

Nutrition and Digestion

Ch. 10 & 11 ICGSE Biology; Ch 48 Modern Biology

Pre-AICE Biology

Section II: Organization and maintenance of the organism

SC.912.L.18.1, SC.912.L.8.7, SC.912.L.18.11, SC.912.L.18.12, SC.912.L.14.45 - 47

Objectives

- Define ingestion, digestion, absorption, assimilation and egestion.
- Identify the gross **structure** of the alimentary canal and associated organs (mouth, esophagus, stomach, small intestine: duodenum and ileum, large intestine: colon and rectum, anus, pancreas, liver). Describe the **functions** of the alimentary canal's various parts in relation to ingestion, digestion, absorption, assimilation and egestion of food.
- Identify the small intestine as the region for the absorption of digested food.
- Describe the significance of villi in increasing the internal surface area.
 - Understand the structure of a villus, including the role of capillaries and lacteals. Indicate the role of the hepatic portal vein in the transport of absorbed food to the liver
- Analyze: digestion in the alimentary canal the functions of a typical amylase, protease and lipase, listing the substrate and end-products.

I. Nutrition



A. Food

1. Needed for growth, energy, and repair
2. Classes of food
 - a. carbohydrates, lipids and proteins

B. Diet



1. Salts/Mineral Salts

- a. Things the body needs other than the three main groups.
- b. **Iron**
 - Needed for production of haemoglobin (hemoglobin). Red Blood Cells
 - Carries oxygen
 - We need about 15 mg/day
 - Found in red meat, eggs, nuts, bread, spinach and other green vegetables.
 - Insufficient iron leads to anemia.

c. Calcium

- Needed for bones, teeth and normal blood clotting.
- Also needed for muscle and nerve contractions.
- Found in milk and cheese, but also found in small amounts in most foods.
- Calcium is not water soluble, so it must be taken with Vitamin D to increase the amount actually absorbed by the body.






Calcium helps build denser bones

d. Iodine

- Needed for the production of the hormone thyroxine, produced in the thyroid.
- Found in sea fish and shellfish, but also found in many vegetables.
- In many countries it is added to the salt to ensure everyone gets enough.

Iodine Deficiency Disorders

Goiter Cretinism

e. Phosphorous

- Needed for DNA and calcium phosphate production.
- Found in nearly all food, but prevalent in cheese, meat and fish.



FIGURE 2—Lamb fed a ration deficient in phosphorus. Note the hunched conformation. (From Idaho Agricultural Experiment Station)

2. Vitamins

- A group of organic substances.
- Not used for energy.
- Only needed in small quantities.
- Needed for chemical reactions.
 - Often coenzymes.

3. Fibre (Fiber)

- Used for roughage.
- Also known as cellulose.
- Helps retain water and decrease constipation.
- Keeps the colon healthy.
- Found in vegetables and whole grains.



4. Water

- An essential part of the body.
 - 70% of tissue is water.
- Water acts as a solvent and helps to carry substance throughout the body and remove wastes.



C. Balanced Diets

1. Energy Requirements

- Most teenagers use 2000 calories or more.
- Carbs = 4cal/gram
- Fats = 9 cal/gram
- Protein = 4 cal/gram

2. Protein Requirements

- The average person needs .57 gram protein for every kilogram of weight.

2.2 pounds = 1 kilo

.26 gram protein for every pound

A person who weighs 115 lbs. needs 29.9 grams of protein each day.



D. World Food

1. Increasing human population caused increased demand for food.
2. Increased farming causes increased pesticide and fertilizer use.
3. Genetically modified foods helps increase the amount of nutrients in food.



- a. Golden Rice = more beta carotene.

