



NATIONAL SCIENCE

YEAR 9

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S

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Body Systems

This chapter provides a brief review of the essential requirements for life, then examines some of the body systems of multicellular organisms by looking at how systems in humans work and respond to external stimuli.

1.1 Requirements for life

- 1.1.1 Oxygen
- 1.1.2 Nutrients
- 1.1.3 Water
- 1.1.4 Wastes
- 1.1.5 The respiratory system
- 1.1.6 The circulatory system
- 1.1.7 The lymphatic system
- 1.1.8 The digestive system
- 1.1.9 The nervous system
- 1.1.10 The endocrine system
- 1.1.11 The excretory system
- 1.1.12 The skeletal system

1.2 Systems working together

- 1.2.1 Each system has a job
- 1.2.2 Combining the systems

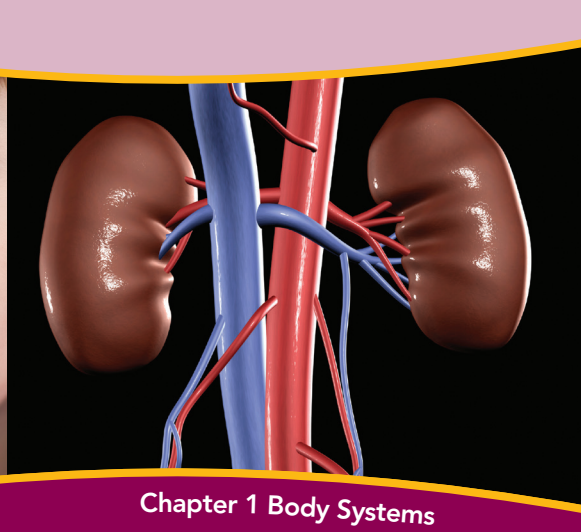
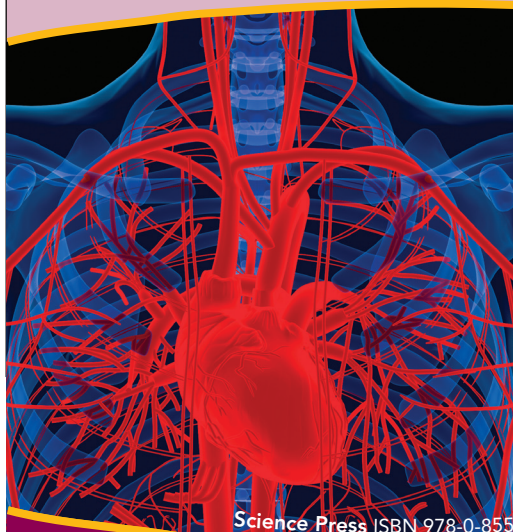
1.3 Responses

- 1.3.1 Sense organs detect external stimuli
- 1.3.2 Nerve cells
- 1.3.3 Reflex arcs
- 1.3.4 Endocrine responses

1.4 Maintaining balance

- 1.4.1 Homeostasis
- 1.4.2 How homeostasis works
- 1.4.3 Homeostasis and sugar levels
- 1.4.4 The inflammatory response
- 1.4.5 The immune response
- 1.4.6 Feedback loops, pharmaceuticals, and sports drinks

Chapter 1 Test



How much do you remember or already know?

1. What is a multicellular organism?
2. What is the function of the digestive system?
3. What is the function of the respiratory system?
4. Which body system is responsible for transporting nutrients, wastes and gases around the body?
5. Which body system consists of ductless glands?
6. Which body system removes wastes made by the body?
7. What is the relationship between cells, tissues, organs and body systems?
8. What is respiration?
9. What is the difference between breathing and respiration?
10. What are the main features of a respiratory surface?
11. What are the main requirements for life?
12. Identify the distinguishing features of living things.
13. What is the function of the heart?
14. Name three types of blood vessels.
15. Which blood vessels have valves?
16. Which type of blood vessels have a pulse?
17. What is the name of the main nitrogenous waste produced by humans?
18. Which organ filters urea from blood?
19. Where is the liver in your body?
20. Outline some functions of the liver.
21. Why are systems needed in multicellular organisms?
22. What is the function of a skeleton?
23. Name the five sense organs.
24. What is the function of the optic nerve?
25. What is the function of the cerebellum in the brain?
26. Name some glands that produce hormones.
27. Name some groups of micro-organisms.
28. Name some organs that are used in organ transplant operations.
29. Name some tissues used in transplants.
30. Why do people need transplants?

1.1 Requirements for life

1.1.2 Nutrients

About 25 of the 92 natural elements are essential to life. Carbon, hydrogen, oxygen and nitrogen make up 96% of living matter.

Calcium is used to make bones hard and is in the cell walls of plants.

An essential nutrient is a substance that must be taken in because it cannot be made from any other material.

Other important elements include sulfur, calcium, phosphorous, iron and sodium.

Iron is needed to make haemoglobin in red blood cells and to make chlorophyll in plants.

Phosphorous is needed to make nucleic acids, e.g. DNA.

Sulfur is used to make some amino acids and proteins.

Organic compounds are produced by living things. Inorganic compounds are all other compounds.

Sodium is needed so nerves can pass messages and so plants can photosynthesise.

Animals need 20 amino acids to make proteins and most species can make half of these if they have organic nitrogen in their diet.

I wonder if these earthlings will be more nutritious than the last lot?

1.1.2.1 The table lists the important elements in the human body in order of their atomic number. From this table list the 10 elements that make up most of the human body in order of most abundant to least abundant.

Element	Symbol	Atomic number	Approximate percentage of human body (%)
Hydrogen	H	1	9.5
Carbon	C	6	18.5
Nitrogen	N	7	3.3
Oxygen	O	8	65.0
Fluorine	F	9	Trace
Sodium	Na	11	0.2
Magnesium	Mg	12	0.1
Phosphorus	P	15	1.0
Sulfur	S	16	0.3
Chlorine	Cl	17	0.2
Potassium	K	19	0.4
Calcium	Ca	20	1.5
Iron	Fe	26	Trace
Zinc	Zn	30	Trace

1.1.2.2 Make up a mnemonic using the symbols for each element to remember the six most abundant elements in the human body.

1.1.2.3 Construct a table using the information in the boxes to summarise why living things need calcium, iron, sodium, sulfur, phosphorus and nitrogen.

1.1.4 Wastes

Reactions in cells produce waste products.

The main waste products made by humans are carbon dioxide, urea and water.

Kidneys filter urea from the blood.

Excretion is the removal of waste products from reactions in the body.

I don't produce any wastes.

Urea from the kidneys travels to the bladder as part of urine and leaves the body from the bladder.

In humans, excretion mainly occurs from the lungs, skin, kidneys and urinary system.

Excretion does NOT include the elimination of undigested or unabsorbed food from the digestive system.



Carbon dioxide is excreted from the lungs.

Waste products can be harmful and need to be removed before they cause damage.

1.1.4.1 Define excretion.

1.1.4.2 What are the two main waste products that need to be excreted from the body?

1.1.4.3 What are the two main excretory organs of the body?

1.1.4.4 The table shows the approximate masses of water gained and lost each day by humans.

Daily loss		Daily gain	
Process	Mass (g)	Process	Mass (g)
Excretion of urine	1500	Drinking	1300
Evaporation from lungs	400	Eating	850
Evaporation from skin	500	Respiration	350
Elimination of faeces	100		
Total	2500	Total	2500

What can be concluded about excretion from this data?

