Chapter

6 Support, Movement and Growth

Keywords

- Endoskeleton
- Exoskeleton
- Hydrostatic skeleton
- Support
- Ecdysis
- Skeletal system
- Axial skeleton
- Appendicular skeleton
- Cartilage
- Tendon
- Muscle
- Centre of gravity

What is the advantage of an endoskeleton compared to an exoskeleton?

Why is an exoskeleton not found in insects such as cockroaches?

What is the type of skeleton found in the earthworm that provides support to its body?

What are the factors that affect the stability of animals?

What kind of support system can be found in humans and plants?

Science Digest

Animal and Human Movement

Cheetah is the fastest terrestrial animal on Earth. Cheetah can move from 0 to 96 km per hour in just three seconds.

Do you know who is the fastest man on Earth? The title for 'The Fastest Man on Earth' is held by Usain Bolt from Jamaica who broke the world record for the 100-metre sprint in 9.58 seconds. How do animals and humans move? Let us learn more about this.

You will learn about:

- support, movement and growth in animals
- human movement and growth
- support, growth and stability in plants

6.1 Support, Movement and Growth in Animals

Flashback

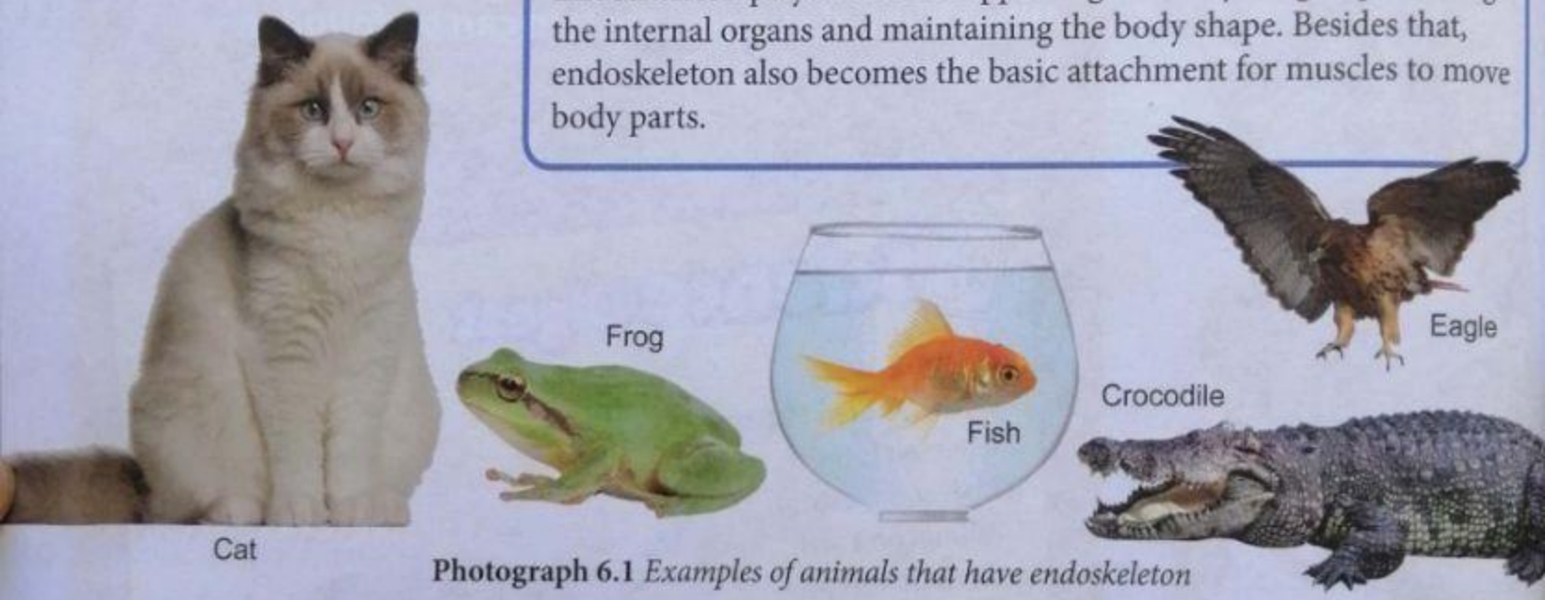
Vertebrates consist of fish, amphibians, reptiles, birds and mammals.

Type of Support in Animals

What is the support system for animals? Skeleton is the support system for all types of animals. There are three types of support for animals, that are, endoskeleton, exoskeleton and hydrostatic skeleton.

Endoskeleton

Endoskeleton is the type of support for all vertebrates including humans. Endoskeleton is made up of internal bones and cartilage. Endoskeleton plays a role in supporting the body weight, protecting the internal organs and maintaining the body shape. Besides that, endoskeleton also becomes the basic attachment for muscles to move body parts.



Photograph 6.1 *Examples of animals that have endoskeleton*

Brain Teaser

What is the type of skeleton in a snake? Endoskeleton or hydrostatic skeleton?

Exoskeleton

Exoskeleton is the type of support for most invertebrates. Exoskeleton consists of an outer layer of waxy chitin or shell. Exoskeleton functions to support the body weight, maintain body shape and support internal organs of animals. Besides that, exoskeleton is also the base for muscle attachment.

Photograph 6.2 *Examples of animals that have exoskeleton*

Hydrostatic skeleton

Some invertebrates with soft bodies such as worms do not have any bones in their bodies. These animals are supported by a hydrostatic skeleton. The hydrostatic skeleton consists of a muscular wall that encloses the body cavity that is filled with fluid. The fluid exerts pressure on the muscular wall of the body in all directions causing the animal's body to be firm. This hydrostatic skeleton maintains and controls the animal's body shape. Hydrostatic skeleton also plays a role in the movement of the animal.

Photograph 6.3 *Examples of animals that have a hydrostatic skeleton*

Activity 6.1

Multimedia Presentation

21st Century Skills

Aim: To prepare a multimedia presentation on the types of supports in animals, that are, exoskeleton, endoskeleton and hydrostatic skeleton.

Instructions:

1. Carry out this activity in groups.
2. Gather information from various sources such as books, video and the Internet about support and movement of animals.
3. Create a multimedia presentation on:
   (a) types of skeleton
   (b) the function of types of skeleton mentioned in (a)
   (c) examples of animals with each type of skeleton
4. Present the multimedia presentation to your friends and teacher.

Exoskeleton Size with Growth

Growth can be measured and observed by plotting a graph of growth unit against time. This graph is called the **growth curve**. Growth unit can be used to measure height (cm), volume (cm^3), wet mass (g) and dry mass (g). The growth curve that is formed shows growth phases and growth rate undergone by the organism.

6.1.1
6.1.2

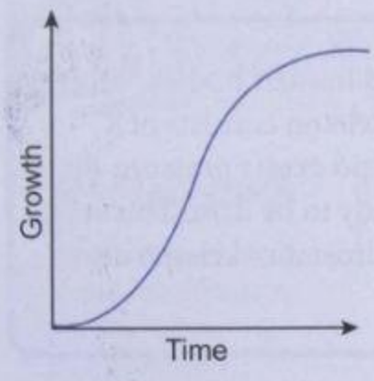


Figure 6.1 *Sigmoid-shaped growth curve*

The growth curve of all organisms basically is **sigmoid** in shape. It is different according to the type of organism. However, the growth curve of animals with exoskeleton is different and unique.

The growth curve of the animals with **exoskeleton** such as the cockroach and grasshopper can be seen in **stages**. This is because the exoskeleton of these types of organisms is made up of hard chitin and it is unable to expand.

These characteristics will prevent the growth of the animals that have exoskeleton such as the prawn, beetle, crab and grasshopper. To overcome this problem, the animals will shed the exoskeleton repeatedly until they reach adulthood. The process of shedding the skin is called **ecdysis**. During the ecdysis process, a new and soft exoskeleton is formed under the old exoskeleton. Figure 6.2 shows the growth curve of animals that have an exoskeleton.

Photograph 6.4 *The insect sheds the hard exoskeleton*

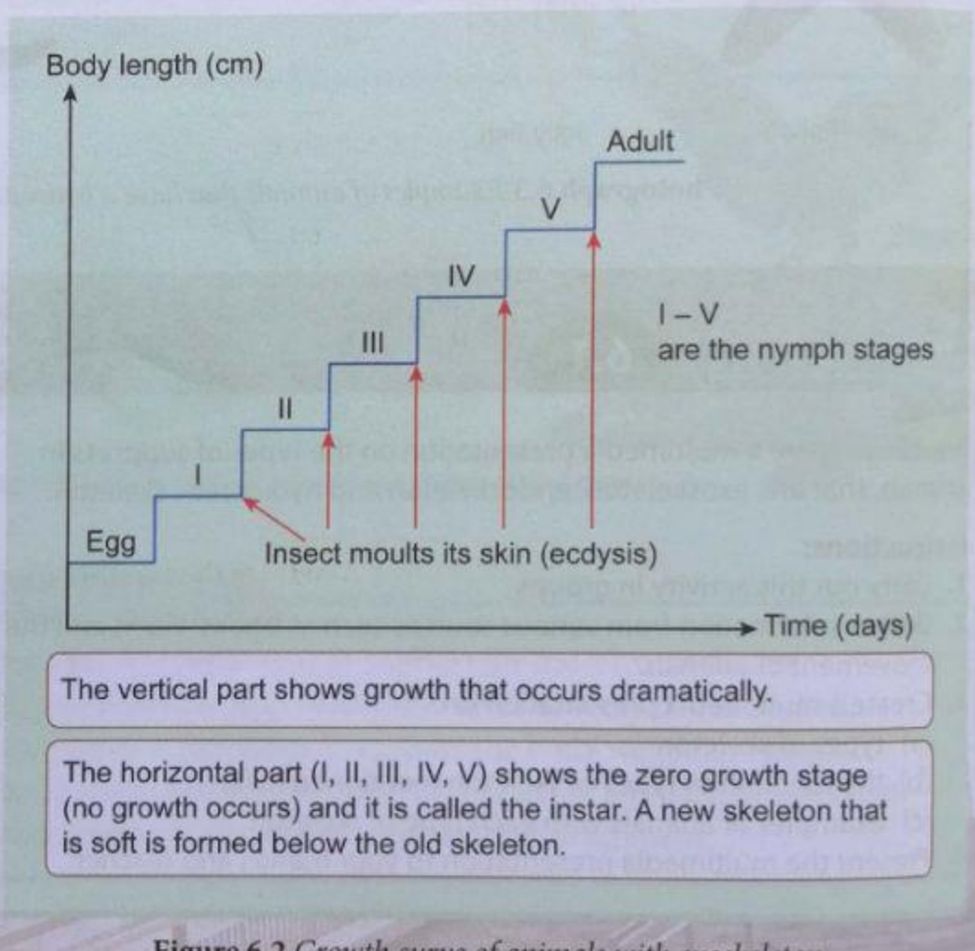
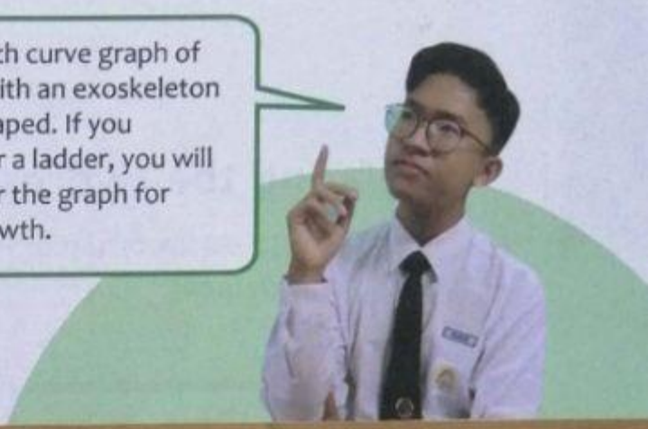


Figure 6.2 *Growth curve of animals with exoskeleton*

During ecdysis, the animals with exoskeleton will suck in air to expand their bodies. The action of sucking air will break the previous exoskeleton that is hard. A rapid growth will occur to increase the size of the organism before the new exoskeleton hardens.