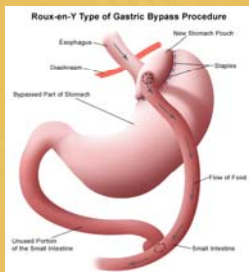
E. Western Diets

1. Eating too much food or too much of the wrong food can lead to malnutrition.
 - a. Refined Sugar
 - Doesn't fill you up so you take in more than you need.
 - b. Fats
 - Can lead to heart disease.



c. Overweight and Obesity

- Can lead to various health issues.
- Some genetic predisposition.
- Exercise



F. Processing of Food

1. Food Additives

- a. Preservatives
 - It takes too long from the field to your table so there has to be a way to stop bacterial growth.
 - **Sodium Nitrate:** added to cured meat
 - **Sodium Dioxide:** added to jams, fruit juice, beer and wine.



b. Bulking Agents

- **Sodium polyphosphate** is added to meat as tenderizers
 - Mainly increases osmosis and makes the meat hold more water.

c. Harmful Effects

- Only 300 additives are regulated by the government.
- Not enough research to know one way or the other.

II. Digestion

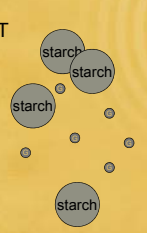
A. Digestion/Absorption

1. Digestion is the complete breakdown of food. (Chemical Process)
2. Absorption is when the products of digestion are absorbed into the bloodstream.

A closer look at absorption...

Food is absorbed (taken in) to the body in the small intestine. (Some absorption does occur in the stomach.) The wall of the small intestine has small holes in it. Only small particles can pass through it:

GUT



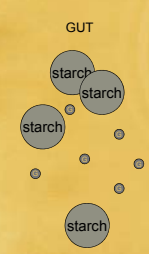
INSIDE THE BODY (BLOOD)

Large particles (e.g. starch) are left in the gut and small particles (e.g. glucose) go through into the blood.

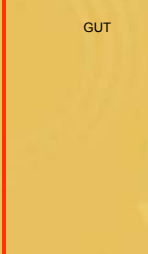
BUT large particles *can* be broken down into small particles. This is called **DIGESTION**

For homework: Draw the before and after slide.

BEFORE ABSORPTION



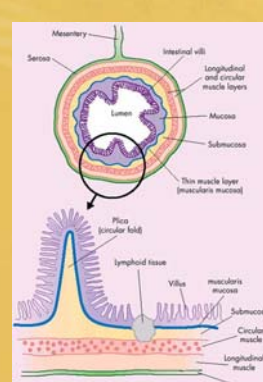
AFTER ABSORPTION



B. The Alimentary Canal

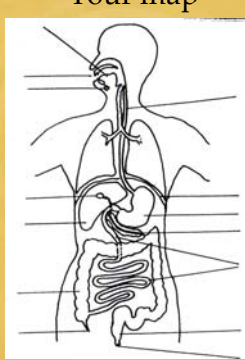
- Structure
 - A tube that runs the length of the organism.
 - Inside is lined with epithelium.
 - quickly replaced.
 - mucus is produced to lubricate and protect by goblet cells.

- Two layers of muscle.
 - Longitudinal
 - Circular



- Function
 - Causes digestion of food with the help of enzymes.
 - Peristalsis
 - Contraction of alimentary canal that pushes food along.

Tour map



Tour guide

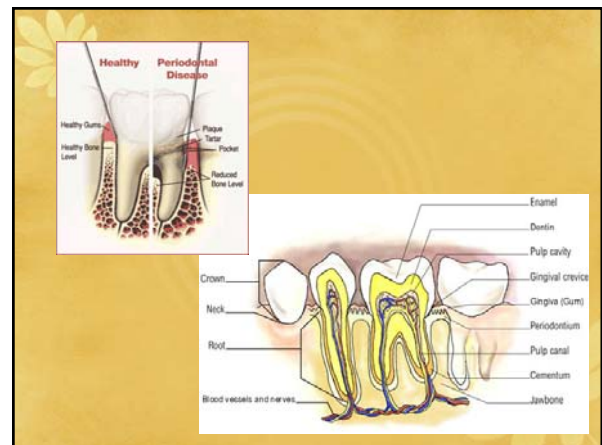
- Mouth
 - Teeth
 - Amylase enzyme (What are enzymes???)
- Oesophagus
 - peristalsis
- Stomach
 - Protease enzyme
 - Enzymes and pH
- Pancreas
 - Amylase, Protease and Lipase Enzymes
- Small intestine
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 - egestion

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Teeth

- Teeth are needed to tear, rip and chew food to physically break it into smaller pieces.
- Mechanical digestion