1.1 Requirements for life

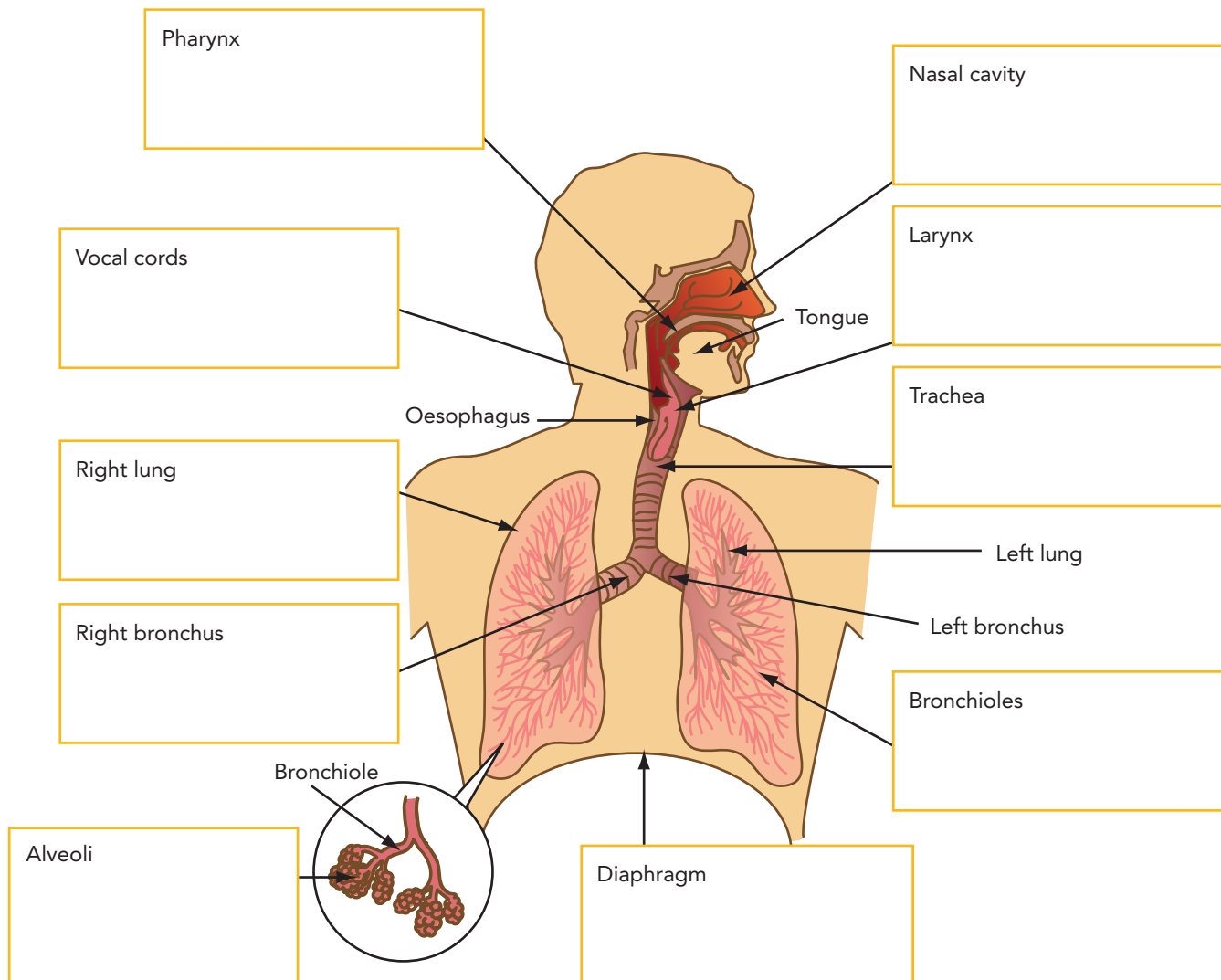
1.1.5 The respiratory system

The respiratory system consists of the mouth, nasal cavity, pharynx, larynx, trachea, bronchi and lungs. The lower section is bounded by the ribs, spine and diaphragm.

The main functions of the human respiratory system are to:

- Provide a large surface area for gas exchange.
- Move air to and from the lungs.
- Protect the gas exchange surface from dehydration and temperature changes.
- Defend the system against invasion by micro-organisms including pathogens.
- Produce sounds, e.g. speaking, singing.

1.1.5.1 Use your knowledge of the respiratory system or research to write a brief description of the function of each part of the human respiratory system in each of the boxes.

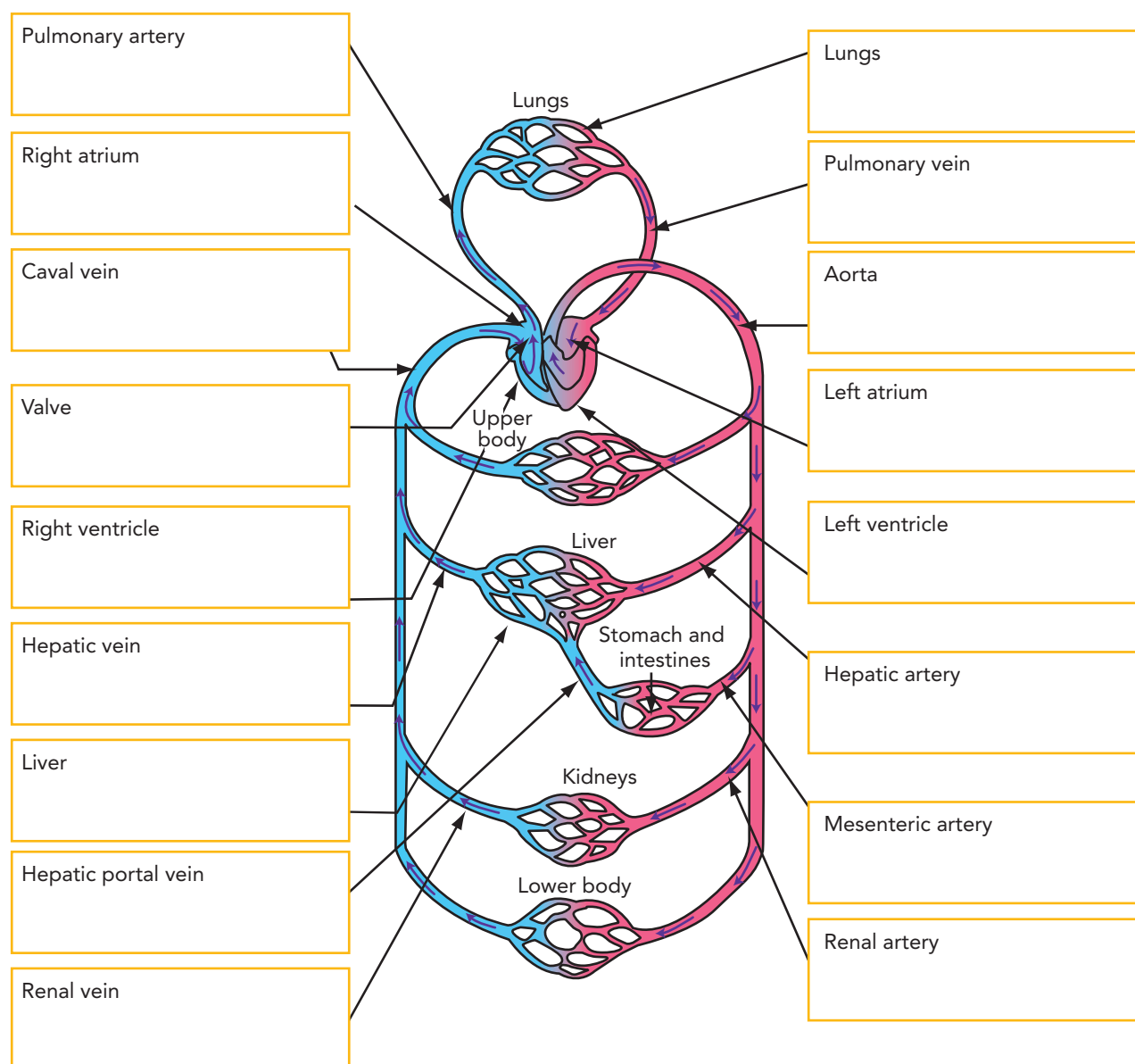


1.1.6 The circulatory system

The circulatory or cardiovascular system consists of the heart, blood vessels and blood.

- **Blood** is a specialised tissue that carries nutrients, oxygen and hormones to the cells of the body. It carries wastes to the organs of excretion and it transports specialised cells to defend against infection and disease.
- The **heart** is a specialised organ that beats to pump blood through blood vessels.
- **Blood vessels** include arteries which take blood away from the heart, capillaries which connect arteries/veins and are the site of the exchange of substances between the blood and body cells and veins which take blood back to the heart.

1.1.6.1 Use your knowledge of the circulatory system or research to fill in the boxes to describe the pathway of blood around the body.