Animals with exoskeleton will always undergo a few stages of ecdysis before reaching adulthood. This ecdysis stage causes the animals **growth curve graph** to be **step-shaped**. At the nymph stages, the animals will eat a lot to build new tissues and increase their weight. A hormone will control every stage of the ecdysis.



Activity 6.2

Inquiry

21st Century Skills

Aim: To study the growth curve of animals with exoskeleton.

Apparatus: Ruler

Procedure:

1. Observe the five grasshopper nymphs and an adult grasshopper in the table below.

Day	1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	16 17 18 19 20	21 22 23 24 25	26 27 28 29 30
Grasshopper	 A	 B	 C	 D	 E	 Adult

2. Measure the length of grasshopper nymph A (from the head to the end of the abdomen) using a ruler.
3. Record the length of nymph A in the table below.
4. Repeat steps 2 and 3 using the pictures of the grasshopper nymphs B, C, D, E and the adult grasshopper.

Observation:

Day	Length of the grasshopper (cm)
1	
2	
3	
⋮	
30	

Questions:

1. Plot the growth curve of the grasshopper.
2. Why does the grasshopper growth curve have such pattern?
3. Explain the metamorphosis process of the grasshopper based on the growth curve.

Relating the Hydrostatic Skeleton with Movement

How does an earthworm move? Let us see how the hydrostatic skeleton helps an earthworm with its movement.

The earthworm has a hydrostatic skeleton, which means its body cavity is filled with fluid. The earthworm moves on land with the aid of **chaetae**, that is, the bristles found at the side of its body. There are two types of muscles on the walls of the earthworm's body, known as the **circular muscles** and **longitudinal muscles** as shown in Figure 6.3.

The muscles in the earthworm also act antagonistically (opposing). When the circular muscles contract, the longitudinal muscles relax causing the earthworm body to become thin and long. When the longitudinal muscles contract and circular muscles relax, the earthworm body will become thicker and shorter.

The antagonistic (opposing) action of the circular muscles and longitudinal muscles exerts a **hydrostatic pressure** on the fluid in the earthworm body. When the earthworm body becomes thinner and longer, the hydrostatic pressure transfers the fluid in its body to the rear end of the body. What would happen to the fluid when the earthworm body thickens and shortens? The body fluid will be transferred to the part shortened by the hydrostatic pressure causing the rear of the earthworm to be stretched to the front as shown in Figure 6.5.

VIDEO

Movement of Jellyfish

http://bukutekskssm.my/Science/F4/JellyfishMovement.mp4

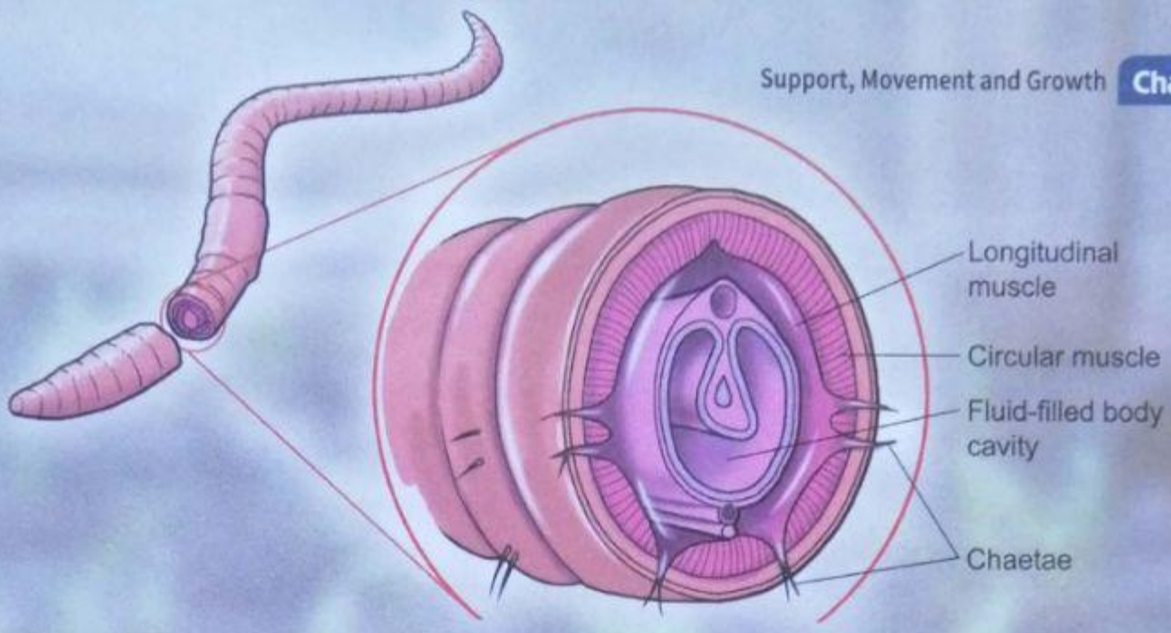


Figure 6.3 *Hydrostatic skeleton in the earthworm*

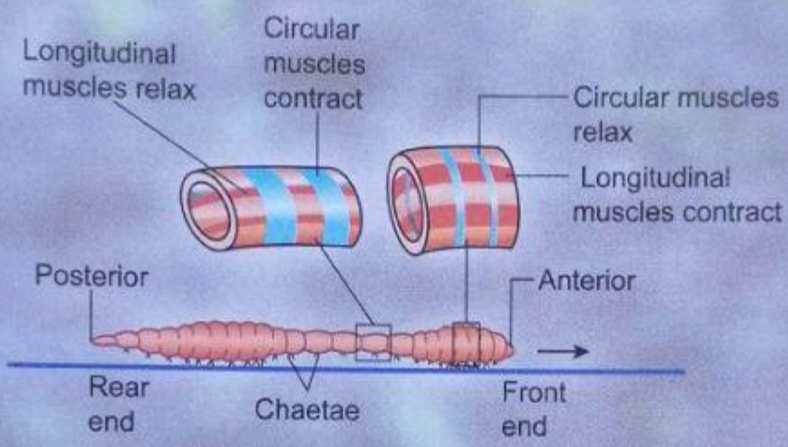


Figure 6.4 *The arrangement of the circular muscles and longitudinal muscles in the earthworm*

- The earthworm moves with the aid of the contraction and relaxation of the circular and longitudinal muscles that take place antagonistically from the anterior part to the posterior part.
- When the longitudinal muscles contract and the circular muscles relax, the segments on the body of the earthworm will shorten and thicken. The chaetae at this segment of the body will grip the ground.
- At the same time, the other segments will become longer and thinner. This occurs because the circular muscles at these segments contract and the longitudinal muscles relax.
  The chaetae at these segments will release the grip to allow the body of the earthworm to lengthen and move forward.

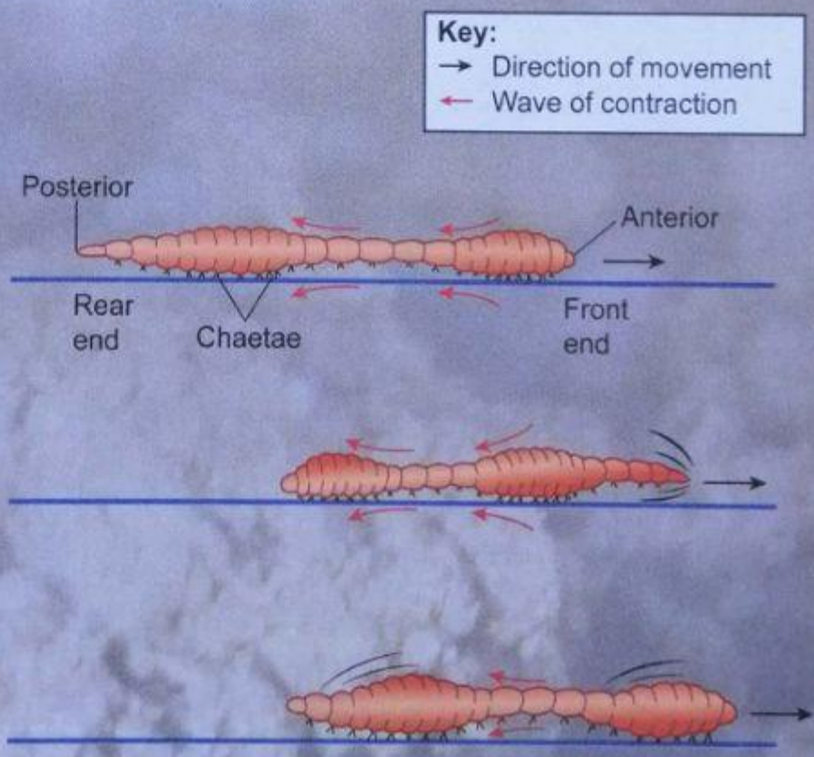


Figure 6.5 *The way the earthworm moves*

Activity 6.3

Multimedia Presentation

21st Century Skills

Aim : To prepare a multimedia presentation to explain the hydrostatic skeleton.

Instructions:

1. Carry out this activity in groups.
2. Gather information from various resources such as books, videos and Internet related to hydrostatic skeleton and movement.
3. Prepare a multimedia presentation on hydrostatic skeleton.
4. Find and share information on the role of fluid pressure in the body cavity in the movement of animals such as the worm and the jellyfish.
5. Present the multimedia presentation to your friends and teacher.

The Functions of the Endoskeleton in Animals

Vertebrates that have endoskeleton are divided into terrestrial vertebrates, aquatic vertebrates and birds. In this subtopic, we will learn the functions of the endoskeleton in all three types of vertebrates. The skeletons of these animals are different according to the habitat of the vertebrates.

Terrestrial Vertebrates

Terrestrial vertebrates need a strong and firm skeleton to support the body. These animals have a big skeletal frame that is compatible to their body size. The body weight of the terrestrial vertebrates is supported especially by the pectoral girdle and pelvic girdle.

An elephant needs a strong pectoral girdle and pelvic girdle to support its body weight. Both these girdles are joined with the legs as shown in Figure 6.6 below.