Types of teeth

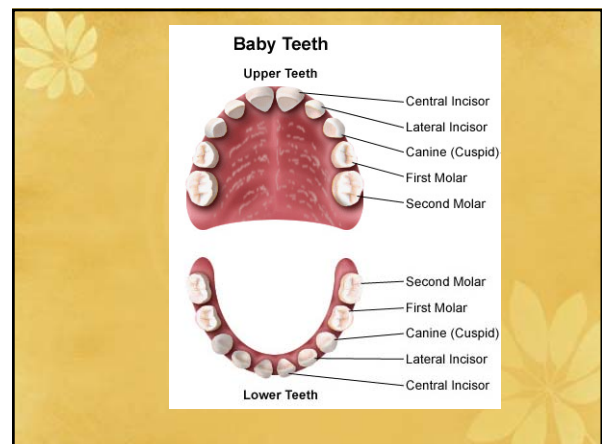
There are different types of teeth for different functions:

Sharp pointed teeth for cutting and tearing food

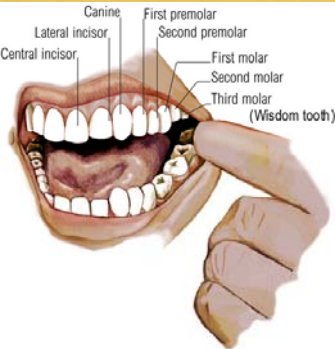
Grinding and mashing food

Crushing and grinding food

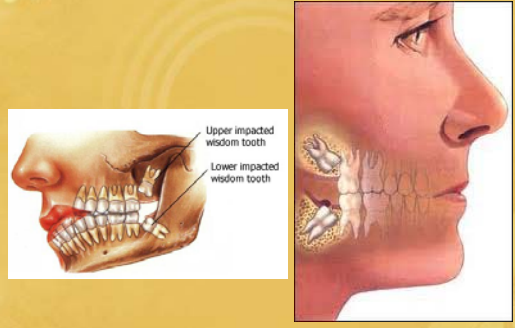
Cutting and chopping food



- An adult has 32 permanent teeth.
- The incisors and canine teeth tear and cut food, and premolars and molars are used to grind and crush.
- The four back teeth are called the wisdom teeth (or third molars).




Wisdom Teeth



Tooth decay

- What do you think causes tooth decay?
- Saliva is normally slightly alkaline. When we eat, bacteria in our mouth feed on sugar and turn it into acid. The sugar starts to attack the enamel and wear it away.

Tooth decay




Decay has started in the enamel	Decay has reached the dentine	Decay reaches the pulp	Decay has spread down to the nerve root
NO PAIN	SLIGHT TOOTHACHE	SEVERE TOOTHACHE	EXCRUCIATING PAIN!!

Preventing Tooth Decay

- How can we prevent tooth decay?
- How well do you brush your teeth?!
- What sort of foods should you avoid?

Tooth Decay



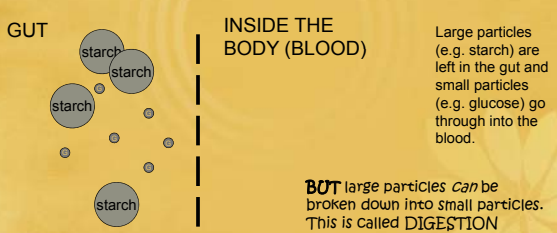
Tour guide

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Enzymes

Remember :

- Large particles cannot be **absorbed** in the small intestine



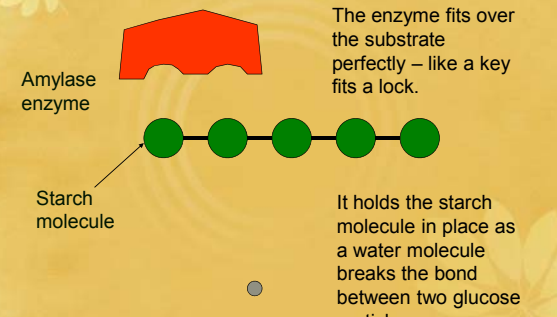
The diagram is divided into two sections by a vertical dashed line. On the left, labeled 'GUT', there are several large blue circles, each labeled 'starch'. On the right, labeled 'INSIDE THE BODY (BLOOD)', there are many small grey dots. Text on the right explains that large particles like starch are left in the gut, while small particles like glucose go into the blood. A note at the bottom states that large particles can be broken down into small particles, a process called digestion.

