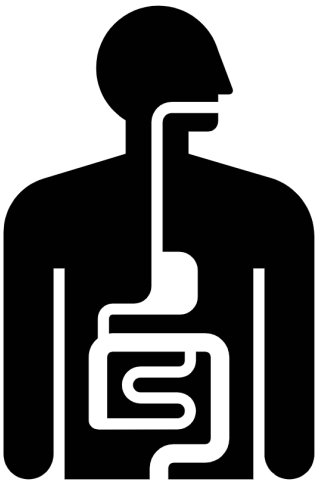
Department of Education

GOVERNMENT OF WESTERN AUSTRALIA

Year 11 ATAR Human Biology

The Digestive System



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Year 11 ATAR Human Biology

Topic: The Digestive System

Instructions to Students

This resource package provides you with learning materials for the Human Biology ATAR Year 11 course. The package focuses on the topic: **The Digestive System**.

This package is designed to support the program you are completing at your school. If feedback is required when completing this package, you should consult your teacher.

CONTENTS

It is recommended that you further investigate concepts covered in this resource package by conducting your own research using the text/s that you use at school or the internet.

Syllabus Points Covered

Science Understanding:

- *the supply of **nutrients** in a form that can be used in cells is **facilitated** by the structure and function of the digestive system at the **cell, tissue** and **organ** levels*
- ***digestion** involves the breakdown of **large molecules** to smaller ones by **mechanical digestion** (**teeth, bile** and **peristalsis**) and **chemical digestion** (by **enzymes** with distinctive operating conditions and functions that are located in different sections of the digestive system)*
- *the **salivary glands**, **pancreas**, **liver** and **gall bladder** produce or store secretions which aid the processes of digestion*
- ***absorption** requires nutrients to be in a form that can cross **cell membranes** into the **blood** or **lymph** and occurs at different locations, including the **small intestine** and **large intestine***
- ***elimination** removes **undigested materials** and some **metabolic wastes** from the body*

Science as a Human Endeavour

- ***lifestyle choices**, including being active or **sedentary**, the use of drugs and **type of diet**, can compromise body functioning in the short term and may have long-term consequences*

Learning content and activities

Use your text (most schools will be using *Human Perspectives ATAR Unit 1 & 2* - TJ Newton and AP Joyce)/references/weblinks below to assist you in completing activities and questions.

Healthy Eating

The cells of the body require nutrients that can:

- release energy from their bonds and
- build and repair body tissue

The digestive system breaks down our food to produce nutrients small enough to be absorbed into the bloodstream and transported to the cells for metabolism.

Lifestyle choices, such as the type of diet we consume, can compromise body functioning and affect our future health. Healthy food choices keep our body functioning at its best and reduce the risk of developing diet-related diseases such as obesity and diabetes. Table 1 below lists the small nutrients needed by the body and some foods in which they are found

Table 1: Nutrients needed by the body and the foods in which the nutrients may be found

Nutrients needed by the body	Foods in which the nutrients may be found
Simple sugars e.g. glucose	Carbohydrates in bread, cereals, fruit and milk
Fatty acids e.g. linoleic acid	Lipids in butter, cheese, milk, vegetable oils
Amino acids e.g. valine	Proteins in meat, fish , eggs
Vitamins and minerals	Found in a variety of foods and needed in very small quantities
Water H_2O	Water makes up about 70% of the mass of the body

Carbohydrates, lipids and **proteins** are classified as **organic** compounds. They are large, complex molecules containing chains of carbon atoms with hydrogen and oxygen atoms attached. Proteins also contain nitrogen atoms.

Vitamins are also organic compounds. Thirteen vitamins are recognised. Click on this link to visit the website Compound Interest if you are interested in seeing the structure of these 13 vital vitamins! https://www.compoundchem.com/2015/01/13/vitamins/

Minerals and **water** are inorganic compounds. They are small, simple molecules which may contain carbon atoms but only in small numbers, e.g. calcium carbonate $CaCO_3$

Carbohydrates

Carbohydrates contain the elements carbon (C), hydrogen (H) and oxygen (O). **Chemical energy** is found in the **chemical bonds** that hold the atoms together.