Science Gallery

The backbone of four-legged terrestrial animals such as the camel and the horse curves up or down. This condition gives stronger support to the muscles attached to the backbone. The curvature enables the backbone to withstand the gravitational force that acts on the animals.

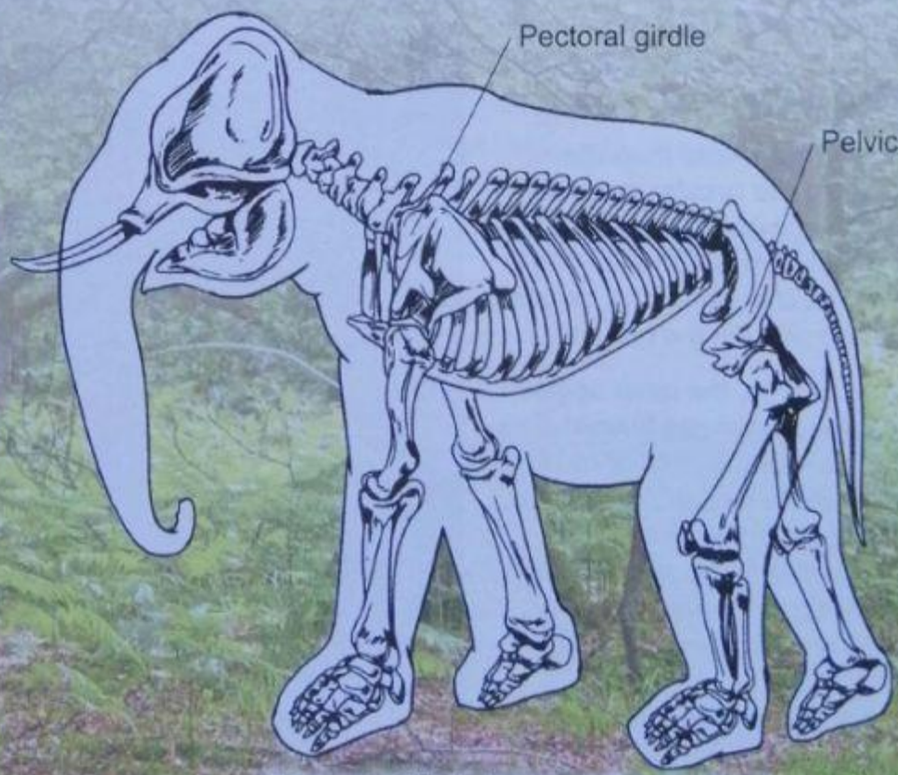


Figure 6.6 *Endoskeleton of an elephant*

Aquatic Vertebrates

Aquatic vertebrates have a smaller endoskeleton compared to their body. The pectoral girdle and the pelvic girdle of the aquatic animals are small and weak. Aquatic vertebrates such as the whale can grow larger than the size of their skeleton. This is because the weight of the aquatic animals is supported by the buoyancy force.

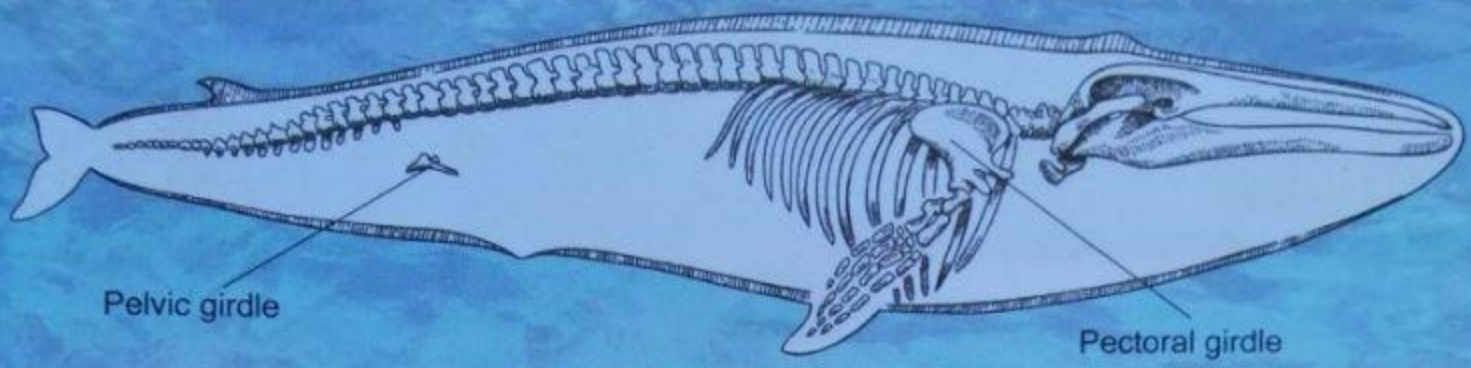


Figure 6.7 *Endoskeleton of a whale*

Birds

A bird has the bone structure that is adapted for flying. The flat and wide sternum bone (breast bone) of the bird functions as a place for the attachment of muscles for flight. The bones of the bird are also hollow and light. Besides, the size of a bird's skull is small compared to other animals' skull and this makes it easy for birds to fly.

Figure 6.8 *Endoskeleton of a bird*

Activiy 6.4

Multimedia Presentation

21st Century Skills

Aim: To gather information on differences in the functions of the endoskeleton of terrestrial vertebrates, aquatic vertebrates and birds.

Instructions:

1. Carry out this activity in groups.
2. Gather information from various resources such as books, videos and the Internet.
3. Prepare a multimedia presentation on:
   (a) the differences in each skeleton in terrestrial vertebrates, aquatic vertebrates and birds
   (b) the examples of animals for each type of skeleton
4. Present the multimedia presentation to your friends and teacher.

The Human Skeletal System

The human skeleton is made up of 206 bones of various sizes and shapes. The human skeleton can be divided into two parts, that are the axial skeleton and the appendicular skeleton. The **axial skeleton** consists of the skull, the vertebral column, the sternum and the ribs. The **appendicular skeleton** consists of the pectoral girdle, the upper limbs, the pelvic girdle and the lower limbs.

Axial skeleton

Skull

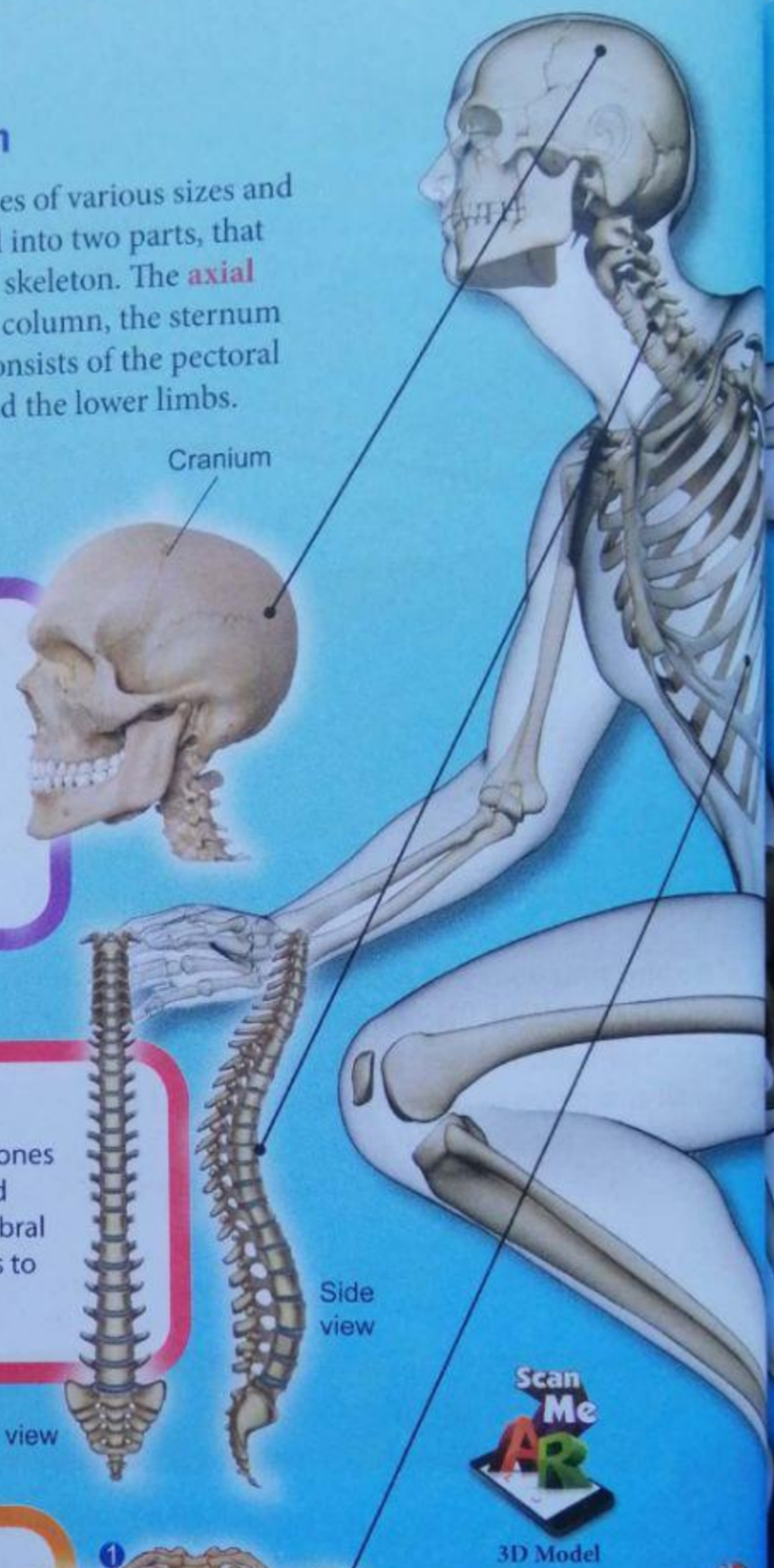
The **human skull** consists of two parts, that are the cranial bones and the facial bones. The function of the **cranial bones** is to protect the brain. **Facial bones** serve to provide the basic shape or the framework for the face and also to support the teeth.

Vertebral column

The **vertebral column** consists of 33 small bones or vertebrae. These bones that are connected form a strong and flexible column. This vertebral column has a very important function, that is to protect the spinal cord.

Ribs and sternum

The human **ribs** consist of **12 pairs of ribs** that are joined to the thoracic vertebra at the back. Seven pairs of ribs are attached to the sternum directly and three more ribs are indirectly connected by cartilage. Two more pairs (the last two) hang free. The sternum and the ribs function to protect the main organs, that are the heart and the lungs.