Large particles (e.g. starch) are left in the gut and small particles (e.g. glucose) go through into the blood.

BUT large particles *can* be broken down into small particles. This is called **DIGESTION**

Enzymes

- They need to be broken down *chemically* by ENZYMES.
- Enzymes are biological catalysts. They speed up chemical reactions in the body.
- Digestive enzymes speed up the breaking down process by holding the large particle (substrate) in place



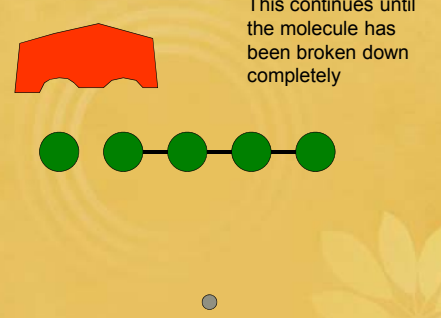
The diagram shows a red, irregularly shaped 'Amylase enzyme' at the top. Below it is a horizontal chain of five green circles representing a 'Starch molecule'. A line points from the label 'Starch molecule' to the first green circle. A small grey dot is positioned below the second and third green circles. Text on the right explains that the enzyme fits over the substrate perfectly, like a key fits a lock, and that it holds the starch molecule in place as a water molecule breaks the bond between two glucose particles.

Amylase enzyme

Starch molecule

The enzyme fits over the substrate perfectly – like a key fits a lock.

It holds the starch molecule in place as a water molecule breaks the bond between two glucose particles

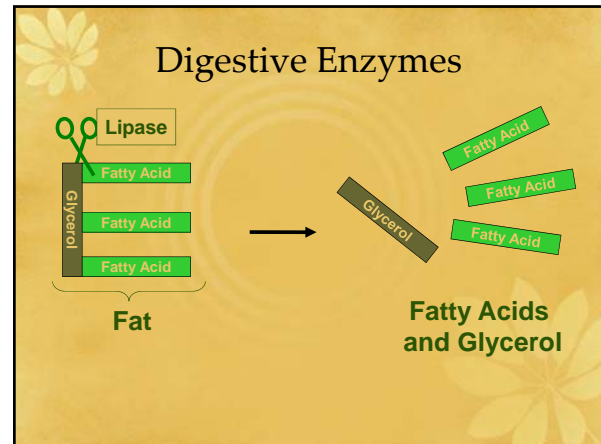
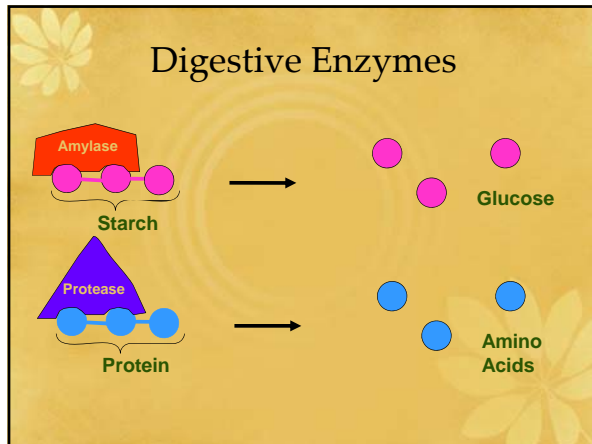


The diagram shows the red 'Amylase enzyme' at the top. Below it, the starch molecule is now completely broken down into five individual green circles. A small grey dot is positioned below the second and third green circles. Text on the right explains that this process continues until the molecule has been broken down completely.