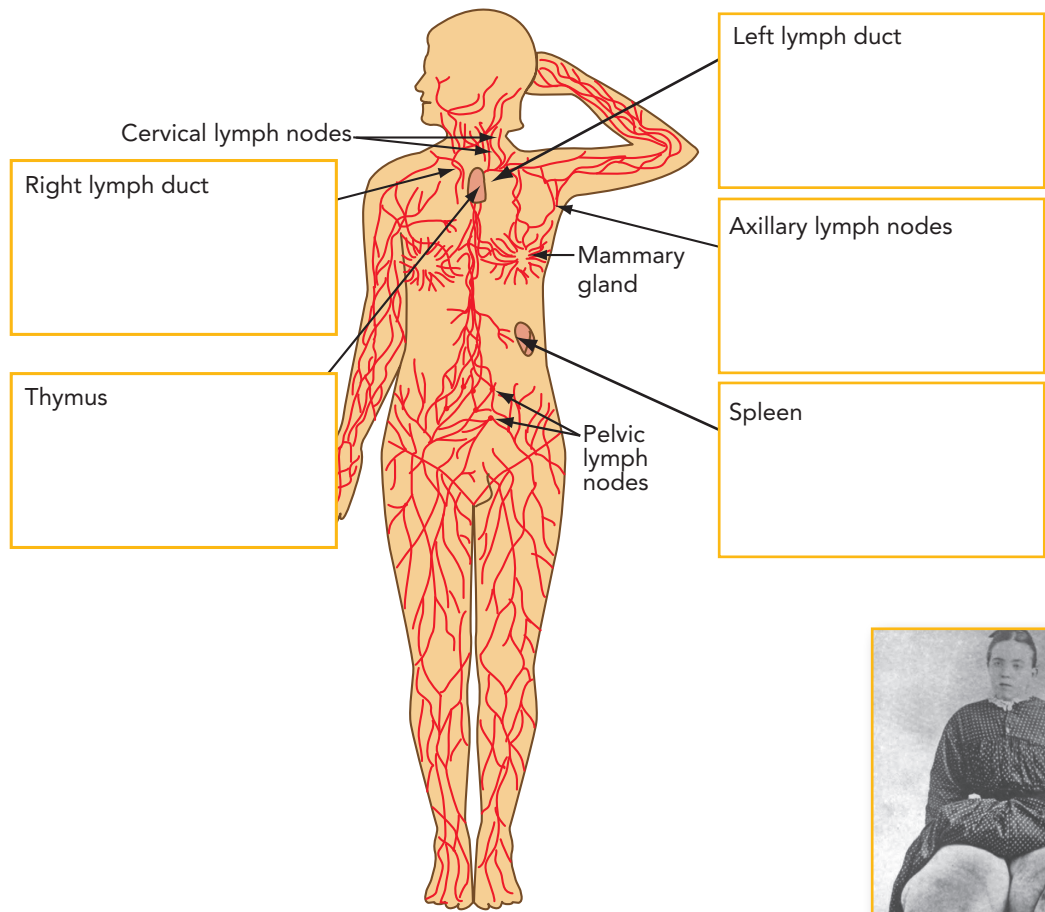


1.1 Requirements for life

1.1.7.7 The table shows the functions of different parts of the lymphatic system.

Part 1	Part 2	Part 3	Part 4	Part 5
Is the largest lymph vessel and collects lymph from the body to drain into the blood circulation.	Collects lymph from the right arm, right side of the head and neck and upper right chest.	Is largest in the first couple of years after birth and then slowly gets smaller. It changes lymphocytes made in the bone marrow into specialised T-cells.	Is the largest lymph organ. It removes old or abnormal red blood cells to be broken down for recycling of materials. It stores iron from recycled red blood cells and starts the immune response if an antigen is detected.	Filter lymph and lymphocytes which help defend against infection and disease. Most of the lymph from the breasts drains into axillary lymph nodes.

Connect each description with its part by writing the description in the box.



1.1.7.8 **Elephantiasis** is a disease caused by parasites blocking lymph vessels, e.g. roundworms are transmitted into humans in a mosquito bite. From the picture, describe what happens when lymph vessels are blocked by parasites.

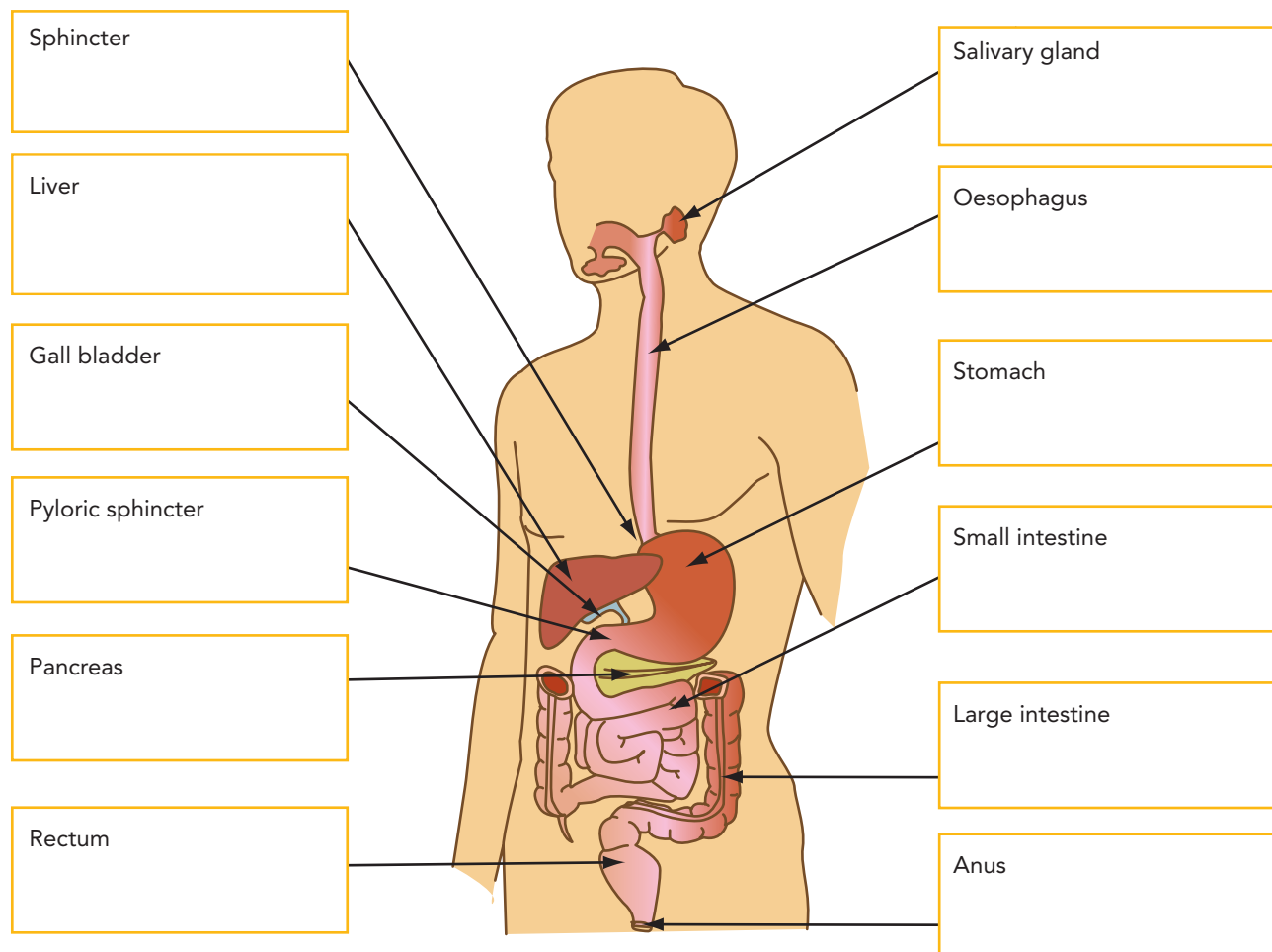


1.1 Requirements for life

1.1.8 The digestive system

The digestive system breaks down food into small soluble molecules that can be absorbed into the body. Proteins are broken down into amino acids, lipids are broken down to fatty acids and glycerol and carbohydrates are broken down to glucose.

1.1.8.1 Use your knowledge of the digestive system or research to write a brief description of the function of each part of the human digestive system in each of the boxes.



1.1.8.2 Complete the table to summarise the substances that break down food in digestion.

Substance	Where produced	Role in digestion
Gastric juice		
Salivary amylase		
Bile		
Pancreatic juices		

1.1.9 The nervous system

The vertebrate nervous system can be divided into the **central nervous system** (CNS) and the **peripheral nervous system** (PNS). The CNS consists of the brain and the spinal cord and the PNS is all the sensory and motor neurons that connect to the CNS.

The nervous system works by sending messages along neurons. A **neuron** is a nerve cell. There are three types of neurons – sensory neurons, connector neurons and motor neurons. A **ganglion** is a cluster of nerve cell bodies.

Neurons link together to form circuits that carry out specific jobs. The most complex circuits are in the brain. The vertebrate brain is divided into three sections – the **cerebellum** which controls balance and movement, the **medulla oblongata** which is concerned with regulation of heartbeat, body temperature and the rate of breathing and the **cerebrum** which is concerned with thinking, intelligence, memory, language, reasoning, feeling and learned skills.