The basic **sub-units** of carbohydrates are **monosaccharides** such as **glucose**, fructose and galactose. When two monosaccharides join together by a chemical bond, they form a **disaccharide**. One common disaccharide is **sucrose**. Sucrose is made up of a glucose subunit and a fructose subunit.

When large numbers of monosaccharides join together chemically, they form a **polysaccharide**. Some examples of polysaccharides include **starch** (an energy store in plants) and **glycogen** (an energy store in animals).

The main function of carbohydrates is to quickly supply energy for the body's **metabolism**. When the body requires extra energy, such as during exercise, the glycogen stores in the liver and muscles are broken down to glucose. Glucose is then transported in the bloodstream to the cells where it is used in cellular respiration to produce energy.

The general equation for cellular respiration summarises how the **chemical energy** held in the bonds of the glucose molecule is released as it is converted to carbon dioxide and water.

glucose + oxygen → carbon dioxide + water + energy

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy

Lipids

Lipids contain the elements carbon (C), hydrogen (H) and oxygen (O). Chemical energy is found in the **chemical bonds** that hold the carbon atoms together within lipids. There are different types of lipids, including fats, oils, phospholipids and steroids. It is the fats in our diet that supply essential fatty acids.

Fats can be classified as either **saturated** or **unsaturated**. Unsaturated fats have two chemical bonds between their carbon atoms and fewer hydrogen atoms than saturated fats. Saturated fats have only one bond between their carbon atoms. Most saturated fats are found in animal tissue, so are found in foods such as meat, cheese and butter. Unsaturated fats are found in plant foods such as nuts, soybeans and olive oil.

Click on the link below to visit the website *Compound Interest* to see the structure and classification of the different types of lipids and to find out how they act in our bodies.
https://www.compoundchem.com/2015/08/25/fat/

Fats are made up of three **fatty acids** joined chemically to **glycerol.** The main functions of fats are to provide a **store** of energy and to protect the body from low temperatures by providing a layer of insulation.

Proteins

Proteins contain the elements carbon (C), hydrogen (H), oxygen (O) and nitrogen (N) bonded together in complex shapes.

Some proteins also contain sulphur (S) and phosphorus (P). These elements combine to form **amino acids**, which are the basic building blocks of proteins.

There are only 20 different amino acids, which join together in different combinations to form many different proteins. Some amino acids can be synthesised in the body, so these are called **non-essential** in the diet. Those that cannot be synthesised in the body must be included in the diet and are called **essential** amino acids.

The main function of proteins is to **repair** and **replace** body tissue. They also make up the structure of **enzymes** and are involved in all the chemical reactions in the body.

If you are interested in checking out how the 2017 Nobel Prize in Chemistry revealed the structure of biomolecules like proteins with cryo-electron microscopy then click on the link to *Compound Chemistry:*
https://www.compoundchem.com/2017/10/04/2017nobelchemistry/

Energy

Carbohydrates, lipids and proteins can all be broken down to produce energy for the body cells. Energy released from food is measured in units called kilojoules (kJ).

1 kilojoule = 1000 joules

The quantity of energy released from 1 gram of food is called the **energy value**. The energy value for carbohydrates, lipids and proteins is shown in Table 2 below.

Table 2: Comparison of energy values for three macronutrients

Nutrient	Energy released (kJ / g)
Carbohydrate	17
Lipid	37
Protein	17

Activity One – Healthy eating

Use your textbook or the internet to answer the following questions.

1. Complete the following summary table of food types.

Nutrient type	Dietary sources	Organic or Inorganic	Types of atoms present	Function in the body
Carbohydrate				
Protein				
Lipid				
Vitamin				
Mineral				
Water				

2. There is much publicity about the increasing levels of obesity in Australia and other developed countries.

   Follow this link to the Heart Foundation website and check out the data https://www.heartfoundation.org.au/about-us/what-we-do/heart-disease-in-australia/overweight-and-obesity-statistics

   One factor contributing to this trend is that less time is spent on meal preparation, so people are buying more take-away or fast food.

   It is recommended that teenage girls should have around 8700–10 200 kJ of energy in their food intake per day, including 74–82 g of fat per day.

