responds to insulin. The body no longer responds to insulin released into the blood the way it used to; it needs much higher levels of insulin to be able store away any excess glucose in the blood. This is called 'insulin resistance', and the result of this is that much higher levels of glucose remain circulating in the blood than normal following a meal.

Research also indicates that this 'insulin resistance' is not permanent. It is able to be reversed by lowering the intake of kilojoules in the diet and by regular exercise.

It's not just the fat deposits that contribute to Type 2 diabetes, but where those fat deposits are. Position is everything. Where fat is deposited around the body is, to a certain extent, determined by whether you are a woman or a man. Differences in hormones between women and men direct fat to be deposited in different locations. Men tend to accumulate fat around the waist and stomach giving them a 'beer belly', otherwise known as an 'apple' shape. Women tend to accumulate fat around the hips and thighs, giving them a 'pear' shape. These are the fat deposits that are easily seen. Both women and men, however, can also develop fat deposits in their abdominal cavity, amongst their stomach and intestines. These deposits aren't easy to see and it is these deposits that increase a person's risk of developing Type 2 diabetes. They also may increase the risk of cardiovascular disease (ie. 'heart attack')

We can determine the distribution of fat within the body using a machine called a Magnetic Resonance Imager (MRI). It's a bit like an X-ray, but instead of using X-rays it uses a very strong magnetic field. The different molecules in our body (including fat molecules) makes the magnetic field change in a characteristic way as it is passed through the body. This allows muscle, bone and fat deposits to be identified. The images produced by the MRI are like sections through the body, as if you cleanly sliced someone across the middle and looked down onto what was exposed. Some examples of MRI images are shown on the following worksheets. These images not only demonstrate the differences in fat deposit between men and women, it also illustrates the large amount of fat that can accumulate around the intestines in the abdomen.

There is a relationship between the deposits of fat inside the abdominal cavity and exercise. These 'bad' deposits of fat can be readily reduced by regular exercise. Even if the fat deposits outside the abdominal cavity are not substantially reduced, the reduction in fat around the intestines by exercising significantly reduces the risk of developing Type 2 diabetes. This has been shown by research done on Sumo wrestlers in Japan. The diet and routine of the Sumo wrestlers means that they have large body weights, and this is a key component of the sport. However, they are also exercising sufficiently that the fat is not deposited around the intestines in the abdominal cavity. Using MRI it has been shown that when a Sumo wrestler retires, and no longer has the same vigorous exercise routine, the deposits of fat shift in to the abdominal cavity. As a consequence, they have a very high risk of developing Type 2 diabetes when they retire but not when they are actively wrestling.

Activity: Identifying the distribution of fat from MRI pictures

Two worksheets with MRI images are provided: one with images of a male and one with images of a female. What is illustrated in the images is what you would see if you sliced a person in half and looked down on top of the sliced area. The top of each image is the back of the person, and bottom of the image is the front (stomach) side. For both the male and female, one image (or 'slice') is shown at the level just above the hips, and one at the level of the waist. Both individuals were overweight, and considered to be at risk of developing Type 2 diabetes.

What to look for.

When you look at the images, the dark areas are things like muscle, bone and internal organs. In each image, towards the top and in the middle, is a large dark shape that is bone- it is a slice through one of the back bones (vertebrae). Either side of the backbones are some dark areas that are strong muscles involved in maintaining posture. In the middle of each image you will see a tangle of dark shapes that are parts of the small and large intestine. Encircling this is a ring of muscle that makes up the wall of the abdominal cavity. Outside this ring of muscle is tissue that appears almost white. This is a fat deposit between the skin and the muscle. You will also notice that in these examples there is some white coloured tissue around the intestines in the abdominal cavity. It is these fat deposits that create a high risk of developing Type 2 diabetes. At the level of the waist, you will also see the kidneys- one on either side of the backbone, nestled in towards the back. Having fat deposits around the kidneys also means there is high risk for Type 2 diabetes.

What to do.

Identify the areas that are fat deposits in the MRI images. In the outlined figures next to the MRI image, colour or shade the regions according to what they are. For example, muscle, bone, intestine or kidney. Highlight the areas of fat deposits. Compare the differences between the male and female in terms of the regions where fat is deposited.

Do you think these people have a high risk of developing Type 2 diabetes?

DIABETES AND YOU

Environmental contributions to diabetes

A graphing activity using data from a study comparing the amount of central abdominal fat to the sensitivity to glucose

We can crudely determine the amount of fat present in the abdominal cavity using a MRI Scan. A more accurate method of measuring the amount of central abdominal fat can be achieved by using a combination of two X-ray beams of different energies. This allows the total volume of the abdominal cavity to be estimated and the amount of fat in the cavity expressed as a percentage of that volume.

As mentioned previously, the presence of central abdominal fat increases the risk of developing Type 2 diabetes. A characteristic of Type 2 diabetes is ‘insulin resistance’, which is the decreased ability of the body to take glucose up into the muscles, liver and fat deposits when stimulated by insulin (called “insulin resistance”). The body’s ability to take up glucose (also known as glucose sensitivity) can be measured in a hospital by connecting the patient to an intravenous drip of glucose solution and then measuring the levels of glucose in the blood continuously. If everything is working well with the insulin system of the patient, the infusion of glucose will be met by an increase in insulin levels in the body, which in turn stimulate the uptake of glucose into muscle, liver and fat tissues. This means the level of glucose in the blood will appear constant. If there is ‘insulin resistance’, then the infusion of glucose will result in increased insulin levels, but the uptake of glucose by muscle, liver and fat will be very much reduced. This means that the glucose levels in the blood will appear to rise if the glucose drip is continued.