This continues until the molecule has been broken down completely

Digestive Enzymes

- There are 3 main types of digestive enzymes:
 - **Amylase** breaks **starch** down into **glucose**.
 - **Protease** breaks **protein** down into **amino acids**.
 - **Lipase** breaks fats down into **fatty acids** and glycerol



Enzymes in Industry

- Enzymes are used in biological washing powders. These enzymes are good for breaking down colored substances from animals or plants like blood or egg stains.
- Protease enzymes break down protein based stains
- Lipase enzymes break down fat based stains like greasy marks.

Enzymes in Industry

Imagine your favorite shirt has a blood stain on it...

The protease enzymes in biological washing powders, break down the Haemoglobin

It is stained because blood contains the red protein Haemoglobin

These smaller molecules are not coloured and dissolve easily in water. They can be washed away.

The diagram shows a white t-shirt with a red stain. A magnifying glass focuses on the stain, revealing a purple triangle labeled 'Protease' with three red circles below it. To the right, several small red circles represent the broken-down hemoglobin molecules.

Enzymes in Industry

- Enzymes are also used in many other processes in industry e.g.
 - **Pectinase** to extract juice from fruit
 - **Protease** to break down the proteins in baby food to make it easier for the baby to digest
 - **Cellulases** to soften vegetables
 - **Amylases** to make syrup from starch

What factors affect the rate of reaction of enzymes

- How do you think you can speed up the rate of an enzymatic reaction?
(Hint: It's the same as any other reaction!)
 - Temperature
 - pH
 - Add more enzyme and more substrate

Tour guide

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Mouth: What happens

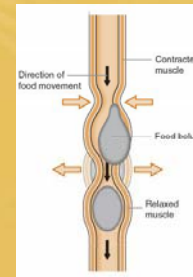
- Food is crushed and ground up by teeth
- The salivary glands make saliva which makes the food moist and easy for swallowing
- Amylase enzyme (in saliva) breaks the carbohydrate starch down into glucose.

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Oesophagus

- Swallowing is voluntary.
- Peristalsis moves the bolus(chewed softened food) down the oesophagus.



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Stomach

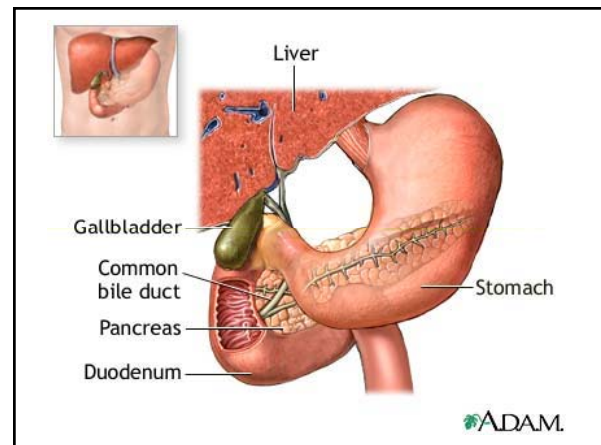
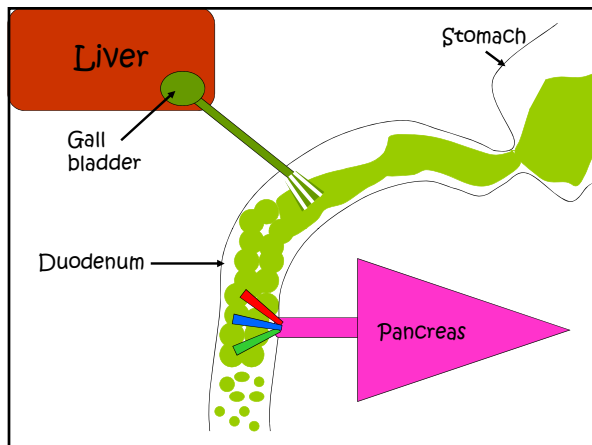
- Stomach muscles contract and relax to mechanically break down the food
- The lining of the stomach produces amylase.
- They also mix the food up with gastric juice and hydrochloric acid
 - The acid kills germs in the food
 - The gastric juice contains the **protease** enzyme **PEPSIN** to digest protein into amino acids
- Food spends about 3-4 hours in here.