   Teenage boys should have around 11 100–13 500 kJ of energy in their food intake per day, including 90–110 g of fat per day.

   Examine the following table giving nutritional information on common fast foods.

Food	Kilojoules	Fat (g)
Burger	2310	32
Fried chicken	1050	15
Large fries	2268	30
Milk shake	2688	14
Meat pie	2100	30
Pizza	2310	19

   You eat a burger, large fries and a milk shake for lunch.

   a) Analyse the table above to choose what you could eat for dinner and still stay within the recommended energy intake.

   b) Explain how you could reduce your fat intake for the rest of the day to stay within the guidelines.

c) Outline the health problems that are linked with eating too much fat.

d) Describe the differences between saturated fats and unsaturated fats. Give some examples of foods where each type of fat is found.

e) Many processed and fast foods contain high levels of salt. What are the harmful effects of eating too much salt?

3. The Heart Foundation assesses the quality of foods and gives a 'tick' to indicate how healthy they are. Levels of saturated fat, salt, energy (kilojoules) and fibre are measured. In addition, the packaging must provide consumers with detailed information on the nutrients contained in the food.
    - To familiarise yourself with the Heart Foundation tick symbol, go to the Heart Foundation website at: https://www.heartfoundation.org.au/healthy-eating
    - Scroll to find the link to the Heart Foundation tick symbol and read about it.

    List five examples of foods from your kitchen that show the Heart Foundation tick.

4. Take-away and fast foods are often low in **dietary fibre** (roughage). What is the role of dietary fibre in the diet? Give some examples of diseases that may result from a lack of dietary fibre in the diet.

Activity Two – Your Diet

So which foods should you be eating and how much should you eat?

The amount and proportions may vary depending on an individual's size, age, gender, the amount of activity or type of occupation and any special dietary considerations like pregnancy.

1. Click on the link to find a PDF of the Australian Dietary Guidelines.

https://www.health.gov.au/sites/default/files/australian-dietary-guidelines.pdf

This provides a summary of dietary guidelines for Australians.

a) List the 5 guidelines discussed in the brochure.

b) To eat a balanced diet, it is important to choose foods from the five food groups.
Scroll to page 10 of the pdf document *Australian Guide to Healthy Eating*.
Draw an infographic to show the proportions of the five groups that we should eat.

The Process of Digestion

The process of breaking down food into smaller particles is called **digestion**. Digestion involves breaking down large molecules found in food that you eat to smaller ones by:

- **mechanical digestion** using teeth, bile and peristalsis and
- **chemical digestion** by enzymes with distinctive operating conditions and functions that are located in different sections of the digestive system.

The digested particles must be small enough to be absorbed into the bloodstream through the capillary walls. Then the small particles can be transported to all the body cells. These small particles are called subunits of the large complex nutrient particles found in food.

As a result of digestion:

- **carbohydrates** are broken down into **simple sugars**
- **lipids** are broken down into **fatty acids** and **glycerol**.
- **proteins** are broken down into **amino acids**

These products of digestion together with substances such as **water, vitamins** and **minerals** are in a form small enough to be taken up by the cells of the body.

The Digestive System

The digestive system consists of two parts, the gastrointestinal tract and the associated organs.

The digestive tract, which is a hollow tube made of smooth muscle, runs from the mouth to the anus The main parts of the gastrointestinal tract are the:

- **mouth**
- **oesophagus**
- **stomach**
- **small intestine**
- **large intestine**

The associated organs that assist in the process of chemical digestion, include:

- **the salivary glands**
- **pancreas**
- **liver**
- **gall bladder**

These organs produce or store secretions which aid the processes of digestion.

Food is ingested at the mouth. The chewed food at the moment of swallowing is called a **bolus**. The bolus moves along the digestive tract by the process called **peristalsis**. Peristalsis is the coordinated involuntary contractions of the **smooth muscles** in the walls of the digestive tract.

Digestion occurs in the mouth, stomach and small intestine where food is broken down by mechanical and chemical digestion.