So, if glucose can be infused into the patient through the drip and the blood glucose levels remain constant, then the insulin system is working well. The rate at which the glucose is infused is measured in an amount called μmols (pronounced micro-moles) per minute. This rate needs to be ‘**normalised**’ with respect to the weight of the patient. As you might appreciate, a larger person weighs more, and has more muscle, more liver tissue and more fat tissue than a person that weighs less. If a person has more muscle, liver or fat, then they will also be able to take-up more glucose. So if we want to be able to compare small people with large people in a meaningful way, the rate of glucose needs to be expressed in terms of the weight of the patient. This is what is meant by normalising the rate of glucose infusion.

We can normalise this rate by dividing the rate of glucose infusion by the weight of the patient. This gives us a total rate that is expressed as the μmol of glucose per minute, per kg of body weight ($\mu\text{mol}/\text{min}/\text{kg}$).

Using the data in the table below, normalise the rate of glucose infusion. Plot this normalised rate on a graph against the percentage of central abdominal fat. Do a separate graph for males and females.

DIABETES AND YOU

Environmental contributions to diabetes

MALES			
% Central abdominal fat	Weight (kg)	Glucose Infusion rate ($\mu\text{mol} / \text{min}$)	Normalised infusion rate ($\mu\text{mol} / \text{min} / \text{kg}$)
19.5	76.0	3681.2	
41.7	105.1	1308.0	
40.3	90.0	2098.6	
25.8	87.8	2292.4	
30.5	96.4	3570.3	
12.9	82.9	4071.1	
23.8	96.2	3534.1	
25.4	84.8	2533.4	
14.5	83.8	4091.8	
30.6	102.3	4858.6	
32.7	88.5	1780.7	
33.3	86.3	1754.9	
36.3	77.9	962.5	
46.5	95.0	2649.6	
31.5	100.9	2220.2	
48	105.4	811.3	
32.4	103.0	834.0	
43.9	117.4	904.0	
46.3	102.3	951.9	
41	95.2	1475.2	
37.6	87.8	1045.1	
43	82.0	393.6	
46	109.1	752.6	

DIABETES AND YOU

Environmental contributions to diabetes

FEMALES			
% Central abdominal fat	Weight (kg)	Glucose Infusion rate ($\mu\text{mol} / \text{min}$)	Normalised infusion rate ($\mu\text{mol} / \text{min} / \text{kg}$)
42.3	72.8	1749.3	
47.5	107.5	2063.8	
42.7	67.1	1701.7	
29.8	65.8	2478.5	
31	76.8	2067.9	
23.2	82.7	4466.6	
44.5	106.6	3116.3	
45.3	74.5	1666.3	
43.8	104.8	3629.9	
50.4	94.1	1580.1	
51	82.3	691.7	
48.5	75.1	1268.4	
52.5	111.6	859.4	
46.8	103.0	968.3	
50.7	69.2	677.8	
50	112.0	918.1	
52.1	99.7	867.8	
50.1	94.2	715.8	
44.7	73.3	293.4	

DIABETES AND YOU

Environmental contributions to diabetes

Once the data is plotted on a graph, inspect the plotted data and interpret the results to answer the following questions.

1. If a patient has a low percentage of central abdominal fat, is their glucose sensitivity higher or lower than a patient that has a high percentage of central abdominal fat.

2. Is the relationship between the percentage of central abdominal fat and glucose sensitivity the same for men and women?