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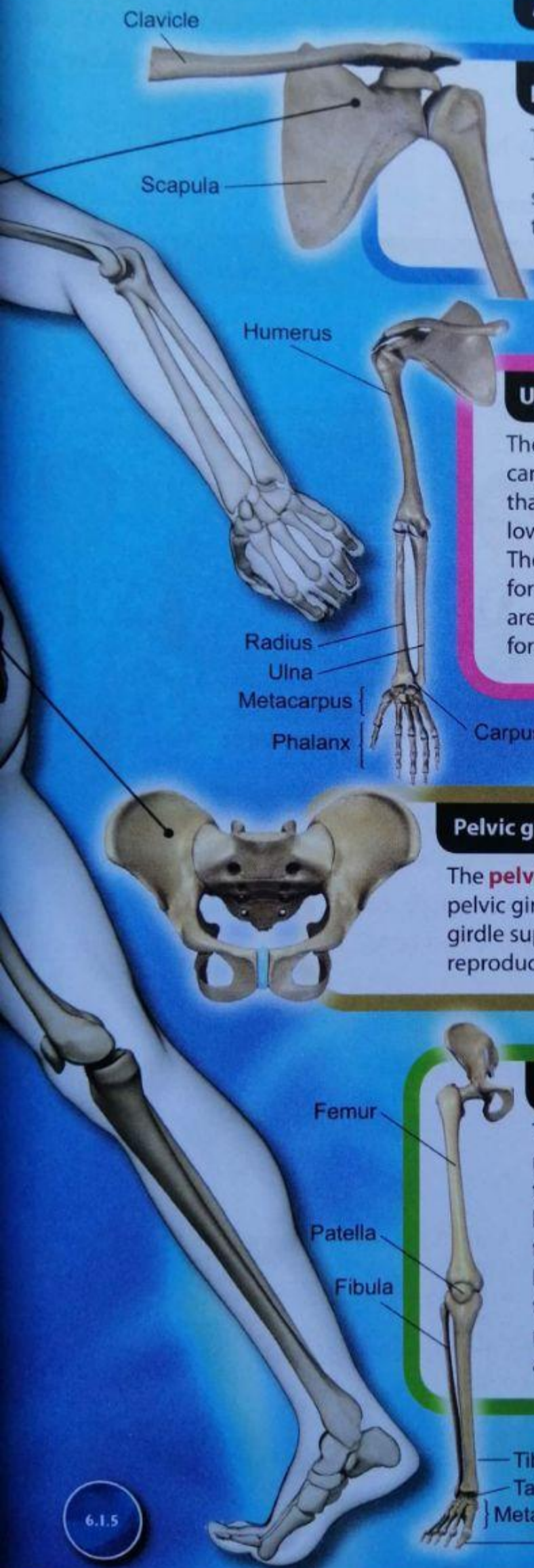
3D Model

Brain Teaser

A baby has 275 bones at birth, whereas an adult has 206 bones. Why does this difference occur?

Figure 6.9 *The human skeleton*

Appendicular Skeleton



Pectoral girdle

There is a pair of **pectoral girdles** in the human body. The pectoral girdle connects the upper limbs to the axial skeleton. The pectoral girdle consists of the clavicle and the scapula.

Upper limb

The **upper limb** consists of the humerus, radius, ulna, carpus, metacarpus and phalanx. The end of the **humerus**, that is ball-shaped, is attached to the pectoral girdle. The lower end of the humerus is attached to the radius and ulna. The **radius** and **ulna** are attached to the **carpus** bones to form the wrist. The **metacarpus** bones form the palm and are attached to the carpus bones. The **phalanx** bones that form the fingers are attached to the metacarpus bones.

Pelvic girdle

The **pelvic girdle** is connected to the axial skeleton. The pelvic girdle is formed from a pair of hip bones. The pelvic girdle supports weight, protects the bladder and the reproductive organs.

Lower limb

The **lower limb** consists of the femur, tibia, fibula, tarsus, metatarsus and phalanx. The upper end of the **femur** that is ball-shaped is attached to the pelvic girdle. The lower end of the femur is attached to the tibia and fibula. The **tibia** and **fibula** are the bones of the calf. The lower ends of the tibia and fibula are attached to the tarsus, that is, the ankle. The **tarsus** is attached to the metatarsus bones to form the foot. The **metatarsus** is attached to the **phalanx** or the bone of the toe.

Activity 6.5

Round Table

21st Century Skills

Aim: To identify and name the bones in the human skeleton.

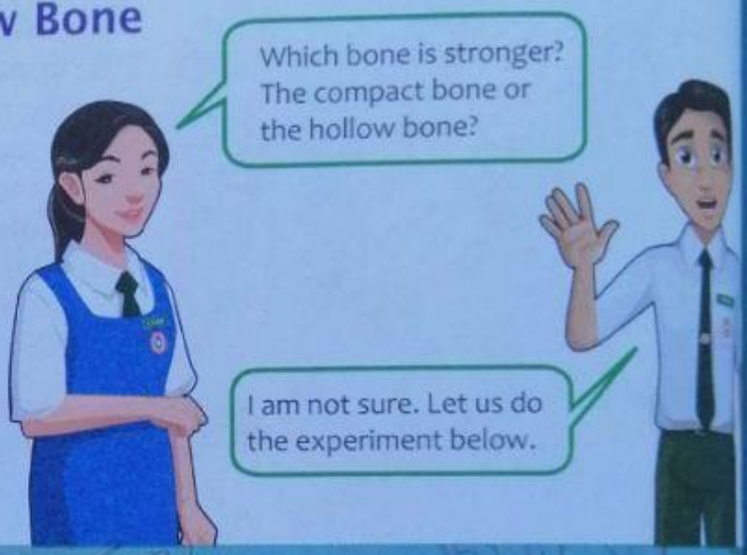
Instructions:

1. Carry out this activity in groups.
2. Take the diagram of the human skeleton from your teacher.
3. Take turns to label the human skeletal system.
4. Put up the diagram on the notice board in your classroom.

Comparing the Strength of the Compact Bone with the Hollow Bone

Terrestrial vertebrates such as elephants have big, compact and strong bones. This is because the whole of its body weight is supported by the endoskeleton.
Birds have hollow bones to enable them to fly. Hollow bones have several advantages:

(a) light and strong
(b) allow the vertebrates to move more quickly
(c) need less calcium and phosphorus



Experiment 6.1

Aim: To compare the strength of the compact bone with the hollow bone.

Problem statement: Is the hollow bone stronger than the compact bone?

Hypothesis: The hollow bone is stronger than the compact bone.

Variables:

(a) manipulated: Type of cylinders (hollow or compact)
(b) responding: Number of textbooks that can be supported by the cylinders
(c) constant: Length and diameter of the cylinder

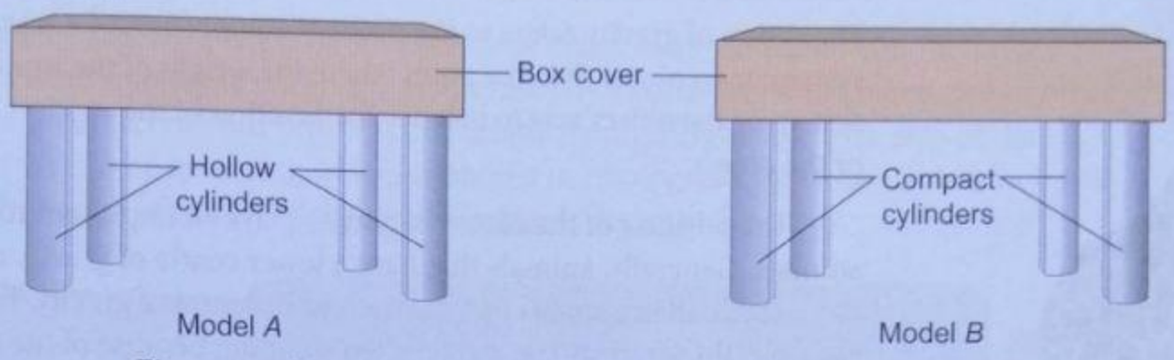
Materials: A4 paper, cellophane tape, box covers

Apparatus: Textbooks, scissors

Procedure:

1. Make a hollow cylinder with a diameter measuring 2.5 cm. Stick the upper and lower ends of the paper roll with cellophane tape. Make three more similar rolls.
2. Stick each cylinder at the corners of the box cover and name the structure as table model *A* as in Figure 6.10(a).
3. Make a compact cylinder with a diameter measuring 2.5 cm. Stick the upper and lower ends of the paper roll with cellophane tape. Make three more similar rolls.

4. Stick each cylinder at the corners of the box cover and name the structure as table model *B* as in Figure 6.10(b).



Model *A*

Figure 6.10(a)

Model *B*

Figure 6.10(b)

5. Place the textbooks one by one on top of each table model *A* and *B* until the paper rolls bend.

Result:

Cylinder	Number of textbooks that can be supported
Hollow	
Compact	

Conclusion:

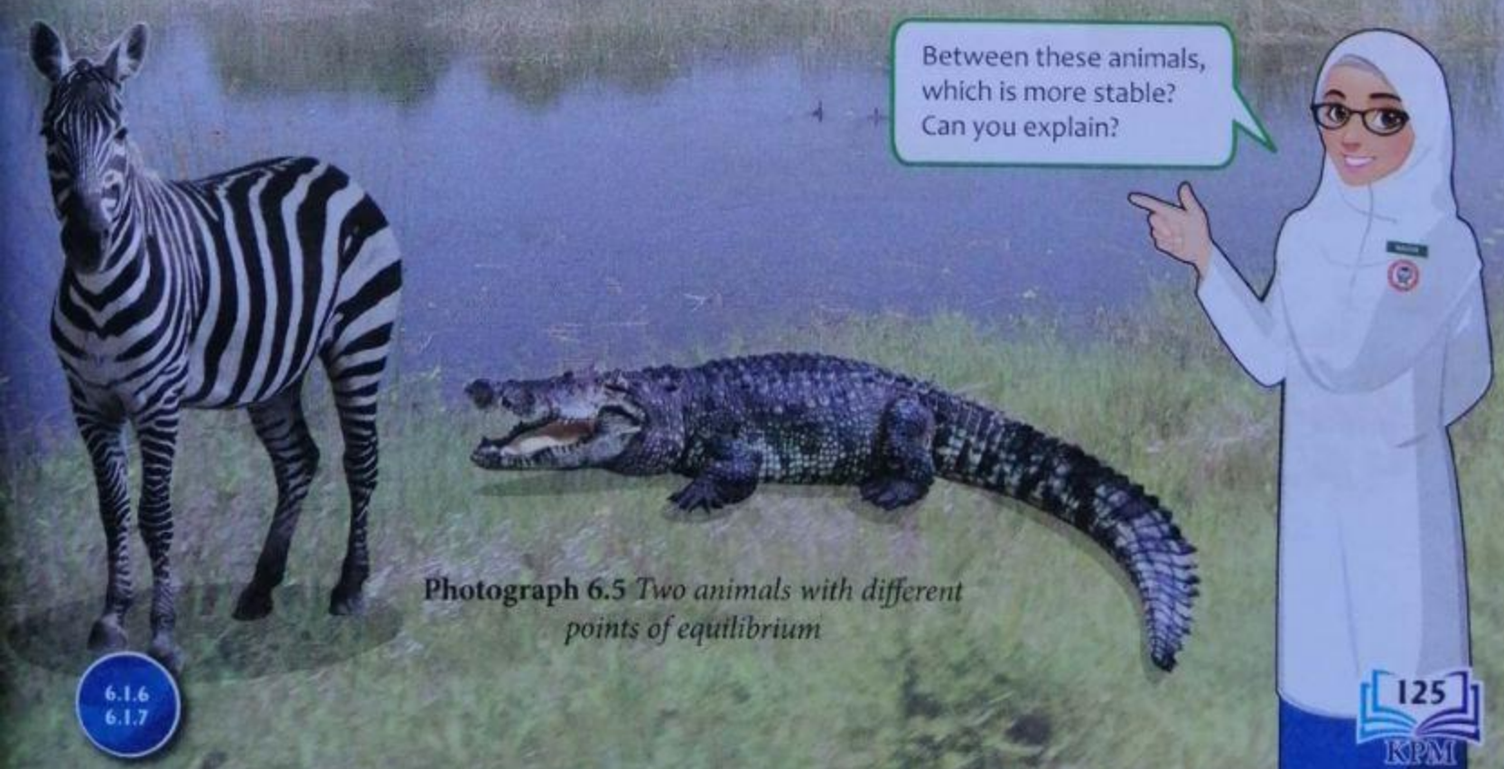
Is the hypothesis of this experiment accepted? What is the conclusion of this experiment?