1.1.9.1 What is the function of the nervous system?

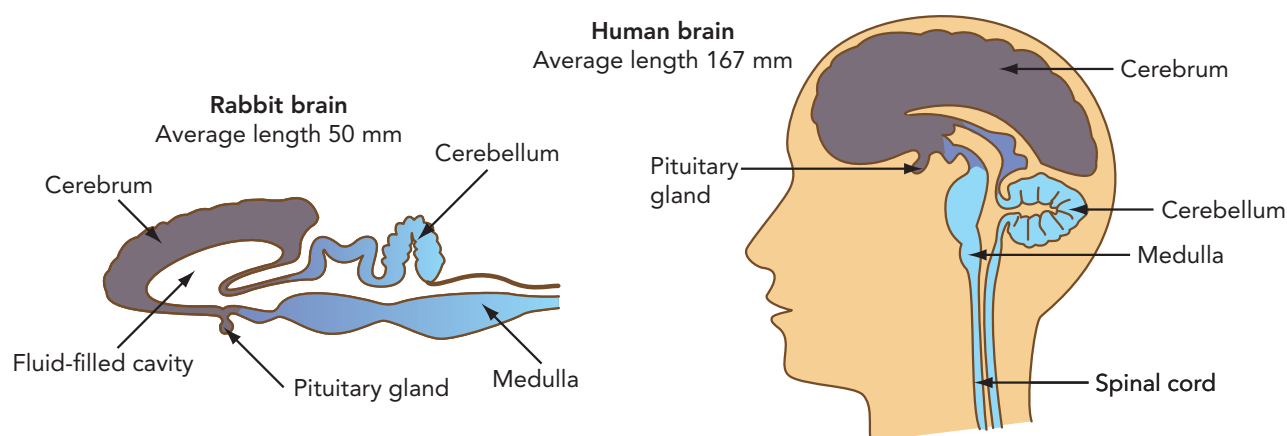
1.1.9.2 What are the two divisions of the vertebrate nervous system?

1.1.9.3 What is a neuron?

1.1.9.4 What is a ganglion?

1.1.9.5 How does the nervous system work?

1.1.9.6 The diagram compares a human brain with a rabbit brain.



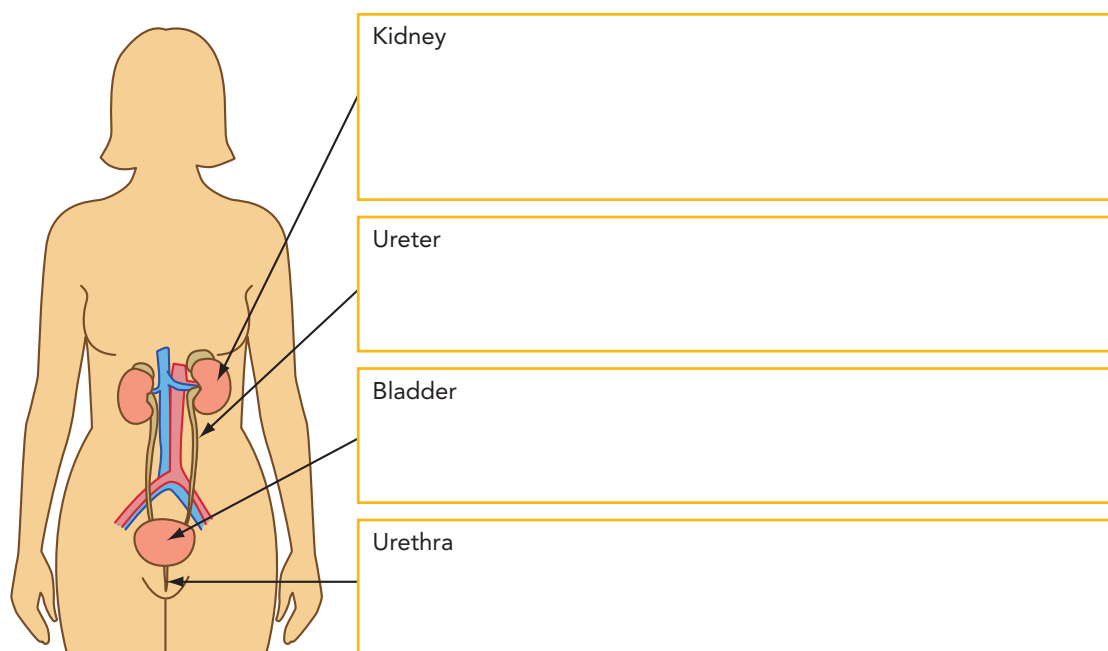
- (a) Which section shows greater development in humans?
- (b) Why is this region of the brain important?

1.1.11 The excretory system

The **kidneys** excrete nitrogenous waste. The nitrogen comes from surplus amino acids that are broken down to **ammonia**. The protein that you eat is used to make new proteins but there is some surplus which needs to be broken down.

Ammonia is poisonous, even in small concentrations, so the liver converts the waste to **urea** which is soluble in water and less poisonous than ammonia. Urea moves from the liver into the bloodstream. When the blood reaches the kidney, the urea is filtered from the blood and sent to the bladder where it combines with salts, water and other substances that will leave the body as **urine**.

1.1.11.1 Use your knowledge of the excretory system or research to write a brief description of the function of each part of the excretory system in each of the boxes.



1.1.11.2 The table shows the different nitrogen compounds in blood and urine.

(a) What are the main differences in the concentration of nitrogenous compounds in blood and urine?

.....

.....

.....

Nitrogen compound	Blood (%)	Urine (%)
Proteins	7 to 9	0
Urea	0.03	2
Uric acid	0.02	0.05
Ammonium compounds	0.001	0.04

(b) If a person has proteins in their urine, why should they see a doctor?

.....

.....

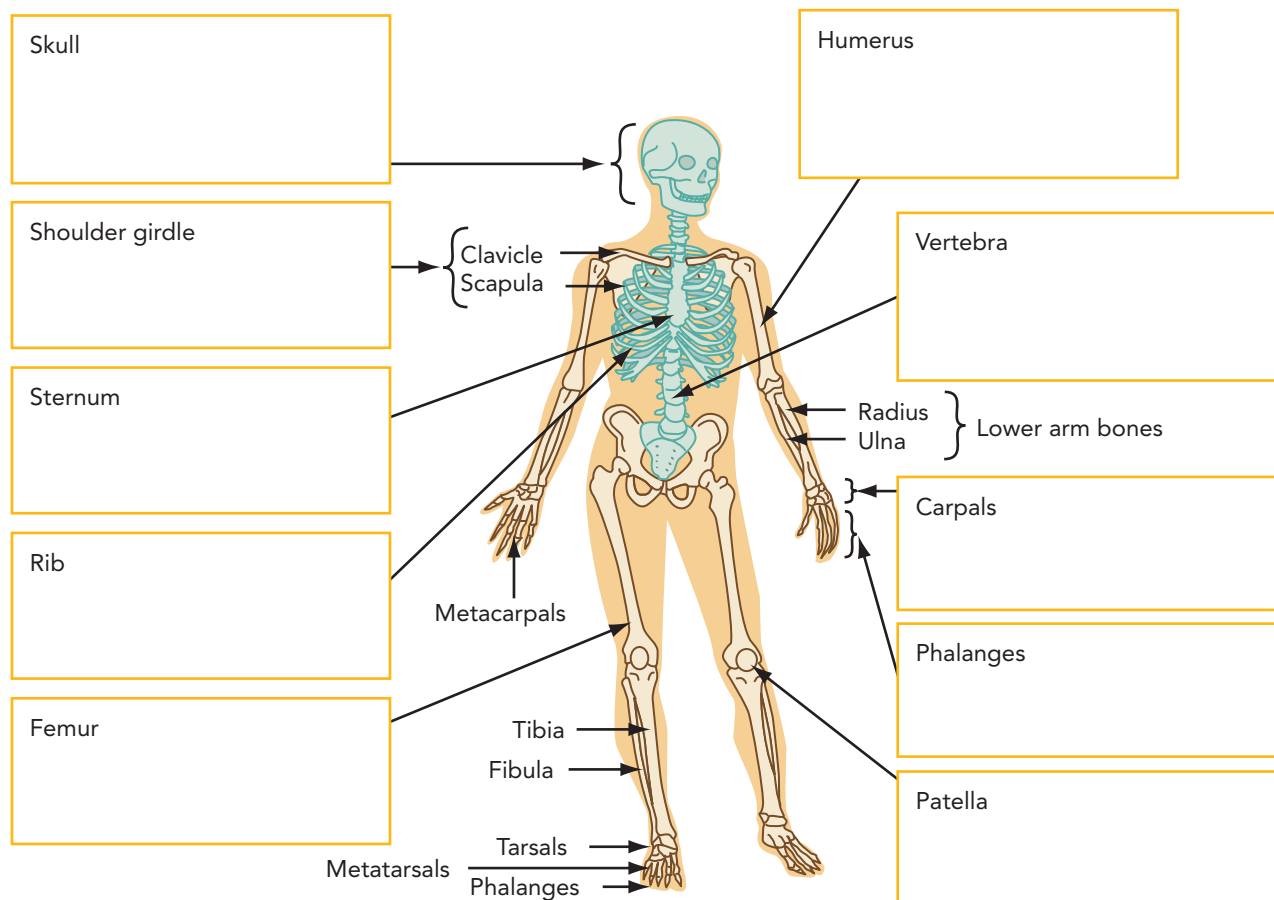
1.1 Requirements for life

1.1.12 The skeletal system

The **skeletal system** consists of cartilage and bone or some combination of each in rigid parts connected by joints. The vertebral column in humans is made up of 33 separate bones called **vertebrae**. The **skull** is made of many bony plates joined together to protect the brain and main sense organs. The chest is surrounded by semicircular bony **ribs**, each attached to a vertebra. The limbs are held in position by a girdle – the arms are connected to the **shoulder girdle** and the legs are attached to the **pelvic girdle**.