3. Does a low percentage of abdominal fat increase your risk of Type 2 diabetes? Explain.

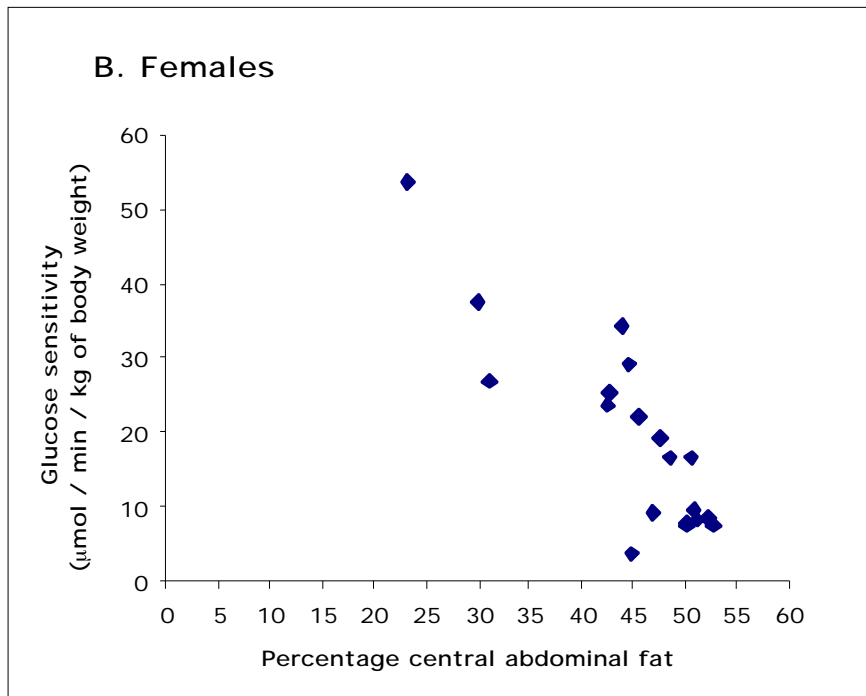
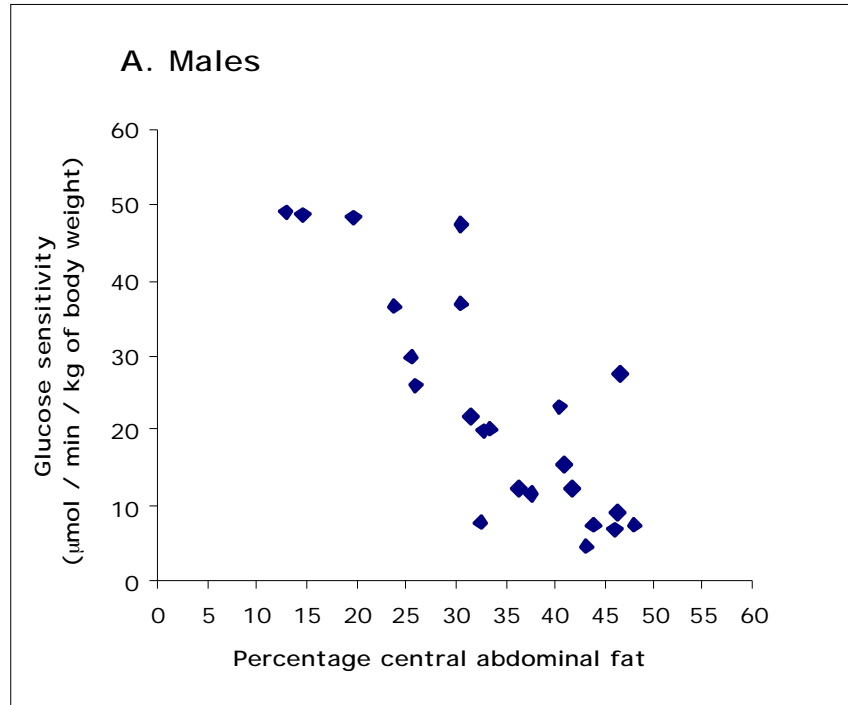
4. What steps can you take to reduce the risks of Type 2 diabetes?

5. Look at the body weight of the subjects listed in the data tables. Is body weight always a good indication of the percentage of central abdominal fat? Explain.

6. Why is it necessary to 'normalise' the data before making any comparisons?

Activity: Environmental contributions to diabetes

Teachers notes and suggestions



DIABETES AND YOU

A Diabetic Study of Indigenous Populations

Urbanised indigenous communities often have a high incidence of diabetes. This growing public health problem affects many countries around the world and has not responded to the usual therapies for a variety of cultural, historic and economic reasons. Many of these populations have traditionally lived a “hunter-gatherer” lifestyle, meaning that they ate only what they could actively collect from the surrounding environment. Research has indicated that the differences in diet and exercise associated with moving from this traditional lifestyle to a more westernised lifestyle has been responsible for the increased incidence of diabetes Type 2 in some indigenous populations.

Written below are the results of a fictional scientific experiment. This study examined the dietary and exercise patterns of a group of indigenous people living in westernised as opposed to traditional surroundings. Read through the study then answer the questions at the end.

Introduction

The Nomado people have lived in small hunter-gatherer tribes on the island of Nomad for thousands of years. In the last century, however, western civilisation has caught up with Nomad. It has become a tourist hot spot and two large cities have formed where small villages used to be. These cities are filled with such conveniences as supermarkets, car parks and lots of fast food outlets. Many of the Nomado people have moved into these cities and as a result have had to immediately alter their lifestyle to fit into the westernised urban culture.

Over the last ten years, Nomad doctors have noticed that the incidence of diabetes Type 2 in the Nomado people has increased to be almost twice that of the newly arrived westernised citizens. This dramatic difference suggested to the doctors that they needed to firstly find out why this was occurring, and secondly to come up with an effective method of stopping it happening in the future.

Armed with the knowledge that Type 2 diabetes is a disease that is strongly influenced by diet and exercise, a group of medical researchers decided to investigate some of the differences between the Nomado traditional lifestyle and their urban lifestyle. They did this using the methods below.

Methods

A group of twenty Nomado people were chosen for a 2-week study. Ten of these people had been living a westernised lifestyle in the city and the other ten had been living a traditional lifestyle in the country. Each person was asked to fill out a daily sheet that listed exactly what they had eaten that day and the estimated amount of time spent doing physical activity. Each person was also asked whether they had a car. Finally, blood samples were taken to quantify their blood glucose levels.

Results

The results of the study indicated that there were some major differences in the two Nomado groups.

Firstly, the amount and type of food eaten varied enormously. The three most common foods consumed by the city dwelling Nomado people were deep fried chicken wings, white bread and soft drinks. The traditional Nomado people ate mainly baked fish, turtles and native fruits. When the composition of the foods was totalled, the average city dwelling Nomado ate 50% carbohydrate, 40% fat and 10% protein. The diet of traditional Nomados consisted of 33% carbohydrate, 13% fat and 54% protein.

Secondly, the exercise levels also varied. Traditional Nomados spent approximately 4 hours a day doing physical activities such as walking and swimming. Urban Nomados spent only 1 hour a day being active. Additionally, 8 of the 10 urban Nomados owned a car.

Lastly, the researchers found large differences in blood glucose levels. All of the urban Nomados had very high blood glucose levels whilst all except one of the traditional Nomados had normal or low blood glucose levels.