Questions:

1. What is represented by:
   (a) the paper rolls of table model *A*?
   (b) the paper rolls of table model *B*?
2. Suggest two advantages of the support system that is represented by the paper rolls of table model *A*.

Support Systems and the Factors of Stability in Animals

A good support system enables an animal to move more smoothly and efficiently. The stability of an animal is different according to the point of equilibrium of the animal's support system.



Photograph 6.5 *Two animals with different points of equilibrium*

6.1.6
6.1.7

Centre of Gravity

The centre of gravity refers to the point of equilibrium of a support system or an object. It is the point where the weight of the support system or the object acts to balance the position of the support system or the object.

The position of the centre of gravity plays an important role in animals. Generally, animals that have a lower centre of gravity are more stable than animals that have a higher centre of gravity. For example, the giraffe is less stable when standing because of the higher centre of gravity compared to the tortoise and the crocodile that are stable naturally as they have a lower centre of gravity.

Photograph 6.6 *Animals with different positions of centre of gravity*

Factors that Affect Stability

Stability is the ability of an object to maintain its original position. There are two factors that affect the stability of an object or a support system that is:

1. Centre of gravity – An object that has a higher centre of gravity is less stable compared to an object that has a lower centre of gravity.
2. Base area – An object with a big base area is more stable compared to an object with a small base area.

Brain Teaser

Can you explain why Formula 1 cars are designed lower in height than ordinary cars?

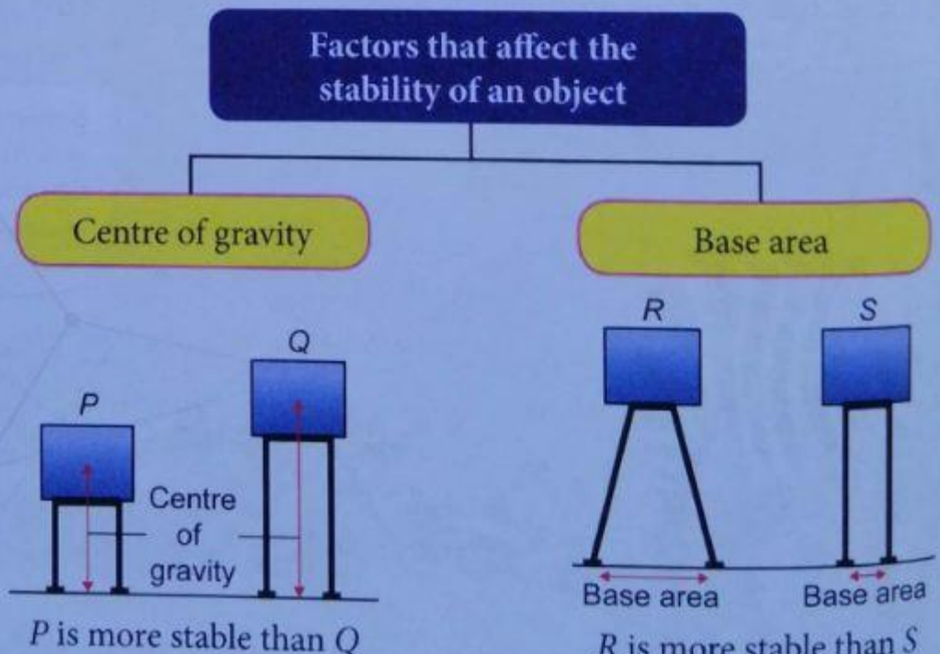


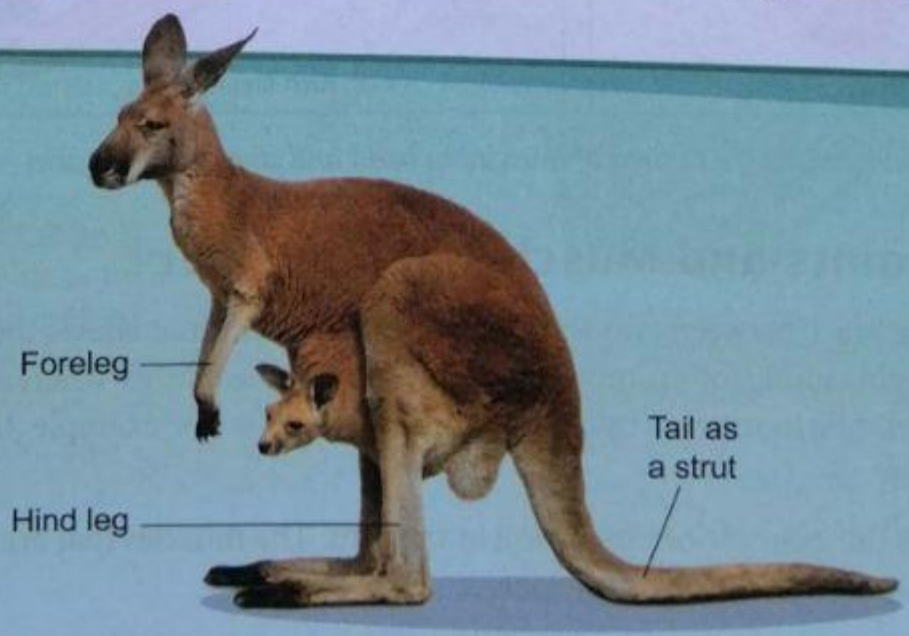
Figure 6.11 *Factors that affect the stability of an object*

Solutions for Animals with Stability Problem

Among the challenges faced by tall animals is to maintain the stability in their daily lives. As an example, the tall giraffe faces difficulty in drinking water compared to other animals. To overcome this problem, the giraffe has to increase the base area of the support system by spreading its legs as shown in Photograph 6.7 below. This action will lower the centre of gravity of the giraffe so that it does not fall easily.

Photograph 6.7 *The way the giraffe maintains the stability of its body*

The same condition is also faced by the kangaroos. This is because kangaroos jump and stand using two hind legs. The front feet or forelegs of the kangaroo are not used for standing. This condition causes the kangaroo to become unstable and to fall easily when not moving. To overcome the problem, the kangaroo uses its tail as the support system to prevent itself from falling. The tail is used as a strut to increase the base area of the kangaroo when not moving.



Photograph 6.8 *The way the kangaroo maintains the stability of its body*
(Source: Biology, a functional approach, 4th edition)

FORMATIVE PRACTICE 6.1

1. State the importance of a support system.
2. Explain the meaning of exoskeleton, endoskeleton and hydrostatic skeleton.
3. Explain the growth curve of an animal with exoskeleton.
4. What is the meaning of ecdysis?
5. State the two factors that affect the stability of an animal.
6. (a) What is centre of gravity?
   (b) What is the relationship between the height of an object and its stability?

6.2 Human Movement and Growth

The skeletal system and muscles enable humans to move. The contraction and relaxation of the skeletal muscles produce movement. The skeletal muscles act in pairs and in opposite direction to one another. Each muscle pair that acts in opposite direction is known as **antagonistic muscles**. The movement of these muscles enables humans to walk, jump, run, swim, crawl and carry things. Figure 6.12 shows the antagonistic movement of muscles.

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3D Model

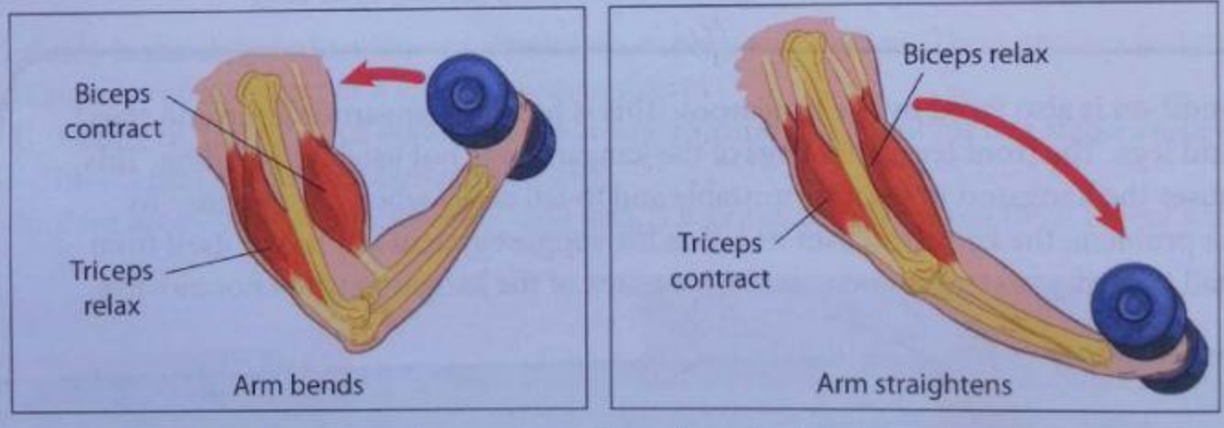


Figure 6.12 *Antagonistic movement of muscles to bend and straighten the arm*

Functions of Joints and Muscles in Movement

The joint is the meeting place between two or more bones. The joint that allows the limbs to move is called the movable joint (for example, the hinge joint at the elbow) whereas the joint that does not allow the limbs to move is called the immovable joint (for example, the joint at the skull).

Figure 6.13 shows the example of hinge joint at the arm. The muscles that are involved in the hinge joint movement are the biceps and triceps.