Joints occur where two bones meet. There are fixed joints, and movable joints. Hinge joints, e.g. the elbow joint and ball and socket joints, e.g. hip joint are movable joints that allow movement. **Ligaments** hold bones together. **Tendons** attach the end of a muscle to bone, e.g. Achilles tendon attaches the calf muscle to the heel bone. **Muscles** are long cells that can contract and shorten. When the muscle shortens it pulls on a bone and causes movement. Voluntary muscles can be controlled by conscious thought.

1.1.12.1 Use your knowledge of the skeletal system or research to write a brief description of the function of each part of the skeletal system in each of the boxes.



1.1.12.2 How many bones are in the human body?

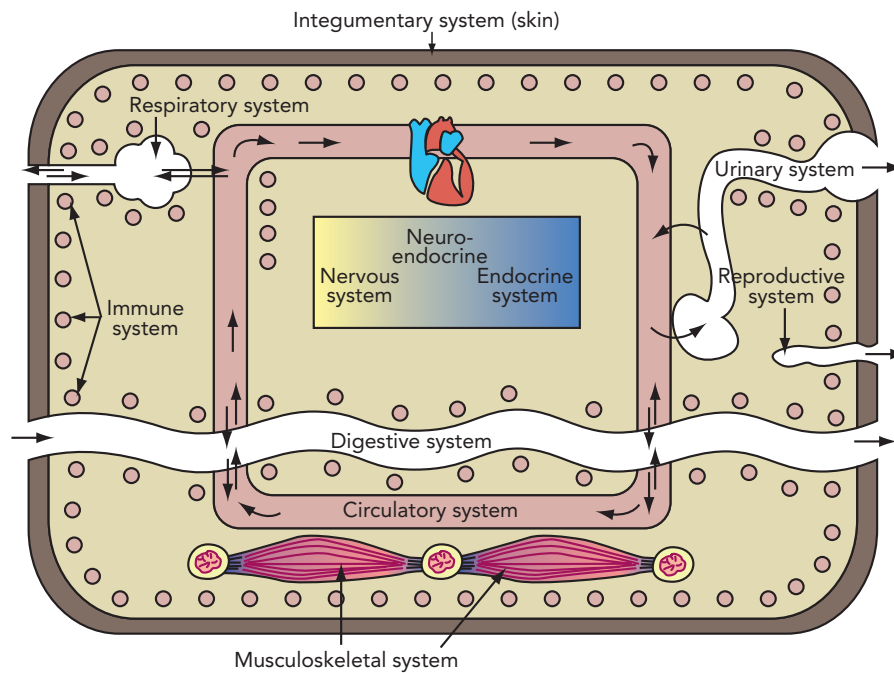
1.1.12.3 Which part of the skeleton has the highest number of bones?

1.1.12.4 Name two types of movable joints.

1.2.2 Combining the systems

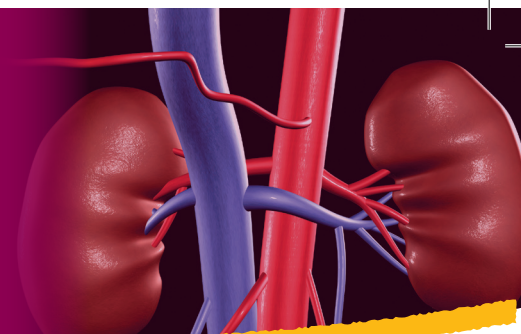
The systems in multicellular organisms need to work together to bring food and nutrients to cells, to take away wastes, to let the organism respond to stimuli, to allow growth, and for reproduction and movement.

1.2.2.1 The diagram shows a stylised body with several systems.



- (a) On the diagram draw the pathway of a substance or an element in a substance as it passes through the body and is in different organ systems. Describe in words what is happening.
-
-
-
- (b) An atom of oxygen enters the body as part of oxygen gas. It is used in respiration in a cell and becomes part of a water molecule. The water molecule leaves the body as part of urine. Draw a flow diagram to show the different systems the oxygen atom travelled in as it passed through the body.
-
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-

1.3 Responses



1.3.1 Sense organs detect external stimuli

The eye

Most people rely heavily on sight to find out about their environment – to see what is around us, to read, watch TV, to view a computer monitor, to collect and cook food, and to find our way around outside. The eye is the organ of sight.

Parts of the human eye and their function

Part of eye	Its function
Conjunctiva	Thin clear tissue which covers the inner surface of the eyelids and the front of the eye. It helps keep the eye moist. (It does not cover the cornea.)
Cornea	Clear window of the front of the eye that lets light in.
Iris	The coloured part of the eye made of muscles that control the amount of light entering the eye.
Pupil	The hole in the centre of the iris.
Aqueous humour	Watery fluid in the front part of the eye. It maintains the shape of the front of the eye and acts as a liquid lens to help focus light onto the retina.
Lens	Transparent body behind the iris and pupil that focuses light onto the retina. It can change shape.
Suspensory ligaments	Hold the lens in position.
Ciliary body	Has muscles and processes that connect to the suspensory ligaments and cause the lens to change shape while focusing.
Vitreous humour	Jelly mass at the back of the eye. It maintains the shape of the eyeball and acts as a liquid lens to help focus light onto the retina.
Sclera	Tough, white protective outer layer of the eye.
Choroid layer	Black middle layer of the wall of the eye. It has blood vessels to bring oxygen and nutrients to the cells and remove wastes. The black stops light being reflected internally around the eye.
Retina	Innermost layer of the wall of the eye with photoreceptors (rods and cones) which pick up light and begin a message that goes to the brain.
Blind spot	The point at the back of the eye where blood vessels and nerves join the eyeball. Since there are no photoreceptors present, any light falling on this point cannot send messages to the brain.
Fovea (yellow spot)	Part of the retina with the highest concentration of cones to give the sharpest vision. Gives colour vision.

1.3.1.1

- Name the three layers of the wall of the eye from the outside in.
- Which parts help to focus light onto the retina?



1.3 Responses

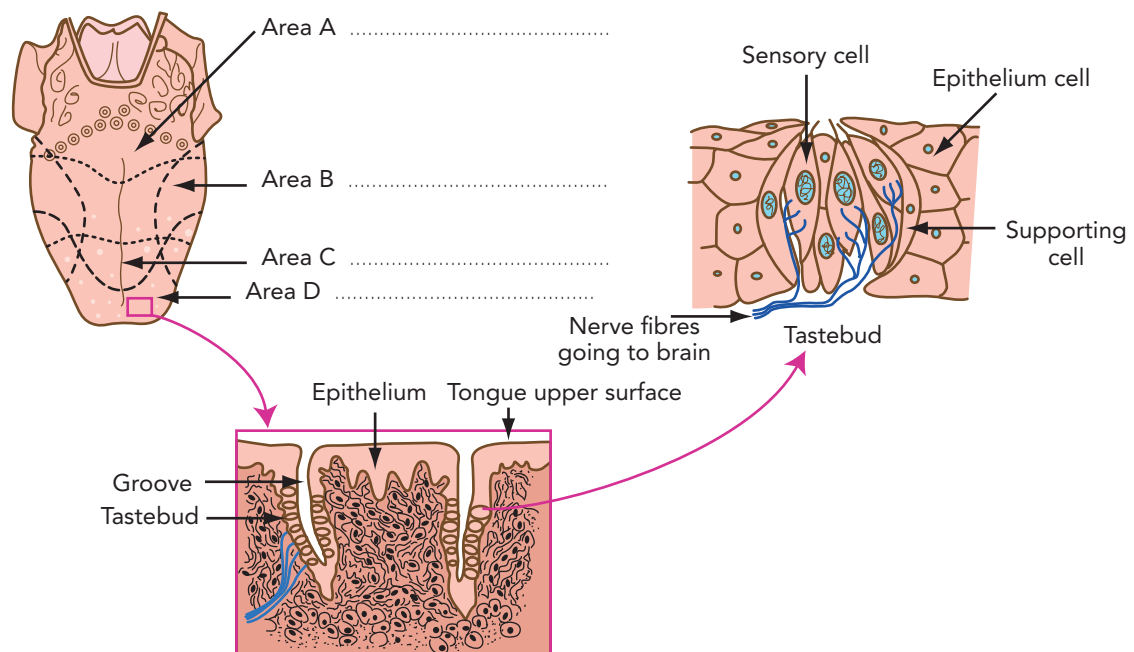
The tongue

The tongue has tastebuds which detect four basic sensations – sweet, sour, bitter and salty. Tastebuds are chemoreceptors and detect chemicals. Tastebuds are mostly in grooves around the bases of small grooves in the upper surface of the tongue. The ‘flavour’ of food is a combination of sensations with the tongue detecting sweet, sour, bitter and salty and the vapours from the food stimulating smell receptors. This is why food can seem ‘tasteless’ when you have a cold and the nasal passages are full of mucus.