Questions and Discussion

- 1) Present the results of this study in your book using appropriate tables and graphs.
- 2) Explain how the differences in diet might influence the Nomados risk of Type 2 diabetes.
- 3) Name two things that Nomado doctors would have to concentrate on in order to change the rate of diabetes Type 2 in urban Nomados?
- 4) Suggest a slogan for a public health campaign designed to decrease the incidence of diabetes Type 2 in urban Nomado people.
- 5) There are a number of factors that weren't considered in this study yet might have had an impact on the final results. List three of these factors and describe how they may have influenced the results that the researchers obtained.
- 6) Write a short discussion summarising and explaining the results of this study.

DIABETES AND YOU

Contribution of Genes to Diabetes

We can identify the extent to which diabetes is caused by genes and/or the environment by studying the lives of separated identical twins.

In 1935 in Sydney, a young unmarried woman gave birth to identical twin boys. At that time, there was very little support to enable a woman in this situation to care for babies and it was considered that it was in their best interests for them to be adopted. Thus the babies were separated and put up for adoption immediately after birth.

One of the twins was adopted by a couple who already had one child; they named him John and moved soon after the adoption to Melbourne. His family moved very often during his schooling years. John grew up unaware that he was adopted and took up an apprenticeship as a plumber in Queensland when he was 18. It was not until his father died in 1980 that John found out he was adopted and that he had a twin brother. John started the long process of contacting his biological family.

The other twin was adopted by a couple in Sydney; they named him Angus. He had a very stable home life and was aware of his adoption from a young age although he was not told that he had an identical twin. He became a graphics artist and had no desire to make contact with his biological family until he was in his mid 40's when he had his first child. He then started trying to find his mother and during this process learnt that he had an identical twin who was also interested in making contact.

It was not until 1984 when both John and Angus were 49 that they finally made contact with each other. They met in Sydney and spent time together for the first time since their birth. They also contacted their mother who was by now in her late 60's. They learnt that she had eventually married their biological father and that they had two sisters, Sally and Mary now aged 34 and 31.

Although they had been separated for almost 50 years, and reared in different environments, John and Angus were so similar in appearance that Angus' neighbour mistook John for his brother. Their hair colour and texture were identical; they even had the same balding pattern! Their eyes were exactly the same colour. Although they had a similar body shape, John was 165 cm tall while Angus was 168 cm. They were both overweight at 106 and 98 kg respectively. Their teeth were very similar in shape and appearance: they even had cavities in the same teeth. Angus, however, was more outgoing and confident than John.

Just after they met, John became affected by a number of symptoms: he was thirsty all the time, urinating more often than usual, began to lose weight, his vision become blurred and he was constantly tired. He was diagnosed as having non-insulin dependent diabetes (Type 2). He was put on a treatment plan which included a healthy diet, regular exercise and some medication to help control the levels of glucose in his blood.

Through John's doctor, John and Angus learnt of the interest that geneticists have in studying identical twins who have lived apart and therefore exposed to different environments during their lives. This is to try to find out what characteristics are influenced by a person's genetic makeup, by the environment (diet, lifestyle etc.) or by a combination of both genetics and environmental factors.

They learnt of a study that was being conducted in Sydney and decided to participate. The geneticist explained that previous studies of twins like them had shown that some physical characteristics were due entirely to their genetic or inherited makeup, which is why some people couldn't tell them apart. Other characteristics like height and weight are also influenced by their diet and therefore are not entirely due to their genes.

As part of the study the geneticist asked them to take several mental and personality tests. The results indicated that their mental abilities and temperaments were similar. Angus scored slightly higher than John on some of the mental tests (perhaps due to his more stable schooling) but the scores were remarkably close and both men displayed weaknesses in the same specific areas. While they differed somewhat in social adjustment, overall their personality characteristics were very similar. On one personality test that included 180 different questions, the twins answered only 20 questions differently.

While both twins were interested in assisting this genetic research, Angus was particularly interested in finding out whether he was likely to develop diabetes like John. Was a susceptibility to develop diabetes inherited? The geneticist referred Angus to a genetic counsellor who first asked him about the health of his newly found blood relatives. The twin's parents were both still healthy although their father had severe back pain after an accident at work. Their sisters were 15 and 18 years younger than them; neither had any health problems and had not yet had any children.

Angus was told that there was indeed an inherited susceptibility involved in Type 2 diabetes: studies of identical twins like them by geneticists have shown that if one twin develops Type 2 diabetes, the chance that the other twin would develop it is between 50% (1 in 2) and 100%. Several genes have now been identified as being involved but it is not clear-cut what their role is. What is known is that regardless of this inherited susceptibility, having an appropriate healthy diet, undertaking regular exercise and losing weight can prevent the onset of the condition, or at least delay it. This is because the development of diabetes Type 2 depends not only a person's genetic makeup but on their environment as well. So Angus was given advice about losing weight and adopting a healthy lifestyle which would most likely prevent the onset of the symptoms that John had.

The twin's two sisters also contacted the genetic counsellor to see what their chance was for developing diabetes. They were told that their chance was not as high as it was for Angus because he is John's identical twin. Their chance was in fact about 1 in 3 that they would develop the condition when they were middle-aged or older unless they also followed the prevention advice given to Angus, in which case their chance of developing Type 2 diabetes would be considerably reduced. The genetic counsellor told them that this 1 in 3 chance would also have applied to Angus if he and John had been non-identical, or fraternal, twins.