ACTIVITY THREE – The Digestive System

Explore the digestive system by clicking on the link below to visit the BBC website, Bitesize: https://www.bbc.co.uk/bitesize/guides/zwqycdm/revision/1

1. Draw a diagram of the digestive system to show the following structures and label each of them. Use a legend to classify them as either part of the gastrointestinal tract or the associated organs.

Appendix	Stomach	Anus
Oesophagus	Pancreas	Liver
Small intestine	Salivary glands	Large intestine
Mouth	Gall bladder	Pharynx

2. Use the correct scientific terms to describe the process of swallowing.

3. Food is passed along the digestive tract by muscular action in a process called peristalsis. Define peristalsis and explain how it works.

4. Some people suffer from a condition called gastric reflux or heartburn. This is where the acid contents of the stomach flow back into the oesophagus. Name and describe the structures that normally prevent this from occurring.

5. Distinguish between the terms bolus and **chyme**.

6. Material remains in the stomach for about four to six hours before moving into the small intestine.
    a. Describe what happens to the material in the stomach during this time.
    b. State the name of the structure that controls the emptying of the stomach contents into the small intestine.

7. Name the three regions of the small intestine and briefly state their functions.

8. Name the three parts of the large intestine and briefly state their functions.

Mechanical and Chemical Digestion

Mechanical digestion

Mechanical digestion is the physical breakdown of large pieces of food into smaller pieces.

The tongue, the teeth and the muscular walls of the digestive tract are responsible for mechanical digestion. When food enters the mouth, the chewing action of the teeth and jaw breaks the food into smaller pieces. This process is called **mastication**. There are four types of teeth involved with mastication:

- incisors
- canines
- premolars
- molars

The tongue helps to move the food around the mouth to be chewed. After being chewed, the tongue forms the material into a rounded mass called a **bolus**. The tongue moves upwards and backwards to push the bolus into the back of the mouth called the **pharynx**. The **epiglottis** then quickly closes and the bolus is diverted to the **oesophagus**.

Activity Four – Mechanical digestion

1. Click on the link below to view an MRI scan to gain an idea what swallowing looks like.

   Note: Juice is used here but the swallowing of bolus looks the same.

   https://commons.wikimedia.org/w/index.php?title=File%3AReal-time_MRI_-_Swallowing_(Pineapple_Juice).ogv

   Whilst viewing the video identify the relevant structures involved in swallowing.

Use your textbook and the internet to answer the following questions:

2. Once swallowing has occurred, the bolus moves down the oesophagus by **peristalsis**. The wall of the oesophagus, like the rest of the digestive tract, is composed of four layers of tissue that enclose the hollow cavity or **lumen**. The layers are the **mucosa**, **submucosa**, a double muscular layer and an outer membrane called the **serosa**.

   Draw a labelled diagram to show the relationship between the mucosa, submucosa, double muscular layer and an outer membrane called the serosa

3. Describe the process of mastication.

4. Draw a diagram to show the arrangement of the four types of teeth in the jaw.

5. The stomach has an extra oblique layer of muscle. Explain how this extra muscle layer related to the functions of the stomach.

6. Describe the function(s) of the mucus secreted by glands along the walls of the digestive tract.

Chemical Digestion

The chemical breakdown of food involves the action of **enzymes**. Enzymes are proteins within cells which catalyse specific biochemical reactions of the body. Enzymes allow chemical reactions to take place by lowering the amount of energy needed for the reaction. **Enzymes** do not get used up in the process, therefore can be used over and over again. Almost all biochemical reactions in living things need **enzymes**.

Mechanical and chemical digestion work together. Once the large pieces of food have been broken down physically into smaller pieces, more surface area is exposed to the action of enzymes.

Digestive enzymes act on the food we eat.

The food on which an enzyme acts is called its **substrate** and the smaller molecules formed are the **products**

enzyme
Substrate ----------> Products

As a result of chemical digestion large, complex substrate molecules are broken down into their smaller, simpler subunits.

- **carbohydrates** are broken down into **simple sugars** such as glucose
- **lipids** are broken down into **fatty acids** and **glycerol**
- **protein molecules** are broken down into **amino acids**

These products of digestion can now be absorbed into the bloodstream. Enzymes are **specific** in their action. Different enzymes, identified by name, are required to break down different foods:

- **carbohydrates**, in particular amylose, are digested by **amylase** enzymes
- **lipids** are digested by **lipase** enzymes
- **proteins** are digested by **protease** enzymes.