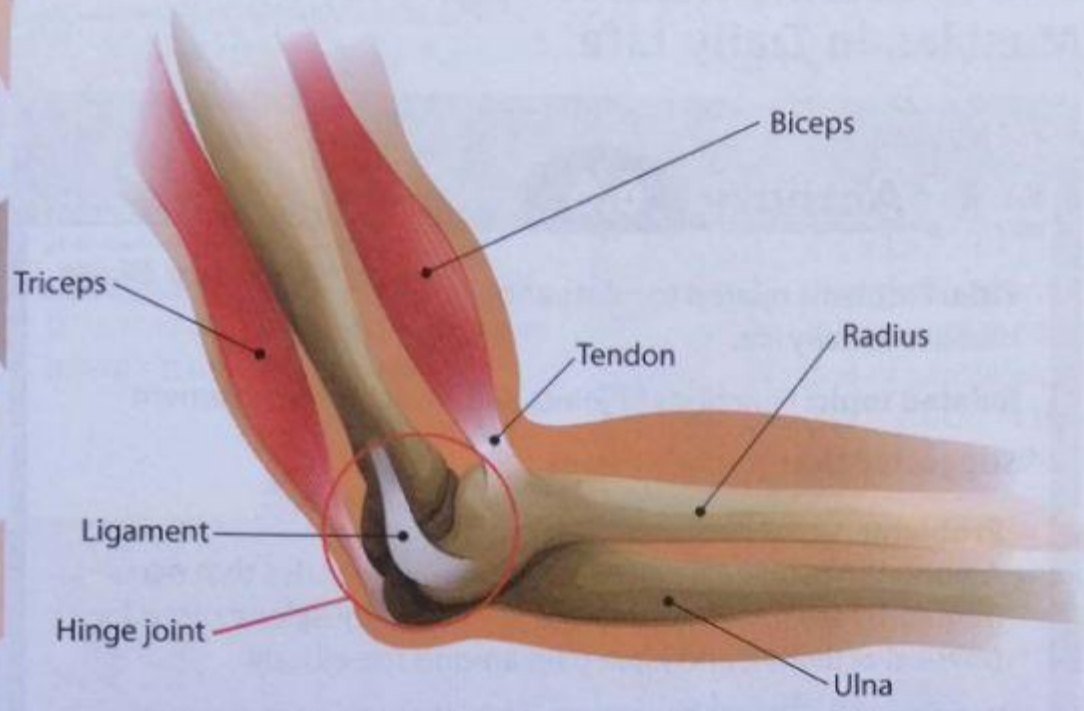
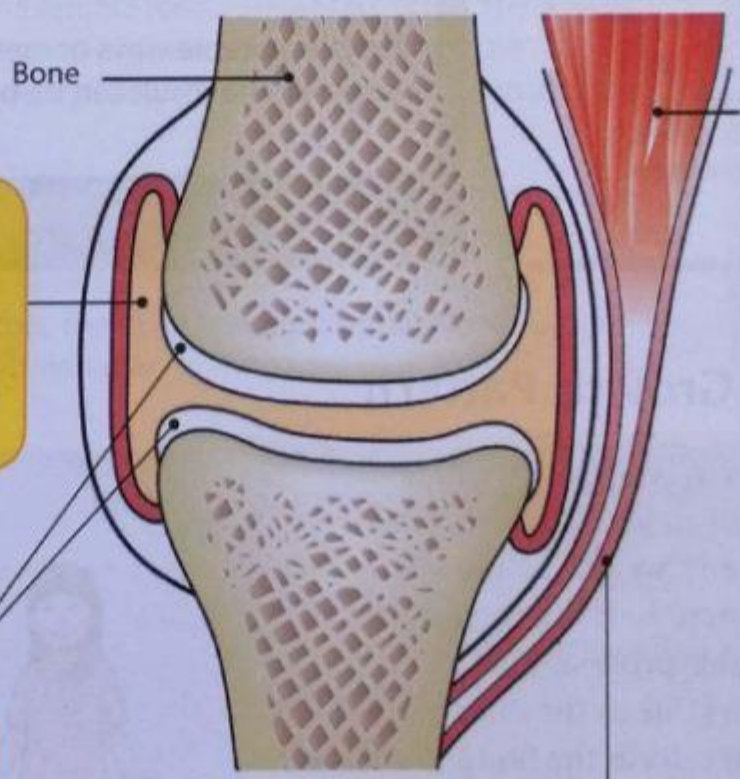


Figure 6.13 *Example of the movable joint (hinge joint)*

Science Gallery

The **ligament** is an elastic, flexible and strong connective tissue that joins two bones. This characteristic of being strong and elastic enables the ligament to hold and connect the bones and allow movement.

Muscles are tissues that are formed by aligned fibres. The muscle cell contains mitochondria that generates energy for contraction and relaxation of the muscles.



The **synovial fluid** functions to lubricate and provide nutrients to the cartilage. The synovial fluid also acts as a lubricant in the joint.

The cartilage or cartilaginous bone acts as a cushion and protects the joint. The cartilage functions to reduce friction.

The tendon is a connective tissue that connects muscles to the bone. The tendon consists of a combination of fibres that are strong and inelastic. The muscle contraction force will be transferred to the bone through the tendon.

Figure 6.14 *Functions of the synovial fluid, cartilage and tendon at the joint*

Science Career

Orthopaedist
Orthopaedist is a specialist doctor who treats injuries such as bone fractures, backbone defects or bone deterioration such as osteoporosis. The orthopaedist helps patients to undergo the skeletal muscle recovery process.

Chiropractor
Chiropractor is a practitioner of complementary medicine that is related to diagnosis and treatment of mechanical muscle system, skeleton and backbone disruptions.

Physiotherapist
Physiotherapist is known as the medical limb rehabilitator or medical rehabilitation officer. Physiotherapist helps patients recover and ensures each patient's physical function is at a high level.

The Problems Related to Joints and Muscles in Daily Life

Activity 6.6

Problem-based Learning

21st Century Skills

Title: Problems related to joints and muscles in daily life.

Related topic: Functions of joints and muscles in movement

Suggested time period: 1 week

Problem:
Among the problems related to joints and muscles that occur frequently are the injuries to the joints and muscles caused by physical activities, and knee pain among the elderly.

Based on this, discuss how these problems can be prevented.

Resources:
- Websites
- Other related references such as journals related to medicine and balanced diet.

Explain suitable ways or methods to prevent injuries to joints and muscles. The result can be presented in the form of *PowerPoint*.

Human Growth Pattern

Human growth is a process where changes occur in terms of size, total number of cells, weight, shape size, and body function. It is a permanent and irreversible process. This growth occurs due to the increase in number of cells in the body. Human growth occurs to the whole body and is different according to the sex and age.

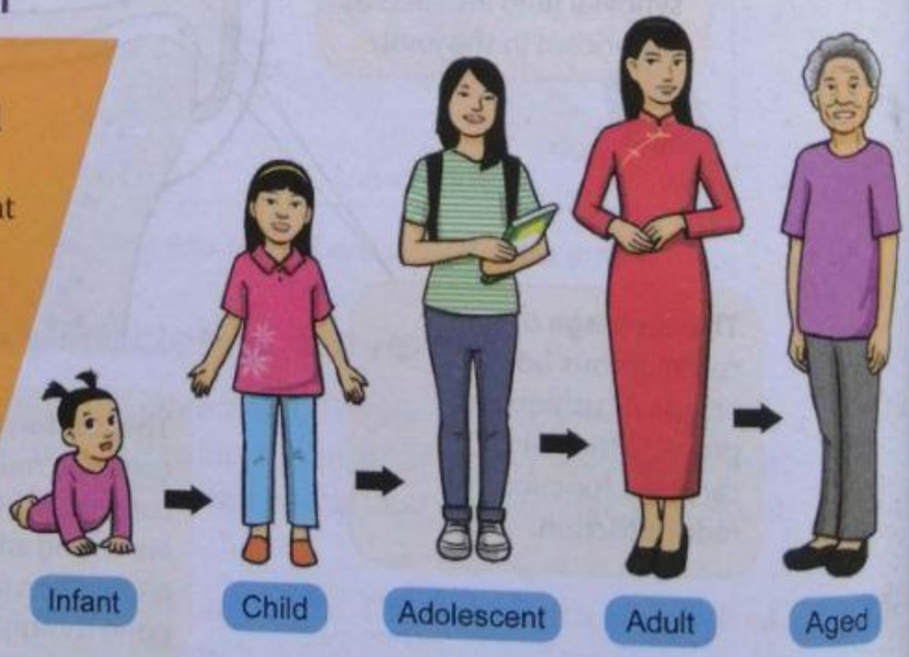


Figure 6.15 *Human growth stages*

Human Growth Stage

Infancy

This stage is from 0-3 years. Male and female infants undergo the same growth. Their rate of growth is very high. At this stage, balanced diet is important for the infant's balanced growth.

Childhood

The rate of growth is not as high as the rate of growth at the infancy stage. At this stage, the rate of growth of a male child is higher compared to that of a female child. Balanced diet is crucial at this stage for a balanced growth.

Adolescence

At the early stage of teenage (13-15 years old), both genders undergo rapid growth. The male teenager will undergo slower growth compared to the female teenager. At this stage, the female teenager is usually taller and bigger compared to the male teenager. At the same time, secondary sexual characteristics for teenagers begin to develop.

At the age of 16-18 years, the rate of growth will begin to decrease for the female teenager and will stop eventually. This is different with the male teenager where his growth will continue until the age of 18-20 years. Due to this, the male teenager usually looks bigger compared to the female teenager.

Adulthood

At this stage, the adult male is taller and bigger than the adult female. This condition occurs because male growth has a longer duration compared to female growth. At this stage, human growth will become constant and nearly zero. This means that human growth stops except for certain parts such as the nails, skin and hair.

Old age

At this stage, the human growth will come closer to a complete stop. Human body begins to shrink and muscle parts become smaller as well as the skin begins to dry.

Let us look at the human growth curve. What is the shape of the curve?

Science Gallery

Premature aging or the "Progeria" disease is a type of disease that seldom occurs. This disease occurs at the child stage and causes a child to look like an adult.

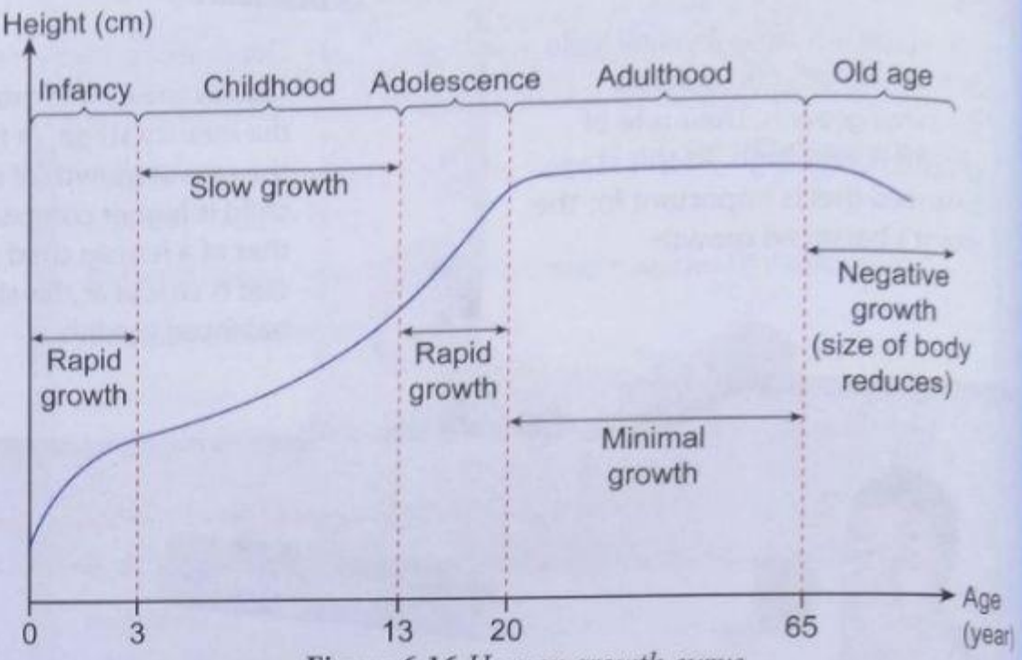


Figure 6.16 *Human growth curve*

(*Source: Junior Biology, Learning Space Australia*)

The rate of human growth is rapid at the infancy stage. After that, the rate becomes slower at the childhood stage.
The rate of growth becomes rapid again at the adolescence stage, and becomes slower once again when it reaches adulthood.