John also asked about the chance that Joanne, his 7 year old daughter, would get diabetes. The genetic counsellor emphasised that this type of diabetes did not usually occur until a person was in their 40's or 50's and that it was a different condition to insulin dependent diabetes that affected children (type 1 diabetes). However, her chance of getting diabetes type 2 in her 40-50's was about 10% or 1 in 10 because of the genetic makeup she would have inherited from John. Nevertheless if Joanne adopted a healthy lifestyle throughout her life and did not become overweight her chances of getting diabetes would be markedly reduced.

Contribution of Genes to Diabetes

Teachers notes and suggestions

Information provided by the Genetics Education Program of NSW

Note: This information may change with new insights being found from scientific research. To ensure the information is up to date, the website of the Genetics Information Service of NSW should be consulted at <http://www.genetics.com.au/>

The contribution of genes to Type 1 diabetes

The evidence that heredity plays a role in the development of diabetes Type 1 has come from studying identical twins. If an identical twin develops Type 1 diabetes, then the chance that the other twin will also develop it is 1 chance in 3, compared to the general population risk of about 1 in 500. However, the fact that the chance of developing the diabetes is not 100% for identical twins shows that the inheritance pattern is not clear cut.

This type of inheritance is referred to as multifactorial, meaning that what is inherited is only a predisposition or susceptibility to develop the diabetes but the disease will only develop if additional factors, such as viruses, the effects of other genes or other unknown environmental factors, trigger its development.

From the investigation of people with Type 1 diabetes, it was discovered that there was an association with certain genes that control the immune system: the genes of the HLA (human leukocyte antigen) system. This is not surprising since diabetes is an auto-immune disease, as described earlier.

The HLA system is primarily responsible for the body being able to distinguish between cells which belong to the person ("self") and foreign cells or invading organisms ("non-self" cells). It is important for example in organ transplantation for the cells of the organ to be HLA 'compatible' (that is, have the same HLA genetic makeup) with the cells of the person receiving the transplant so the body does not reject it as something foreign.

The genes of the HLA system have been localised to chromosome number 6. These genes contain the information for the body to make certain proteins (called antigens) that 'mark' the white blood cells so the body can recognize them as part of "self". Cells which do not have the same 'antigen' would be considered "non-self".

The HLA system is made up of a large number of different genes including HLA-A, B, C, D, DR and DQ. Each of these genes can have many different forms (designated as HLAA-A1, A2 etc.), so that there are many possible combinations of the HLA gene types. Each one contains the information for particular antigens which mark the cells, so a person can be classified according to their white blood cell antigens or HLA makeup. Similarly, red blood cells are marked with antigens so that they can be distinguished as belonging to blood group A, B, O or AB.

Everyone has two copies of each gene, one inherited from their mother and one from their father. Thus the HLA genes for the white blood cell antigens are passed from parent to child: each parent contributes one set of HLA genes to the child.

Figure 1 shows the possible combinations of the HLA-DR genes in a family; this HLA gene has been chosen because it is important in predisposing to Type 1 diabetes. The father's HLA-DR genes are of type DR3 and DR7; the mother's are of type DR4 and DR5.

If a child inherits the HLA-DR3 gene from one parent and the HLA-DR4 from the other parent, they will have an HLA type described as DR3, DR4. Having this combination of HLA antigens makes person predisposed to or at high risk of developing Type 1 diabetes.

In Figure 1, one of the children with the HLA makeup actually has diabetes. On the other hand there are many people with the HLA makeup of DR3, DR4 who never develop Type 1 diabetes, even within the same family. In fact their risk of developing the disorder is estimated at 19% (or 19 chances out of 100) and not 100% of developing the disorder as shown in Figure 1. These risks however relate to the chance that these family members will develop diabetes over their lifetime.

Type 1 diabetes is more likely to develop at a younger age: the older the person gets, the less this risk becomes for them of developing the disorder. The risks for other family members to develop diabetes who have different combinations of the HLA-DR group are shown in the Figure.

It is also known that a person who has inherited HLA-DR2 from one parent and HLA-DR5 from the other parent - and therefore has an HLA type of DR2, DR5 - has almost no chance of getting Type 1 diabetes. DR2 and DR5 are referred to as 'diabetes resistance' genes.

In a family where one or more members have Type 1 diabetes, knowing the HLA-Dr antigen composition can enable doctors and genetic counsellors to give risk figures regarding the chance of other members developing the disorder.

If one of the parents has diabetes, the risks for his or her children also depend on the child's HLA type which has been inherited. Each family needs to be studied very carefully and the risk figures provided to the parents will relate to their HLA genetic makeup. Other research is continuing to identify other HLA genes and perhaps genes associated with the insulin gene.

Genetic counselling can assist people to understand this very complex inheritance information so that they can make decisions on an informed basis.