See **Table 3** on the next page for a summary of enzymes, their site of action and the substrate they work on.

Table 3 Digestive enzymes, where they are found and the substrates they act upon

Enzyme	Location	Substrate
salivary amylase	mouth	carbohydrate
gastric protease	stomach	protein
pancreatic and intestinal amylase	small intestine	carbohydrate
pancreatic and intestinal protease	small intestine	protein
pancreatic and intestinal lipase	small intestine	lipid

Enzyme activity is dependent upon **temperature** and **pH** (acidity).

Temperature

- Enzymes in the human body work best at 37°C, which is the normal human body temperature.
- At lower and higher temperatures enzymes do not work properly.
- Enzymes are inactive at low temperatures.
- At very high temperatures enzymes break down and no longer function. We say that the enzyme has been denatured.

pH (acidity)

- pH is a measure of acidity, using a scale from 0 to 14. The midpoint of 7 is neutral. Any value below 7 is acidic and any value above 7 is alkaline or basic. A weak acid would have a pH of 5 or 6 and a strong acid would have a pH of 2 or 3. Water has a pH of 7.
- Different enzymes have different optimum pH levels. Some enzymes work best in an acid environment, while other enzymes work better in alkaline environments. For example, protease enzymes in the stomach work best in an acid medium of pH 1–3. Other enzymes, such as lipase, work best in an alkaline medium as found in the small intestine with a pH of 7–8.
- The pH of the digestive tract varies along its length as seen in Table 4 on the next page.

Table 4: The location, pH and the type of environment in which enzymes act

Location	pH	Environment
mouth	6-7	weakly acidic
stomach	1-3	strongly acidic
small intestine	7-8	slightly alkaline

- As food passes along the digestive tract the pH changes and so different enzymes are active. For example, salivary amylase in the mouth functions best at pH 6-7. When the food reaches the stomach, salivary amylase is no longer active as hydrochloric acid secreted in the stomach makes the pH acidic at pH 1-3.

Activity Five – Chemical Digestion

Click on this link to find the Bozeman Science video on Enzyme Action

https://www.youtube.com/watch?v=ok9esggzN18

Use your text and the internet to answer the following questions.

1. Define the term enzyme.

2. Define **co-factors** and **co-enzymes**. Explain how they affect enzyme activity.

3. Describe the role of **bile**, which is produced in the **liver**.

4. Complete the table below showing the substrates, enzymes and products in various parts of the digestive tract.

Location	Substrate	Enzyme	Products
mouth	carbohydrate	salivary amylase	
stomach			
small intestine			
small intestine			
small intestine			

5. Add the name of the enzyme expected to act in the following locations.

Location	pH	Environment	Enzyme
mouth	6–7	weakly acidic	
stomach	1–3	strongly acidic	
small intestine	7–8	slightly basic	

6. In the Enzyme Action video in the hyperlink above (at the beginning of this activity) it is stated that molecules are either built up (where two smaller molecules are joined into one) or broken down (where one molecule is broken down into two products).