Wonder why you lick an ice cream with the end of your tongue? Different areas of the tongue have different numbers of tastebuds so we pick up tastes more strongly in some parts – sweet and salt on the front, bitter on the back and sour on the sides.

The sense of taste changes as you age. People begin with over 10 000 tastebuds but after the age of 50 the number quickly declines. This is why children often find food too spicy and older people find food bland.

1.3.1.8 Identify areas A, B, C and D on the tongue.



1.3.1.9 Complete the sentences using the following words.

bitter, heat, smell, grooves, sour, chemoreceptors, cold

- (a) Tastebuds are and detect chemicals.
- (b) Tastebuds at the back of the tongue detect taste.
- (c) Tastebuds are found in on the upper surface of the tongue.
- (d) Nearly all acids give a taste sensation.
- (e) The flavour of foods is a combination of both taste and
- (f) The tongue also has receptors that detect and

1.3 Responses

1.3.1.16 Complete the table to summarise the five sense organs.

Sense organ	Stimulus	Parts of the sense organ	Diagram

2.1 Asexual and sexual reproduction

2.1.6 Variation among offspring

This unit of work involves you working with three friends in your class and conducting research to answer the following questions. Note that there are four questions. Your group is to discuss each question and then perhaps allocate different aspects of the answer to each group member to research.

However, you are not only going to answer these questions, but you are also each going to **produce a colourful, happy infographic** to summarise what you find so that it can be displayed around the room and perhaps at the next parents meeting so they can see how well you are progressing.

When families have more than one child, unless they are identical twins, there is genetic variation between offspring. These differences are due to several mechanisms that occur during the reproductive process. Your job is to describe each mechanism and illustrate how it works on your infographic. You have one week to complete this task!

2.1.6.1 What happens during the reproductive process that makes offspring in the same family different to each other unless they are identical twins?

2.1.6.2 Why are identical twins not different? Why are non-identical twins different?



Identical twins look the same.



Non-identical twins don't look the same.



Strawberries.

2.1.6.3 Why don't these differences occur in plants and animals which undergo asexual reproduction?

2.1.6.4 Strawberries reproduce sexually through pollination as well as asexually through runners. What are the advantages and disadvantages of sexual and asexual reproduction in strawberries?

3.1 Kinetic and gravitational potential energy

3.1.1 Kinetic energy (E_K)

Kinetic energy is the energy an object has because of its mass and its velocity. The kinetic energy of an object is directly proportional to the mass of the object and to the velocity of the object squared.

The equation we use to find the kinetic energy of a moving object is:

$$E_K = \frac{1}{2}mv^2$$

Where: E_K = kinetic energy in joules (J)

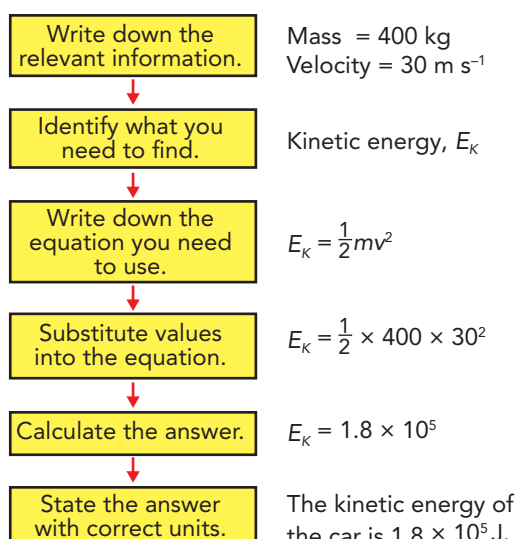
m = mass in kilograms (kg)

v = velocity in metres per second (m s^{-1})

Solving problems in physics

Example: How much kinetic energy does a 400 kg car have when it is moving at 30 m s^{-1} ?

Solution: Solving problems like this is easy if you are systematic in your approach.



3.1.1.1 A 12 kg rock is rolling down a hill at 2.0 m s^{-1} . How much kinetic energy does it have?

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3.1.1.2 A 7.0 kg bowling ball is rolled down the alley at 3.0 m s^{-1} . How much kinetic energy does it have?

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4.2 Using electromagnetic energy

4.2.2 More about X-rays



Technologies such as X-rays (discovered by **Wilhelm Roentgen**) have enabled us to find out more about the human body, and to diagnose some problems and diseases.

X-rays are a part of the electromagnetic spectrum. They have high energy and a wavelength of 0.01 to 10 nanometres.

While experimenting with cathode rays (the same rays used in cathode ray tube televisions), Roentgen noticed a fluorescent effect even though the tube was surrounded by heavy black cardboard. In a series of experiments to study properties of these rays he saw part of his own skeleton.

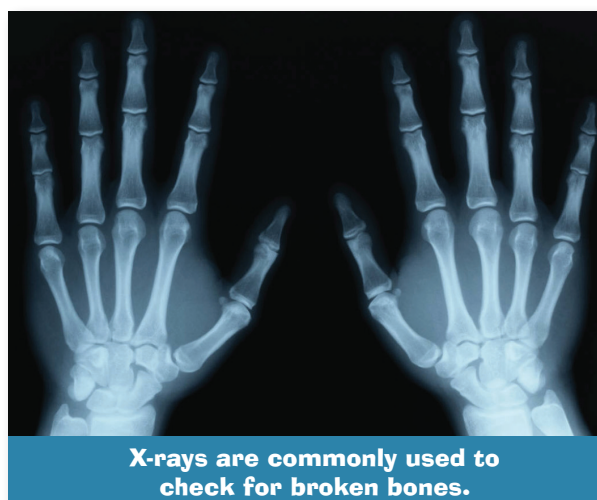
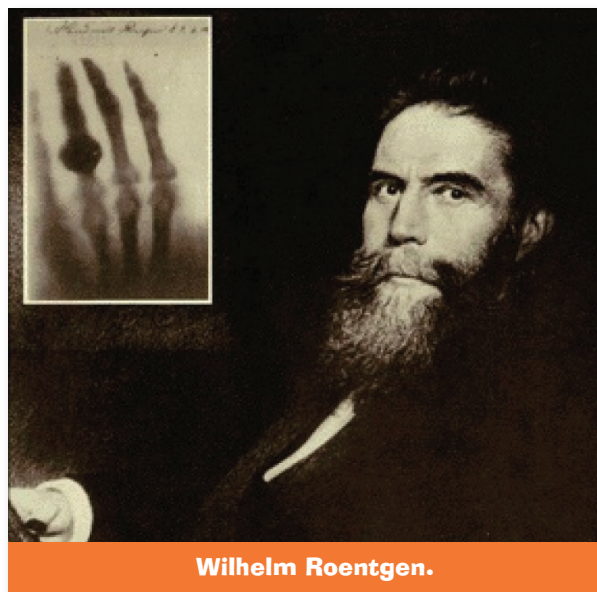
The first X-ray picture showed the bones of his wife's hand. Roentgen published a paper 'On a New Kind of Rays' in 1895 and became the father of diagnostic radiology.

The use of X-rays is now very common in modern medicine. X-rays can pass through skin and muscle but are blocked by teeth and bone. When the image is captured on photographic film it is called an X-ray.

Common uses are dental X-rays to help fix teeth, checking for broken bones, dislocations or fractures, diagnosis of chest problems including cancers, and images needed during surgery or to find foreign objects such as metal fragments in the body.

X-rays have also been used to work out the structure of organic molecules. Rosalind Franklin used X-ray crystallography to take a picture of a DNA molecule. This picture enabled James Watson and Francis Crick to work out the double helix structure and win the Nobel Prize in Physiology or Medicine in 1962.

X-rays are an ionising radiation which means they can cause an electron to be removed from an atom or a molecule to make it a charged ion.



If an organic molecule is ionised it becomes a **free radical**. Organic free radicals are chemically reactive and, in large amounts, can damage cells and tissues.