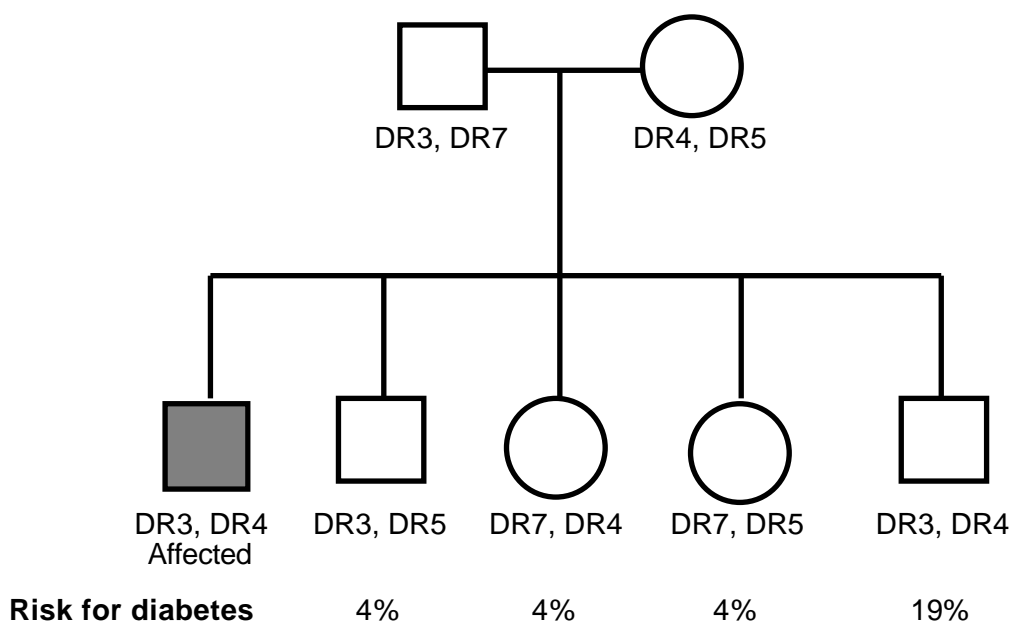


Figure 1. Example of a family tree showing the parent's HLA antigen genes, and those which each child had inherited from the parents. Males are shown as squares, and females are shown as circles. The percentage risk of becoming a diabetic for each of the brothers and sisters of the affect boy is shown.
 Source: S. Serjeantson (1994), "The genetics of diabetes", in Diabetes and You: An Owners Manual.

Contribution of Genes to Diabetes

Teachers notes and suggestions

Information provided by the Genetics Education Program of NSW

Note: This information may change with new insights being found from scientific research. To ensure the information is up to date, the website of the Genetics Information Service of NSW should be consulted at <http://www.genetics.com.au/>

The contribution of genes to Type 2 diabetes

When one twin of an identical twin pair develops diabetes Type 2, the risk that the other twin will develop the disorder is between 50% (1 in 2) and 100%.

Despite this clue to the involvement of genetics in the development of the condition, just as with Type 1 diabetes, the inheritance pattern of Type 2 diabetes is not clear cut. It also involves the inheritance of a genetic predisposition interacting with environmental factors that trigger the onset of the disorder (multifactorial inheritance). One of the known triggers for the disorder is obesity: even though a person may have inherited susceptibility to develop diabetes, diet and exercise may postpone the onset of the condition, or it may not develop at all.

However, unlike Type 1 diabetes, no clear association with the HLA complex of genes has been shown. Since Type 2 diabetes involves development of resistance to the action of insulin, mutations in the genes associated with insulin production and action were thought to be likely candidates. However this research has not proven to be successful in understanding the genetic basis, and further work is concentrating on the genes containing information which governs the transport of glucose in and out of cells.

Scientists are also comparing the development of diabetes in animals, for example mice and rats, which can be used as models. The genetic makeup of these animals is similar to that of humans and may provide clues to guide the research on the genetic basis of Type 2 diabetes in humans. From this work on animals, it is suggested that predisposition to develop Type 2 diabetes may be due to mutations in one or more of several genes. Genes located on chromosome number two and on chromosome number 12 have been implicated.

Thus, while research is continuing to define the genetic involvement in Type 2 diabetes, the risks that relatives of a family member with diabetes will also develop the disorder has been estimated from observation of families with a history of the condition.

For example, the risk for developing Type 2 diabetes to the siblings of people with the condition is about 30%. When one parent has Type 2 diabetes, the risk that their child will also develop diabetes in middle age is about 10% or 1 chance in 10. If both parents have Type 2 diabetes, however, that risk increases to about 20% or 1 chance in 5 and the diabetes may also onset earlier than middle age. Nevertheless, since these risks relate to the tendency or predisposition to develop the disorder, diet and exercise may postpone the onset of the condition, or the diabetes may not develop at all.

DIABETES AND YOU

Research Institutions

Work in groups of 3-4 people to identify the contributions of **one** institution that conducts research into diabetes (see suggestions below). Each group should research a different institute.

Remember to define what type of research the institute concentrates on, and how it influences our knowledge of diabetes. For example, are they conducting research into diabetes treatments, investigating the genetic or environmental causes of diabetes, calculating how many people have diabetes, providing support for people who have diabetes or providing educational information about how to avoid diabetes?