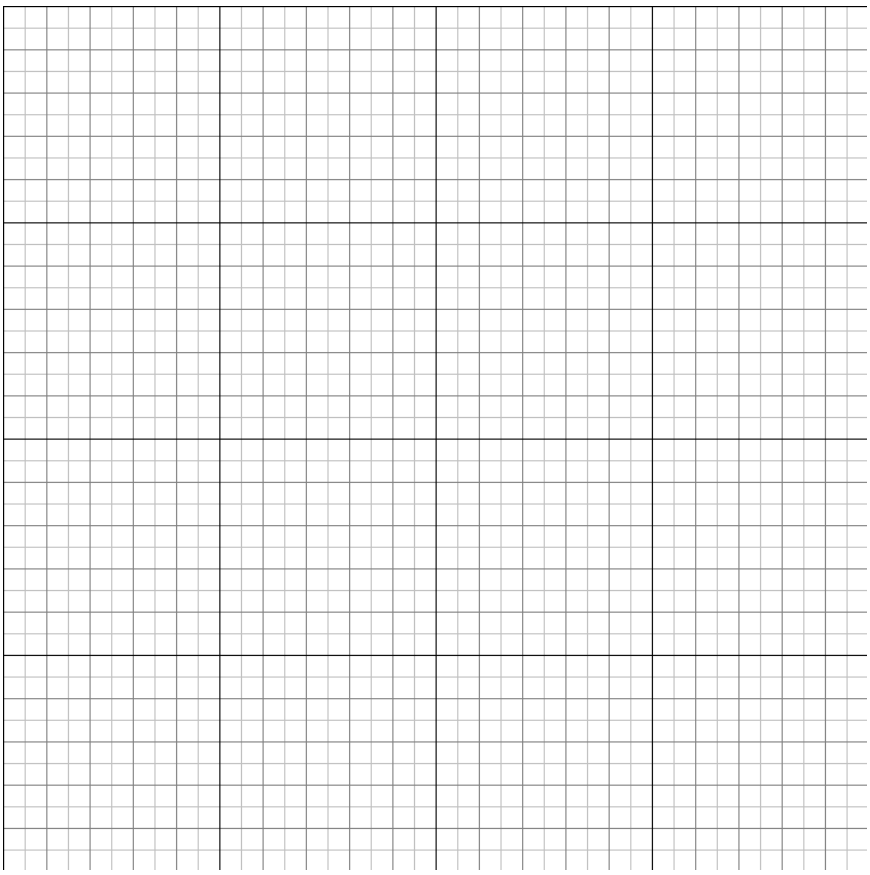
    a. Decide which of these two processes is largely occurring in chemical digestion.
    b. Give a reason for your decision.

7. In an experiment investigating the effect of temperature on a particular enzyme the following data was collected.

Temperature (°C)	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**
Rate of reaction (mg product per hour)	0.8	1.3	1.9	2.6	3.2	3.5	3.6	2.2	0.8	0.0

The concentrations of both the enzyme and its substrate were kept constant throughout the experiment.

a) Plot the results on the graph on the next page.



b) Describe the relationship between temperature and rate of reaction of this enzyme.

c) State the temperature at which this enzyme most active. This is called the **optimum temperature** for this enzyme.

d) List three other variables would need to be controlled for these results to be considered reliable.

e) This enzyme is found in the stomach. Name the enzyme and the type of substrate it would act on.

Absorption of nutrients

Before food can enter the cells of your body it has to be taken in (ingested), digested and then absorbed into the bloodstream.

Absorption of nutrients occurs by two main processes:

- **Diffusion** –the movement of molecules from high concentration to low concentration.
- **Active transport** –the movement of molecules from low concentration to high concentration. For molecules to move against the concentration gradient the cells must use energy.

Search for animations of diffusion and active transport on the Internet

Absorption mainly occurs in the small intestine. However, some easily digested and simple substances such as water, ions and some drugs such as aspirin and alcohol are able to be absorbed from the stomach

Villi

The inner lining of the small intestine has minute finger-like projections called **villi** which greatly increase the surface area of the small intestine. The villi themselves are a single layer of tissue one cell in thickness and are richly supplied with blood capillaries and lymph vessels.

Monosaccharides and amino acids are absorbed by active transport through the intestinal wall and into the blood capillaries. Water-soluble vitamins are absorbed into the capillaries by diffusion.

The products of fat digestion, fatty acids and glycerol also pass through the intestinal wall by diffusion but are too large to directly enter the blood capillaries. Absorbed fats enter lymph vessels of the villi known as **lacteals** because of their milky appearance. Fat-soluble vitamins are absorbed with the fatty acids and glycerol. The fats then travel in the lymphatic system until they reach larger veins in the neck region where they enter the bloodstream.

Activity Six – Absorption of nutrients

Find a labelled diagram of the internal structure of a villus in your textbook, or on the internet.

1. Draw a villus and label the following parts of it;
   - lacteal
   - capillary network
   - arteriole
   - venule
   - epithelial cells
   - mucus-producing cells
   - microvilli

2. In the small intestine the folds of the villi are only one cell in thickness. The cells of a **villus** (singular) are specialised epithelial cells with even smaller folds called microvilli on their exposed surface.