This growth pattern forms an "S-shape" (sigmoid curve) as in Figure 6.16. The growth curve enables us to determine the rate of human growth at different stages throughout the growth of life. For humans, the growth will stop when it reaches maturity.

Science Gallery

Puberty is a stage that occurs at the early adolescent stage. Secondary sexual characteristics begin to develop and become distinct, and sexual organs mature.

Growth Pattern Between Males and Females

The growth rate of males is different from the growth rate of females. From the infancy stage until early childhood stage, males and females grow at the same rate. Then, males grow a little more rapidly than females beginning at the age of 4. In females, puberty begins earlier, between the ages of 12 to 14. At this stage, females grow more rapidly than males; they are taller and heavier than males of the same age. Nevertheless, after the age of 14, males undergo rapid growth compared to females.

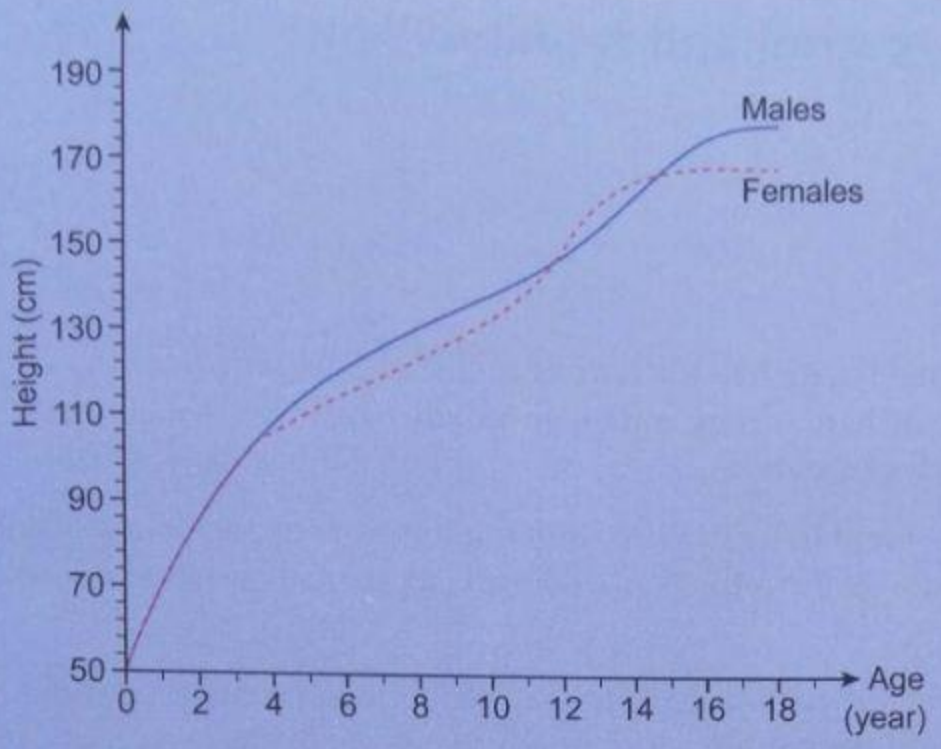


Figure 6.17 *Growth curve for males and females*

Science Gallery

During the examination of babies and children at the health clinics or hospitals, characteristics such as the body mass, height and the diameter of the head are the normal measurements taken by the nurse or doctor to monitor their growth development.

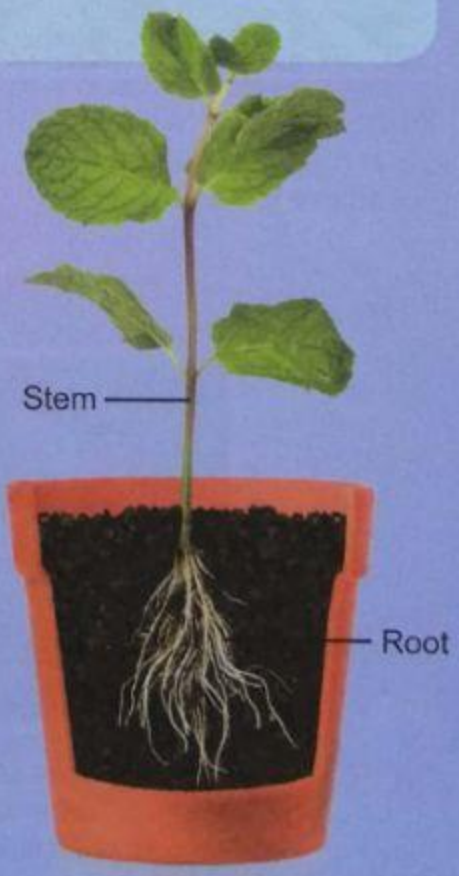
FORMATIVE PRACTICE 6.2

1. State two parameters that can be used to measure the human growth rate.
2. Explain the shape of the growth curve for males and females.
3. Describe briefly the effect of diet on growth rate.
4. How can the growth rate be measured?

6.3 Support, Growth and Stability in Plants

Why you think plants require support? A support system will help plants to stand vertically to obtain sunlight. The support system ensures the leaves are exposed to sunlight to carry out photosynthesis. Support is also needed to accommodate the plant weight and provide strength to withstand wind.

The main support for plants is the stem and root. The plant stem supports its own stem weight and also the weight of leaves, flowers and fruits. The root provides support to the plant by gripping the soil. There are also some plants that have roots on the soil to provide support.



Photograph 6.9
The main support system in plants

6.2.4
6.3.1

Support System of Terrestrial and Aquatic Plants

Terrestrial Plants

Terrestrial plants can be divided into:
(a) woody plants
(b) herbaceous plants (non-woody)

Woody plants are usually big and tall such as the rambutan tree and angsana tree. The support system for woody plants is the hard, strong and tough woody tissue. This tissue is built from lignin, a tough and hard complex substance.

Non-woody plants depend on stored water in the cells of the stem for support. These plants obtain their support from the turgidity of the cells. Non-woody plants are soft and they will wilt when they lack water.

Some plants form a special structure to provide additional support, and some climb onto other supports to obtain sunlight. Additional supports in woody plants are the buttress roots, prop roots and stilt roots. For the non-woody plants, the additional supports are tendrils, clasping roots and hollow stems.

Buttress roots are found in big and tall trees such as the durian tree and angsana tree.

Prop roots are roots that grow from stems or branches into the soil to support the plant. This type of roots is present in the banyan tree, pandan tree and fig tree.

Stilt roots support mangrove plants living in swamps.

Tendrils is a fine and coiled structure that wraps around other plants or objects for support. Tendrils are present in cucumber, bitter gourd and pumpkin plants.

Clasping roots hold onto another plant or structure for support. Clasping roots are found in orchid plants and money plants.

Photograph 6.10 *Characteristics that provide support to plants*

Aquatic Plants

Aquatic plants do not have woody tissue for support, unlike the land plants. Aquatic plants obtain their main support from the water buoyancy force. Besides that, the aquatic plants also have stems and leaves that have aerenchyma tissue. The **aerenchyma tissue** which consists of thin-walled cells, form air spaces in the aquatic plants. The buoyancy of these plants is aided by the air spaces. For some aquatic plants, the plants swell and have hollow and big stems to increase the buoyancy force such as the water hyacinth and lotus.

(a) Water hyacinth

(b) Lotus

Photograph 6.11 *Examples of aquatic plants*

INFORMATION

Aerenchyma Tissue

http://bukutekskssm.my/Science/F4/Pg135.jpg

Determining the Age of Woody Plants

There are a few methods to determine the age of the woody plants. The most common method is to determine the growth rings that are present in the plant stem. Photograph 6.12 and Figure 6.18 show the methods to count the growth rings that are found in the trunk of woody plants.

Photograph 6.12 *A method to count the growth rings seen in the cut of a woody plant trunk*

First method

1. The selected tree is cut down.
2. The tree trunk is cut across as in Photograph 6.12.
3. The growth rings seen in the trunk are counted.
4. One ring represents one year of the tree's age.

6.3.1
6.3.2

Second method

1. The tree is not cut but is bored using a special drill.
2. The tree is drilled to 75% of the drill depth or half the diameter of the tree.
3. The drill bit is removed and the growth rings are counted.
4. This method will save the tree from being cut.

VIDEO

Determining the Age of a Tree

http://bukuteksksm.my/Science/F4/Pg136.mp4

Figure 6.18 *A method to count the growth rings found in the woody plant trunk that has been bored*

Science Gallery

Tall woody trees such as timber trees (chengal tree) have buttress roots that grow extensively on the surface of the ground and the tap root that penetrates deep into the earth. The diameter of the trunk is usually big to ensure it is stable and strong.

Relating the Support System and Stability in Plants

A plant is said to be stable in its position if it does not fall easily. The plant stability is influenced by the centre of gravity and the base area. The lower the centre of gravity, the more stable the plant. Can you predict which is more stable in terms of the position of the centre of gravity, the bougainvillea or the durian tree?

Activity 6.7

Result Showcase

21st Century Skills

Aim: To study the relationship between the support system and the stability of plants.

Materials: Balsam plant (herbaceous plant), lotus plant (aquatic plant), hibiscus plant (woody plant), A4 paper, pencil

Instructions:

1. Carry out this activity in groups.
2. Study and gather information about the support system of the plants provided.
3. Relate how the support system of the plants help in their stability.
4. Create a portfolio based on the information gathered.
5. Present your findings in front of your friends.

Plant Growth Pattern

Experiment 6.2

Aim: To study the growth pattern of a green bean plant.

Problem statement: What is the growth pattern of a green bean plant?

Hypothesis: The growth pattern of a green bean plant is sigmoid-shaped.