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The Pancreas

- The pancreas produces 3 enzymes to complete digestion:
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 - **Protease** breaks **protein** down into **amino acids**.
 - **Lipase** breaks lipids down into **fatty acids** and glycerol



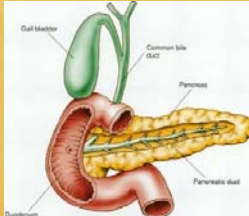
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- Small intestine
 - Duodenum
 - Absorption
- Large intestine
 - egestion

The duodenum

- The first part of the small intestine is called the duodenum.
- Food, still mixed with gastric juice is squirted into it from the stomach.
- The food is now a semi liquid, highly acidic mush.
- It needs to be neutralised and digestion needs to be continued...

- o The pancreas now releases its enzymes to neutralise the acidic liquid coming from the stomach.
- o The layers of the small intestine also secrete amylase to further digestion.

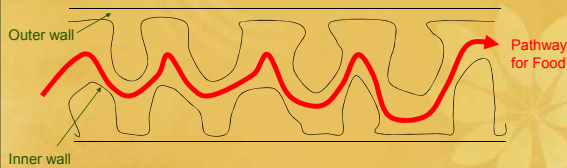


Absorption

- The digested food is **ABSORBED** through the wall of the small intestine into the blood stream.
- To do this effectively, the small intestine needs to have a large surface area.
- This is achieved in the following ways:

Absorption 1

- The tube is over 6 meters long
- The inner wall of the tube has bends in it
- The wall is covered in villi (small finger like structures)

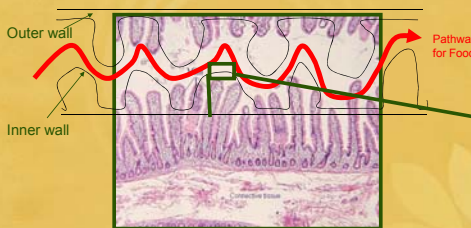


Absorption 2: Villi

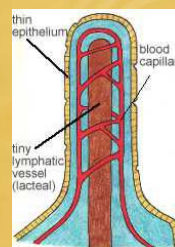
- Absorption takes place through villi.
- These are small finger like structures that stick out into the small intestine tube.
- They help to **increase the surface area** of the small intestine.



Absorption 2: Villi



Absorption 2: Villi



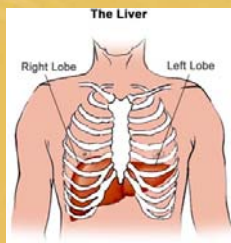
The digested food passes through the wall of the villi (epithelium).

Why does the epithelium have to be thin?

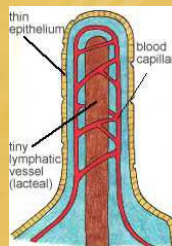
The glucose and amino acids pass into the blood capillary. From here they go to the liver in the HEPATIC PORTAL VEIN

The Liver

- The liver has many functions. Read about them on page 104-105 in your text book
- Answer the 3 questions on page 105 -in full sentences.



Absorption 2: Villi



Lymph is a fluid that is made when the liquid part of blood comes out of blood vessels and washes over the cells.

Lymph drains into lymphatic vessels before joining the blood again.

The fatty acids and glycerol go into one of these lymphatic vessels in the villus.

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Large Intestine/Egestion

- Any indigestible food (e.g. fibre) passes into the large intestine (colon).
- Many beneficial bacteria live in the colon.
- Water is absorbed back into the body.
 - Where has this water come from?
- The food becomes a solid waste called **faeces**.
- Faeces are stored in the rectum and removed through the anus. This removal is called **EGESTION**.

Resources

Understanding the Risks of Diet Drugs

Pamela Walker
The Rosen Publishing Group
2000

Discovery
EDUCATION

Resources

Audio Visual Inc.. (2002). Biologically speaking: systems of the human body. Retrieved September 29, 2010 from Discovery Education website <http://www.discoveryeducation.com/>

Campbell et.al. (2004) Biology: Exploring Life. *Prentice Hall*

Jones, M., Fosbery, R., Taylor, D., & Gregory, J. (2007). AS Level and A Level *Biology, 2nd ed.* Cambridge, UK: Cambridge University Press.

Mackean, D. (2009). IGCSE Biology, 2nd ed. London, UK: Hodder Education.