In the 1920s, Hermann Muller discovered that X-rays caused genetic changes in fruit flies – called X-ray mutagenesis. He realised that not only did he create mutant fruit flies, but the laboratory workers were also at risk. He warned of the long-term dangers of radiation, e.g. from nuclear testing.

4.2 Using electromagnetic energy

4.2.2.1 What was Wilhelm Roentgen's contribution to our use of X-rays in medicine?

.....

.....

4.2.2.2 What are X-rays?

4.2.2.3 What is meant by ionising radiation?

.....

4.2.2.4 What is the potential biological hazard of ionising radiation?

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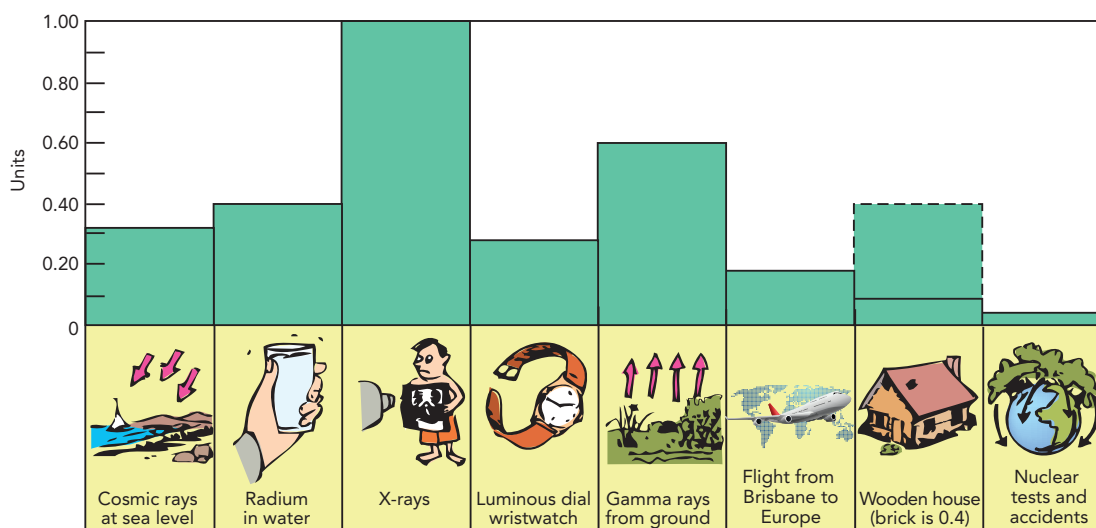
4.2.2.5 List four medical uses for X-rays.

.....

4.2.2.6 What is X-ray mutagenesis and why is it a problem?

.....

4.2.2.7 The diagram shows the average radiation dosage per year from some environmental sources.



(a) From the diagram determine the radiation dosage for 1 year from:

(i) Living in a brick house.

(ii) Wearing a luminous dial wristwatch.

(b) List five sources of 'background radiation' to which you are exposed.

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(c) List five possible problems that can occur if a person has too much exposure to X-rays.

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4.2.3 Microwaves and radar



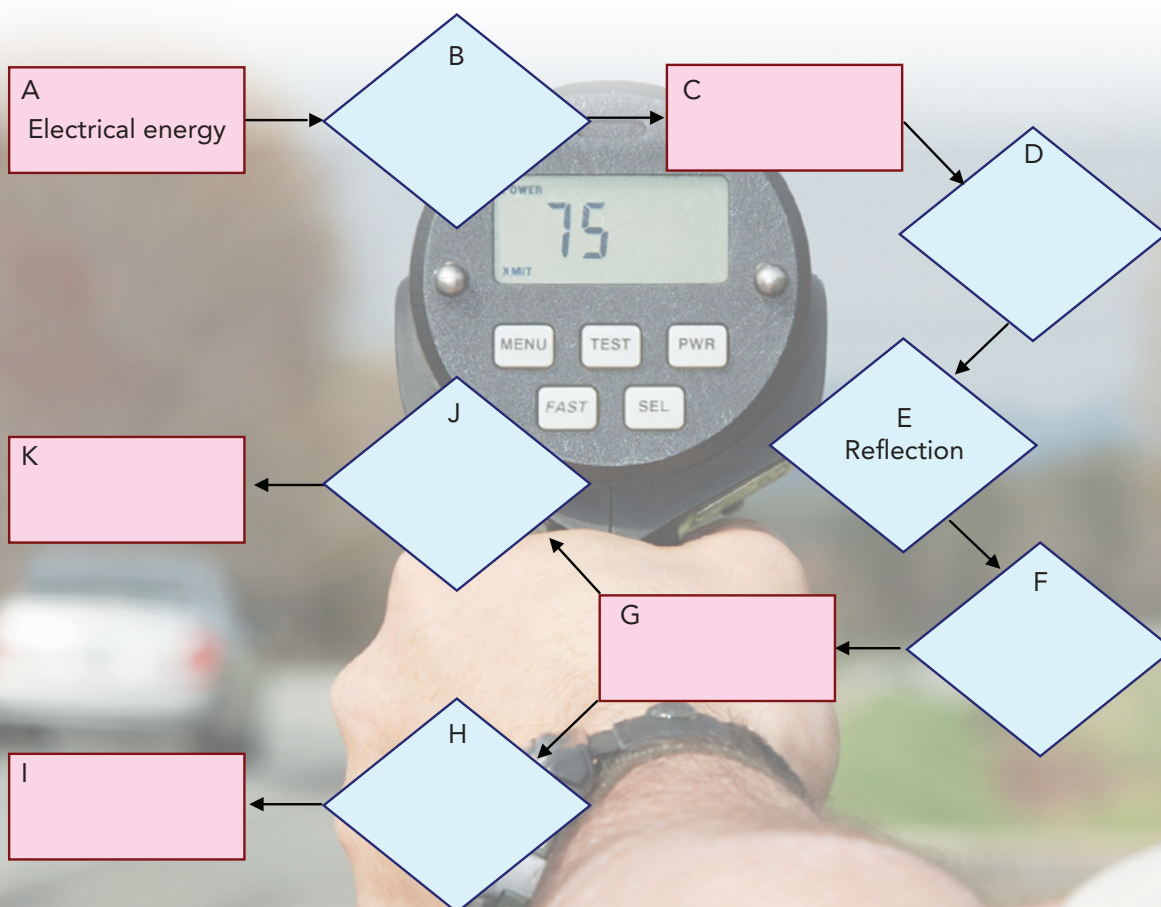
Microwaves are part of the electromagnetic spectrum and are a non-ionising radiation as they do not have enough energy to remove electrons from atoms or molecules to make the atoms and molecules into ions. They are shortwave radio waves with wavelengths between about 1 mm and 1 m. They also include UHF (ultra high frequency) and EHF (extremely high frequency) radio waves.

Microwaves are generated by electrons vibrating in electrical devices. Radar devices use microwaves to improve air and water transport by detecting storms, reefs, underwater hazards, and their use in police speeding devices assists in making road transport safer.

4.2.3.1 Read the information below on how radar works then use it to complete the flow diagram to summarise the energy changes that occur in radar operations. Note that you should write the names of devices or processes in the diamond shapes and energy forms in the rectangles.

How radar works

Radar uses electromagnetic radiation – microwaves. A microwave transmitter converts electrical energy into microwaves and sends them outwards towards a target. If they hit the target, some of the microwaves reflect back to their point of origin where a receiver detects them and converts them back into electrical energy. The electrical signals then pass into a loudspeaker to produce sound and a cathode ray oscilloscope to produce a light ‘blip’ on a screen.



4.2 Using electromagnetic energy

4.2.4 Microwaves and communications



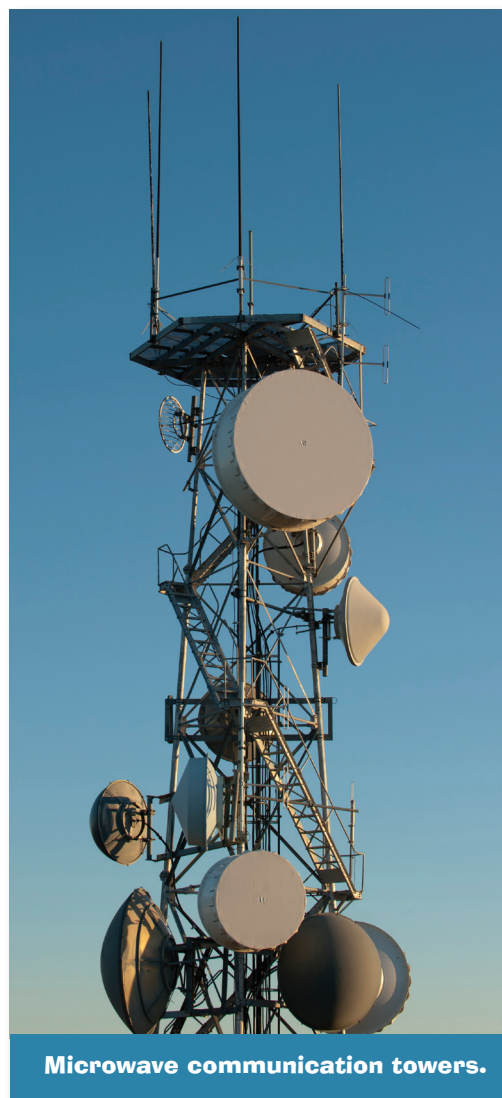
Microwaves can transmit information through light rain, snow, clouds, smoke and haze. Observational satellites use microwaves to view Earth from space as these waves pass through the ionosphere (a region of highly ionised particles from the Sun trapped by the Earth's magnetic field high in the atmosphere). Telecommunication satellites use microwaves. TV news vans send information back to their TV station using microwaves and GPS navigation systems (global positioning systems) use microwave signals from orbiting satellites to work out a receiver's location, speed and direction of travel.