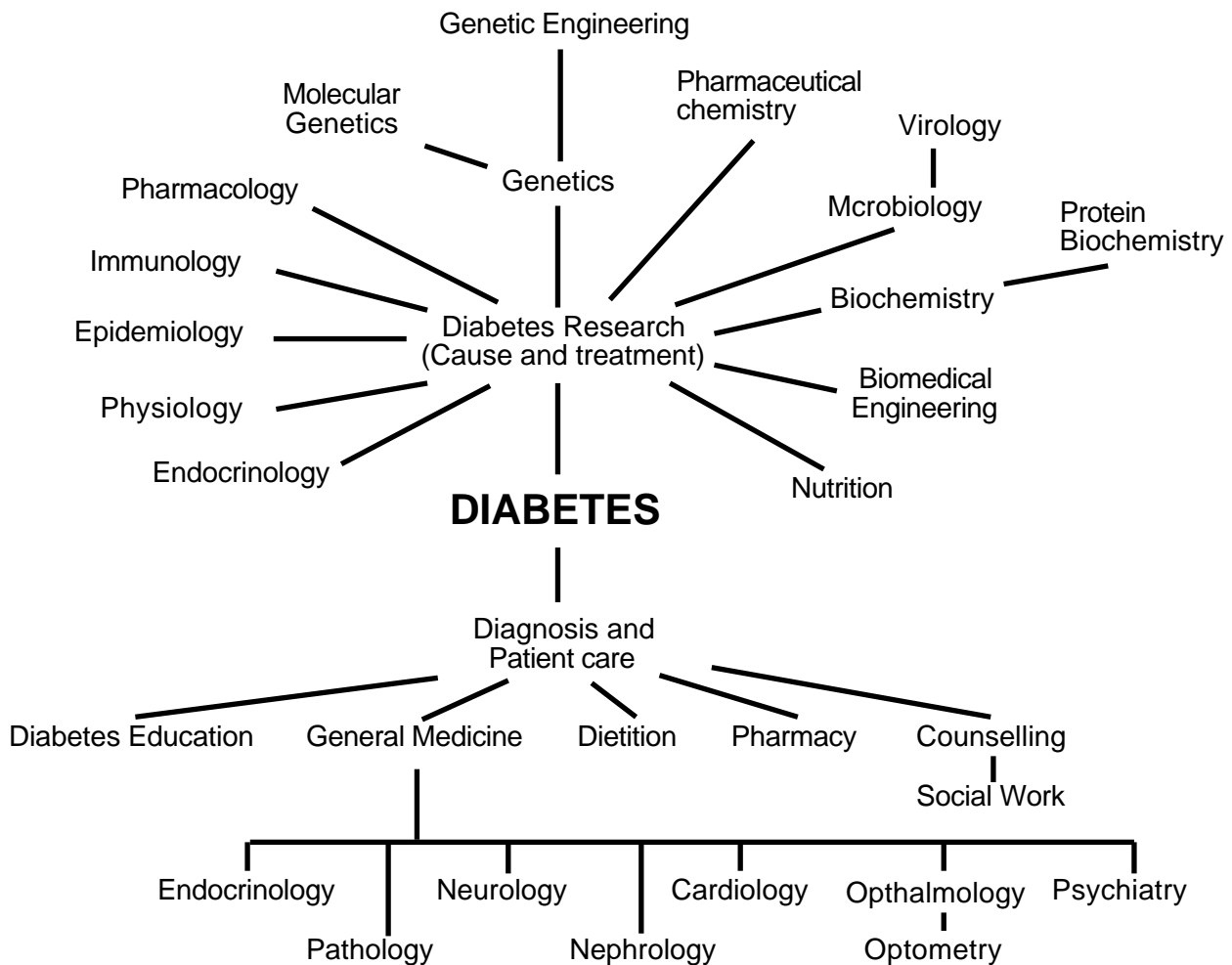
Present your information as an oral report to the class.

Examples of institutions that research diabetes are listed below. There are many more that can be accessed by conducted an internet search.

- Garvan Institute of Medical Research www.garvan.org.au
- The Juvenile Diabetes Foundation Australia www.jdfa.org.au
- Diabetes Education and Research Center www.libertynet.org/diabetes
- Alberta Foundation for Diabetes Research <http://afdr.ab.ca/>
- Juvenile Diabetes Foundation International www.jdfcure.org/
- The Institute for Diabetes Research www.ipd-discovery.com/idd/index.htm
- Western Australian Research Foundation. Royal Perth Hospital, Wellington Street, Perth, WA. Ph: 08 9224-1006, Fax: 9224-1008
- Diabetes Institute (International). 260 Kooyong Road, Caulfield, Victoria. Ph: 03 9258-5050 Fax: 9258-5090
- Walter and Eliza Hall Institute of Medical Research, Melbourne. Royal Melbourne Hospital, Gratten Sreet, Parkville, Victoria. Ph: 03 9345-2555 www.wehi.edu.au

DIABETES AND YOU

Careers and fields involved in diabetes



- Research five fields or careers of interest and explain the specific role or relevance to diabetes.
- Suggest any other related fields or careers that may be involved in diagnosis, patient care or disease research.
- Prepare a brief oral presentation (approx. two minutes) using ONE of your chosen fields or careers. Include in your presentation-
 - General description of activities
 - Specific role with respect to diabetes
 - Examples of any new research, new technology or new treatments for diabetes

DIABETES AND YOU

Diabetes Research: The Scientist

Find information on one scientist who is currently or has previously been involved in research related to diabetes. Use the chart over the page to write a report on the scientist that includes information such as:

- when/where they live
- career history
- current research
- effects of findings/contributions

Below is a list of scientists who have achieved success in this field. Remember you can choose others if you wish.

- Lesley Campbell (Garvan Institute)
- Joseph Bornstein
- Professor Paul Zimmet (Monash University)
- Professor David James (Garvan Institute)
- Professor Mark Cooper (Austin Repatriation Hospital, Melbourne)
- Professor John Shine (Garvan Institute)

Information on the web:

- Garvan Institute of Medical Research www.garvan.org.au
- Diabetes Australia www.dav.org.au
- Juvenile Diabetes Foundation Australia www.jdfa.org.au
- The Genetics Education Program www.genetics.com.au
- International Diabetes website www.idi.org.au
- ABC website, 'The Lab', www.abc.net.au

DIABETES AND YOU

Diabetes Research: The Scientist

When writing the report on the scientist, use the chart below to make rough notes of what to include.