   Explain how the structure of the villi and its microvilli aid absorption in the small intestine.

3. Use the following table to summarise the method of absorption for the end products of digestion.

	Water	Fatty Acids and Glycerol	Monosaccharides	Amino Acids
Transport method for absorption. Choose from **Osmosis**, **Simple Diffusion** or **Active transport**.				
Structure involved. Choose from **capillaries** or **lacteals**.	Villi _____ in small intestine and in the _____ of the large intestine	_____ in the villi of the small intestine	Small intestine's villi _____.	Small intestine's villi _____.

4. Name the blood vessel that carries absorbed nutrients from the small intestine to the liver.

5. Explain why absorbed nutrients are taken to the liver before they go anywhere else in the body.

6. The term colon is sometimes used to refer to the entire large intestine. However, the large intestine consists of four parts: the **caecum, colon, rectum** and **anus**. Briefly describe the roles of these parts of the large intestine.

Activity Seven – Learning Tactic – Glossary – The Digestive System

For each topic you need to build a glossary of key words, or terms. Key words and terms are used for concepts within the topic you are studying.

You need to use these key words and terms to demonstrate that you understand the concepts studied.

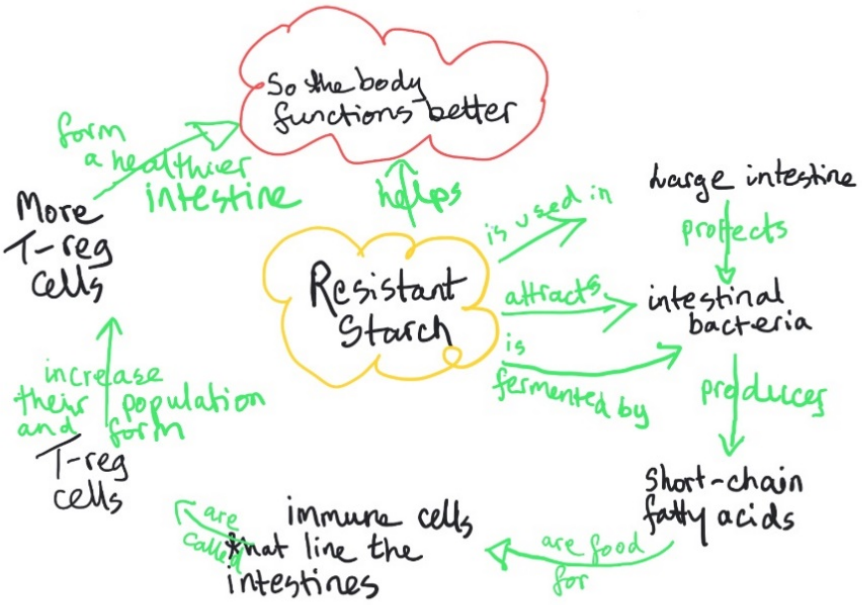
1. Find the syllabus content for this Topic. Key words have been written in **bold**.
2. List these bold words in the left-hand column of the Glossary Table below.
3. Use your text or the internet to write a definition and
4. Draw a diagram to help you remember this term
5. Continue working through this document and list other key wards and terms that appear in **bold** text. Repeat steps 3 and 4.
6. Re-read this document and add any other key terms that you do not understand yet.
7. Copy and paste the template below to complete your glossary.

Concept, Term or Vocabulary	Description	Draw it / Apply it

Concept, Term or Vocabulary	Description	Draw it / Apply it

Activity Eight – Learning Tactic – Concept Mapping – The Digestive System

Figure 1 below shows an example of a concept map. It is a description of a nutrient called resistant starch. To read it start in the middle and read along each arrow in turn. You should be able to write a paragraph describing resistant starch.



Supplied by Catherine Morritt

Now you have a go at building a concept map for the digestive system.

1. Find the syllabus dot points for this Topic.
2. For each syllabus dot point:
    a) Write out the syllabus dot point
    b) Pick out the key terms, or concepts from the syllabus dot point and arrange them on a page.
    c) Draw arrows between the ideas that are related.
    d) Complete a sentence along the arrow to show the relationship between the key words or concepts.
3. When you have finished the concept map you should be able to write a paragraph, or two using it as a guide.