A microwave tower can transmit information for telephone calls and computer data. Before fibre optics were developed most long-distance telephone calls used microwave radio links. Wireless internet access services, mobile broadband wireless access and Bluetooth use microwaves.

Radioastronomy also uses microwaves. The famous radio telescope at Parkes in western NSW has microwave detectors as well as radio wave detectors. Cosmic microwave background radiation from the Universe gives us information about the big bang theory of the origin of the Universe.



Radio telescope at Parkes in NSW.



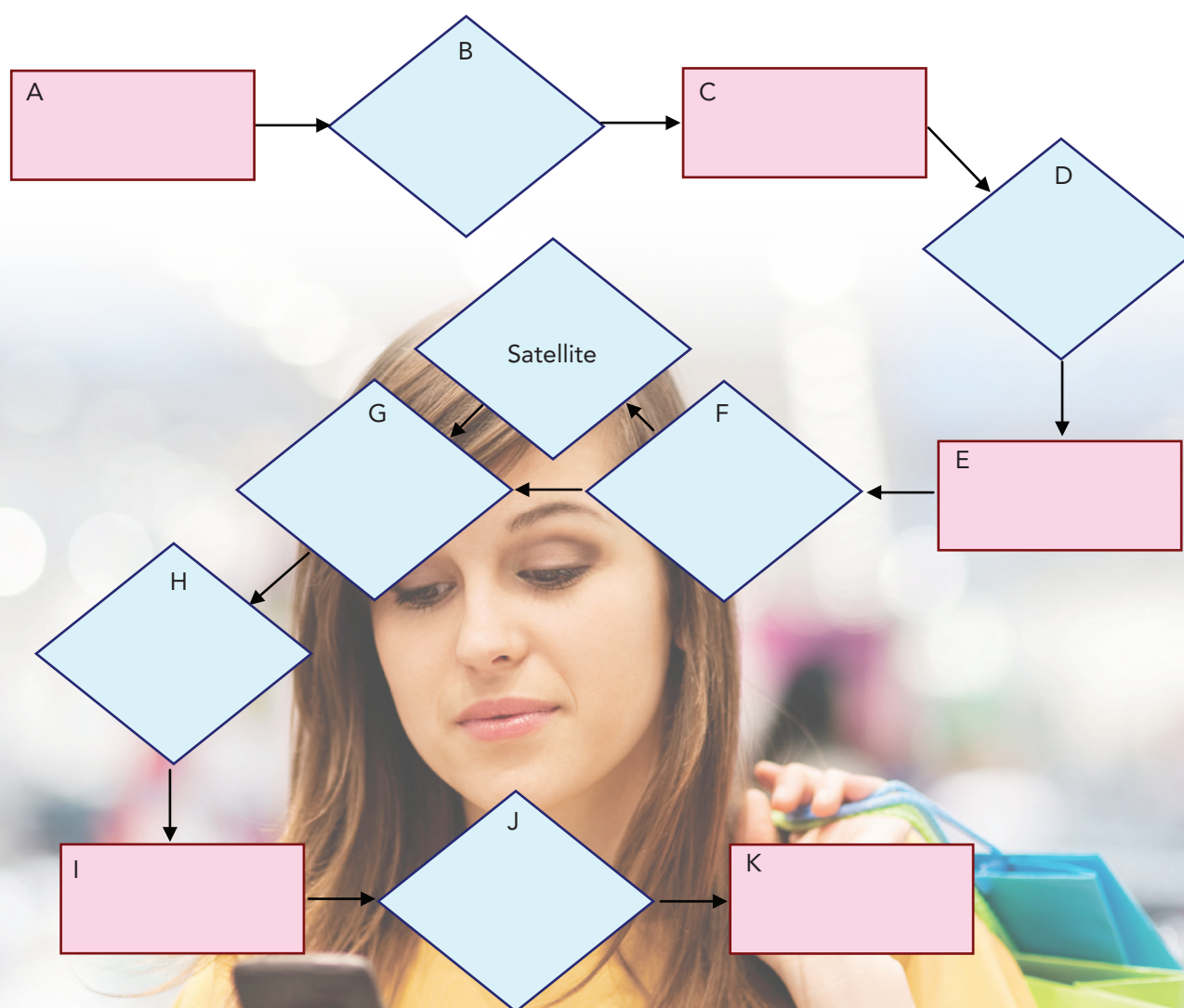
Microwave communication towers.

4.2 Using electromagnetic energy

4.2.4.1 Read the information below on how mobile phones work then use it to complete the flow diagram to summarise the energy changes that occur in mobile phone operations. Note that you should write the names of devices or processes in the diamond shapes and energy forms in the rectangles.

How mobile phones work

The microphone in your mobile phone converts sound energy into electrical energy and the electronic circuits in the phone convert this into electromagnetic energy (microwaves) and then transmits the microwave message to a base station near the sender. This base station sends the signal to another base station near the receiver (via a satellite if necessary). This base station sends the signal to the receiver's mobile phone which converts it back into electrical energy. A speaker within the mobile phone then converts the electrical energy into sound energy.



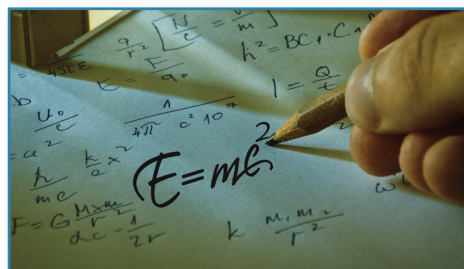
- 9.** Write a balanced chemical equation for the reaction between sodium carbonate and copper sulfate.
-
- 10.** Write a balanced chemical equation for the thermal decomposition of copper carbonate.
-
- 11.** Write a balanced chemical equation for the ionisation of sodium.
-
- 12.** Write a balanced chemical equation for the reaction between magnesium carbonate and hydrochloric acid.
-
- 13.** Write a balanced chemical equation for the reaction between sodium carbonate and sulfuric acid.
-
- 14.** Write a balanced chemical equation for the reaction between magnesium hydroxide and hydrochloric acid.
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8.6 Energy-mass equivalence and radioisotopes

8.6.1 Understanding energy-mass equivalence

Energy-mass equivalence is the principle that a small amount of mass can be converted into a large amount of energy during a radioactive decay process, following Einstein's equation $E = mc^2$. In radioisotope decay, the total mass of the resulting particles is slightly less than the original mass of the parent radioisotope. This 'mass defect' is converted into nuclear binding energy, which is released as heat and radiation (like gamma rays), providing the enormous energy observed in nuclear phenomena.



To find out how the law of conservation of energy applies to both energy and mass watch a video on energy-mass equivalence. A good example is produced by Bozeman Science. Read the questions below before you watch the video as they will give you an idea of the information to look for while watching. You will have to research some information. Watch the video, then answer the questions below.

8.6.1.1 Briefly explain what is meant by the equation $E = mc^2$.

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8.6.1.2 'Little Boy', the nickname for the atomic bomb dropped on Hiroshima in Japan in 1945, contained 64 kilograms of the U-235 isotope, of which only about 1 kg underwent nuclear fission, and of this, less than 1 gram was converted into energy. This is the same mass as the plastic cap from a biro.

Calculate, in joules, how much energy Little Boy released.

.....

8.6.1.3

(a) When were the laws of conservation of mass, conservation of energy and conservation of mass-energy proposed and by whom?

Law of conservation of mass:

Law of conservation of energy:

Law of conservation of mass-energy:

(b) Why were the initial two laws combined to become the law of conservation of mass-energy?

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8.6.1.4 Explain why the mass of every atom is less than the total combined mass of the protons, neutrons and electrons that it is composed of.

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