Title:
Scientists name- When they live/d- Where they live/d-
Introduction/General Statement:
Career history- Have they worked on diabetes for their entire career? Where have they worked? In what area of science or medicine are they trained?
Description of their research Previous research- Current research- The contribution of their research to the understanding or treatment of diabetes

Teacher notes and suggestions

Activity: Research Institutions

Activity: The Scientist

Both of these activities require similar resources. Use the library or computer room for the research lessons. If these are not available use reference books, pamphlets, photocopies of relevant information or printed information from various websites.

DIABETES AND YOU

Diabetes Research: Technology

Find information on a technological advance in diabetes research, and identify how it has impacted on both the community and scientific research.

Examples of advances you could research include:

- Transplantation of islet cells into Type 1 diabetics
- Finger prick monitoring of blood sugar
- Production of human insulin rather than animal insulin using genetic techniques
- Identifying genes which determine insulin resistance
- Development of laser photocoagulation

Information on the internet:

- Garvan Institute of Medical Research www.garvan.org.au
- Diabetes Australia www.dav.org.au
- Juvenile Diabetes Foundation Australia www.jdfa.org.au
- The Genetics Education Program www.genetics.com.au
- International Diabetes website www.idi.org.au
- ABC website. "The Lab" www.abc.net.au

DIABETES AND YOU

Diabetes Research: Technology

Teacher notes and suggestions

As homework, a few weeks before this topic, have students collect 1-2 articles from newspapers on any recent technological advance in science. Discuss how the advances have changed/influenced/impacted on our lives

To promote discussion on the implications of technological advances, use stimulus materials such as videos or articles in newspapers/magazines. Discuss the pros and cons of the advances.

eg. show the video 'Gene Blues: Dilemmas of DNA Testing' (a Video Education Australasia video tape)
eg. have newspaper articles on cloning, new medicines, new medical techniques, DNA being used in forensic science.

Discuss new technologies such as fax machines, computers, internet and their impact on our lives.

Students could present the information as a written report, a pamphlet, a poster, an oral presentation, a video presentation or role-playing. Students could work in groups.

Use the library or computer room for the research lessons. If these are not available use reference books, pamphlets, photocopies of relevant information or printed information from various websites.

DIABETES AND YOU

Genetically engineered human insulin vs. other methods of treatment of diabetes

Background facts

- Insulin is a hormone that regulates the level of sugar (glucose) in the blood.
- Insulin is normally produced by the Islets of Langerhans in the pancreas.
- People who have insulin-dependent (Type 1) diabetes and a small number of people with non-insulin-dependent (Type 2) diabetes require insulin to control the levels of glucose in their body.

Methods for provision of insulin for diabetics

- Human insulin produced by genetic engineering (available since 1982)
- Insulin derived from animals such as pigs or sheep
- Transplantation of pancreas
- Transplantation of insulin-producing cells (Islet cells) into a person's pancreas
- Insertion of correct copy of an insulin gene into some cells in the body (most likely to be liver cells) so that they produce their own insulin (gene therapy)

Classroom Debate

“That it is better for diabetics to use genetically engineered insulin”

Note: The use of the term “better” means that it enables a “middle ground” from the negative. Although there is very minimal difference in the effectiveness of animal insulin versus genetically engineered insulin, there are significant differences in the cost of production. Genetically engineered insulin is much cheaper than animal insulin. The middle ground is the use of other means of delivery of insulin such as total pancreatic transplantation, islet cell transplantation and gene therapy.

Affirmative side points to consider:

- What is genetically engineered insulin (must provide a definition)
- Benefits of genetically engineered human insulin allows the production of slightly modified forms of insulin that act over a longer period of time and act sooner after being injected (at present it takes approximately 40 minutes before the injected insulin has any affect)
- Concerns about safety and ethical implications of gene therapy and transplantation treatments

Negative side points to consider:

- knowledge of genetically engineered insulin (possibly only limited knowledge required)
- other possible methods of treatment now and in the future
- gene therapy
- pancreatic islet cell transplantation
- pancreatic transplantation

Suggested readings

1) Production of genetically engineered insulin

Information for the affirmative

A CSIRO Education sheet: insulin production using recombinant DNA technologies
URL: <http://www.csiro.au/enquiries/insulin.htm>

The Australian Biotechnology Association
PO Box 4 Gardenvale Vic 3186
Tel (03) 9596 88789
URL: <http://www.aba.asn.au/>

Information for the negative

What was the first commercial use of genetic engineering?
(Simple one page summary of the production of genetically engineered insulin)
URL: <http://www.biotech.wisc.edu/Education/Poster/firstcommerce.html>

2) Public survey of views on genetic engineering and background to genetic engineering

International Social Science Survey. Final report to the Department of Industry, Science and Technology, May 1995
URL: <http://dist.gov.au/pubs/reports/genengin/chap5.html>

3) Gene therapy as a means of curing diabetes

Gene Therapy - An Overview
BIO. "Biotechnology in Perspective." Washington, D.C.: Biotechnology Industry Organization
URL: http://www.accessexcellence.org/AB/TWT/Gene_Therapy_Overview.html

4) Pancreatic transplantation and transplantation of islet cells (the cells in the pancreas that produce insulin) as a means of curing diabetes.

URL: <http://www.insulin-free.org/main.htm>