Variables:

(a) manipulated: Time
(b) responding: Height of sprout
(c) constant: Type of seed

Materials: Green bean seeds, cotton wool, water

Apparatus: Petri dish, pincers, ruler

Procedure:

1. Immerse three green bean seeds in a Petri dish filled with water until they swell.
2. Keep the apparatus in a dark place for a night.
3. Transfer the green bean seeds into another Petri dish filled with wet cotton wool.
4. Measure the length of each green bean seed using a ruler.
5. Repeat step 4 every day for seven days and record the height of the green bean sprouts in the table.
6. Calculate the average height of the green bean sprouts and record in the table.
7. Plot a graph of height of the green bean sprouts (mm) against time (day).

Result:

Time (day)	Height (mm)			
	Sprout 1	Sprout 2	Sprout 3	Average
0				
1				
2				
3				
4				
5				
6				
7				

Conclusion:

Is the hypothesis of this experiment accepted? What is the conclusion of this experiment?

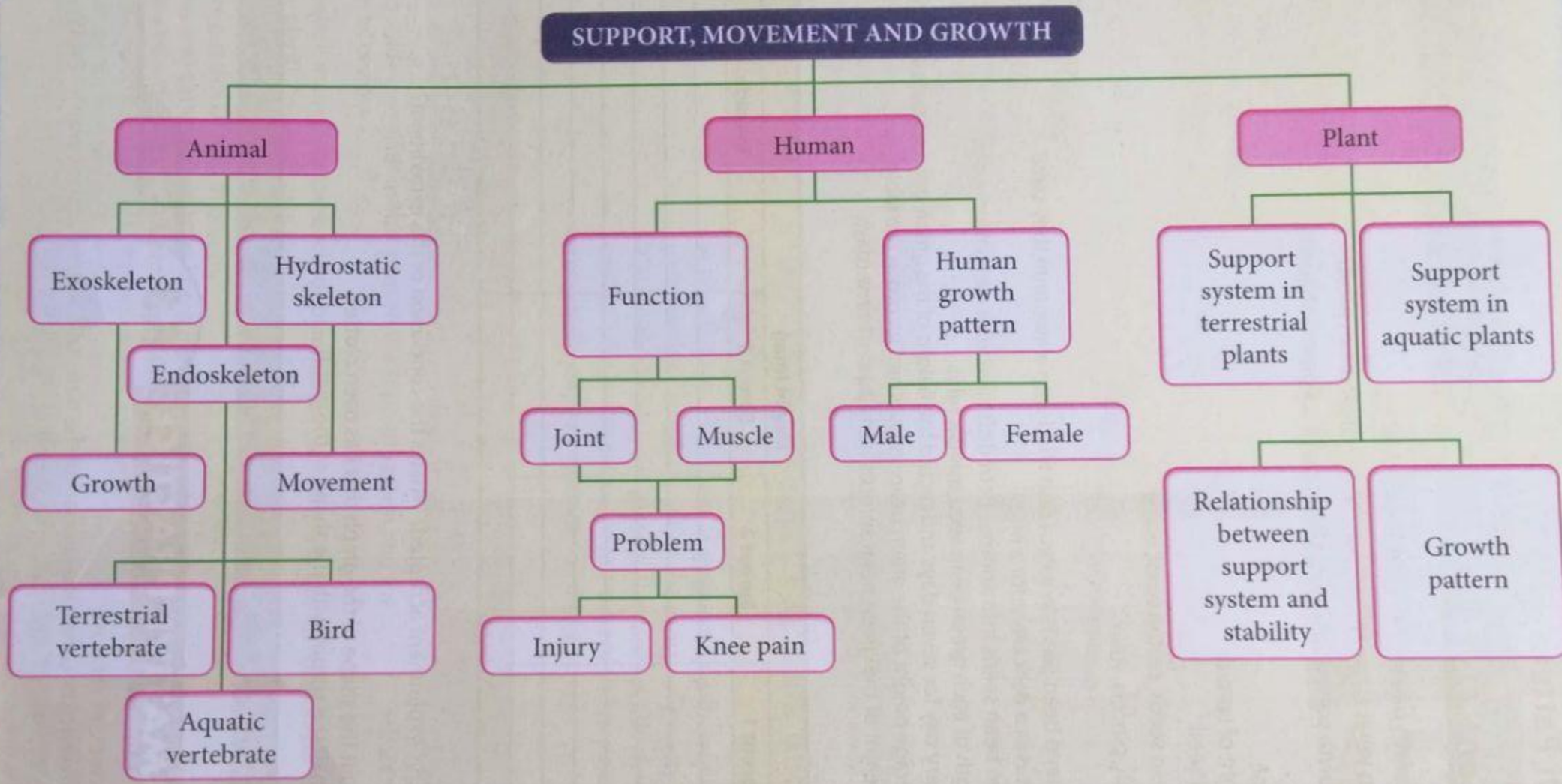
Questions:

1. Give a review about the shape of the graph that has been plotted.
2. Relate the growth of the sprout with the shape of the graph.

FORMATIVE PRACTICE 6.3

1. Why do plants require support?
2. What is the difference between the support of the terrestrial and the aquatic plants? Explain.
3. How does the herbaceous plant obtain its support?

Summary


SUPPORT, MOVEMENT AND GROWTH
Animal
Exoskeleton
Hydrostatic skeleton
Endoskeleton
Growth
Movement
Terrestrial vertebrate
Bird
Aquatic vertebrate
Human
Function
Joint
Muscle
Problem
Injury
Knee pain
Human growth pattern
Male
Female
Plant
Support system in terrestrial plants
Support system in aquatic plants
Relationship between support system and stability
Growth pattern

Self-reflection

After studying this chapter, you are able to:

6.1 Support, Movement and Growth in Animals

- ☐ Explain with examples the types of support in animals.
- ☐ Relate the size of exoskeleton with growth.
- ☐ Relate hydrostatic skeleton with movement.
- ☐ Elaborate the function of endoskeleton in animals.
- ☐ Dissect the human skeletal system.
- ☐ Carry out an experiment to differentiate the strength of compact bones with hollow bones.
- ☐ Relate support system with animal's stability.

6.2 Human Movement and Growth

- ☐ Explain the functions of joints and muscles in movement.
- ☐ Generate ideas regarding problems with joints and muscles in daily life.
- ☐ Explain the pattern of human growth.
- ☐ Compare and contrast the growth pattern between males and females.

6.3 Support, Growth and Stability in Plants

- ☐ Explain the support systems of terrestrial and aquatic plants.
- ☐ Determine the age of woody plants.
- ☐ Relate the support system with stability in plants.
- ☐ Carry out the experiment to determine a plant's growth pattern.

Summative Practice 6

QUIZ

Objective Questions
http://bukuteksksm.my/Science/F4/Q6

1. Figure 1 shows the human skeletal system.

Figure 1

(a) (i) Name the structure labelled *R*.

(ii) State the function of the structure stated in question **1**(a)(i).

(iii) List the characteristics of the structure stated in question **1**(a)(i).

(b) What will happen if the structure in question **1**(a)(i) experiences an injury?

(c) State the difference between tendon and ligament.

2. Photograph 1 shows a moving earthworm.

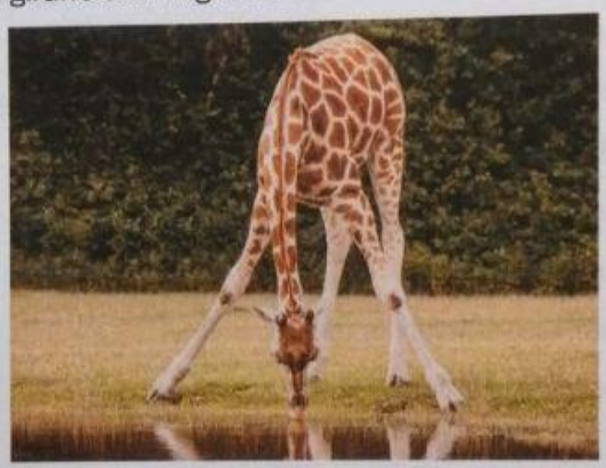
Photograph 1

(a) What type of skeleton does the earthworm have?

(b) The earthworm moves with the aid of two types of muscles. Name the types of muscles.

(c) Explain how the muscles in the body of the earthworm cause movement.

3. Photograph 2.1 shows a giraffe drinking water.



Photograph 2.1

(a) (i) Based on Photograph 2.1, state the way the giraffe stands while it is drinking water.

(ii) How can this stabilise the giraffe?

(b) Photograph 2.2 shows two types of animals, *X* and *Y*.

X

Y

Photograph 2.2

(i) If both animals have the same mass, which animal is more stable.

(ii) Explain your answer in question **3**(b)(i).

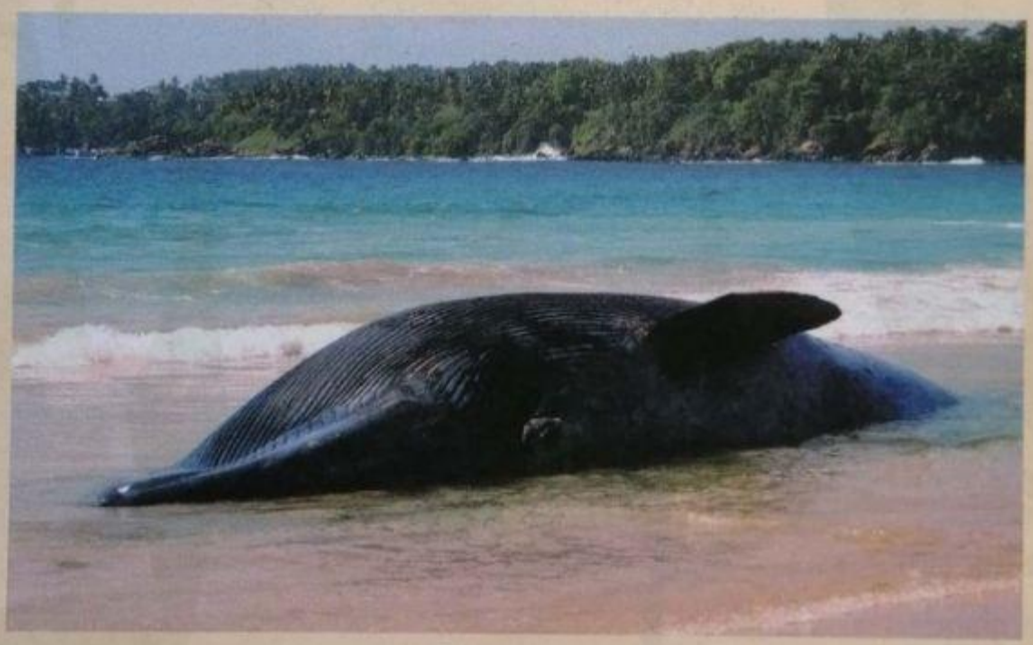
(iii) Suggest a posture when animal *Y* is more stable.

4. Woody plants have roots such as the buttress roots, prop roots and stilt roots to add support.

Based on the statement above, describe the way woody plants can stabilise their position without falling due to strong wind.

Mind Challenge

5. Photograph 3 shows a whale stranded on the beach.



Photograph 3

(a) Based on your knowledge about the support system of whales, can the whale return to the sea on its own?

(b) Explain your answer.