Practice Examination Questions

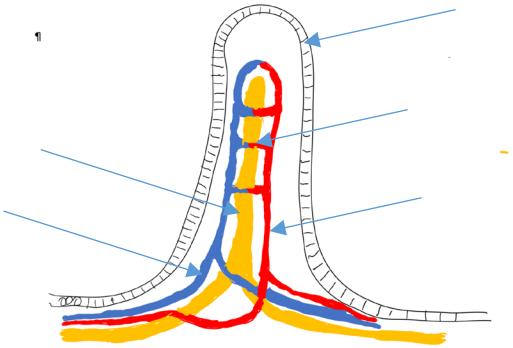
1. Villi are structures at the interface between the gastrointestinal tract and the circulatory system. The structure of the villi are ideally suited to their function.

   The diagram below shows a simplified drawing of a single villus. It is about 1mm long from the base to the tip.

a) State the name of the organ where villi are found. (1 mark)

_____

b) Label the arrows with names of the parts of the single villus. (5 marks)



Sketch by CM.

c) Name the organic nutrient absorbed by the lacteal of the villi. (1 mark)

_____

d) Name two organic nutrients absorbed by the capillaries of the villi. (2 marks)

_____

_____

e) Describe two features of villi that make them well-suited to their function and explain why each feature is well-suited. (4 marks)

Practice examination questions answer key

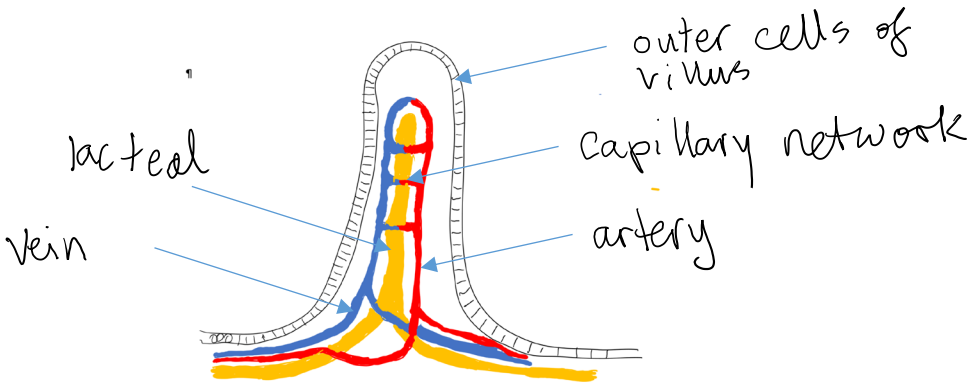
1. Villi are structures at the interface between the gastrointestinal tract and the circulatory system. The structure of the villi are ideally suited to their function.

   The diagram below shows a simplified drawing of a single villus. It is about 1mm long from the base to the tip.

a) State the name of the organ where villi are found. (1 mark)

Description	Mark
Small intestine	1
Total	1

b) Label the arrows with names of the parts of the single villus. (5 marks)



c) Name the organic nutrient absorbed by the lacteal of the villi. (1 mark)

Description	Mark
Lipids, or Fatty acid and glycerol	1
Total	1

d) Name two organic nutrients absorbed by the capillaries of the villi. (2 marks)

Description	Mark
Amino acids	1
Simple sugars/ monosaccharides	1
Total	2

e) Describe two features of villi that make them well-suited to their function and explain why each feature is well-suited. (4 marks)

Description	Mark
Any 2 with a description for 1 mark And an explanation for 1 mark • Villi are covered by a single layer of cells • Single cell layer allows for rapid absorption (diffusion/osmosis/active transport) of nutrients	4 marks
• Long thin shape • Gives a high SA:V ratio for rapid absorption	
• Fine capillary network • Single-celled walls of capillary allow for rapid absorption or • Network increases SA for absorption	
• Lacteal for insoluble nutrients and capillaries for water soluble nutrients • Efficient absorption of water soluble and insoluble nutrients	
Total	4