

# 14.1 TYPES OF SKELETON

1. There are three types of skeleton in humans and animals..
  - Exoskeleton
  - Endoskeleton
  - Hydrostatic skeleton
2. Neccesities of skeleton to humans and animals.



Supports body weight

Protects internal organs

For muscle attachment

Allows the growth of organisms except animals with exoskeleton

Storage for calcium and phosphate ions

Allows movements and locomotions

Produces blood cells in vertebrates

Gives body shapes



# 14.2 Musculoskeletal System of Humans

Human skeleton consists of axial skeleton and appendicular skeleton.



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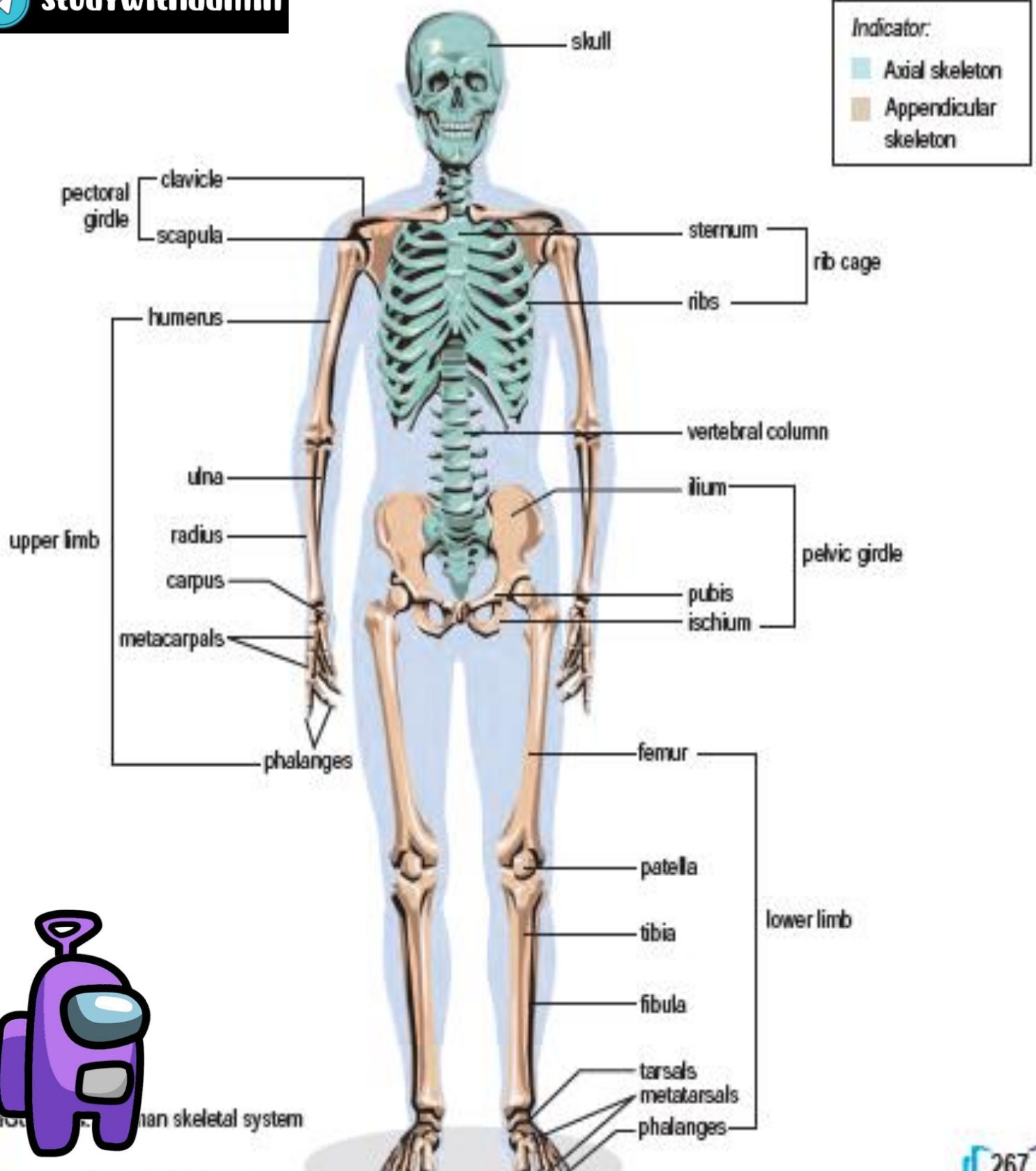


FIGURE 14.2 Human skeletal system

# 1. Structures of a typical vertebra and its function:



atlas vertebra

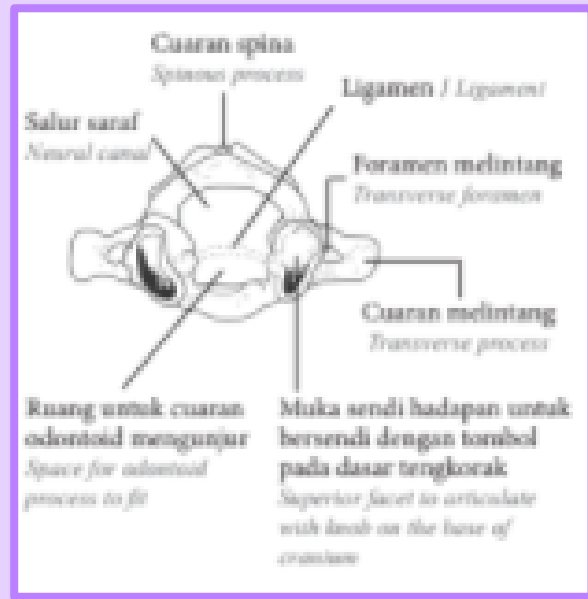
axial vertebra

cervical vertebra



# 2. Characteristics of cervical vertebrae:

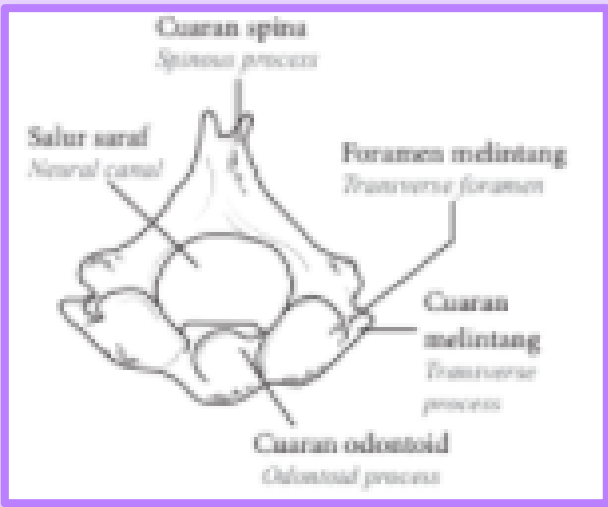
## ATLAS (I)



- a) Has large neural canal
- b) No centrum
- c) Has two vertebrarterial canals / transverse foramen – allow arteries to pass through to the brain
- d) Functions:
  - Nodding movement
  - Supports the skull

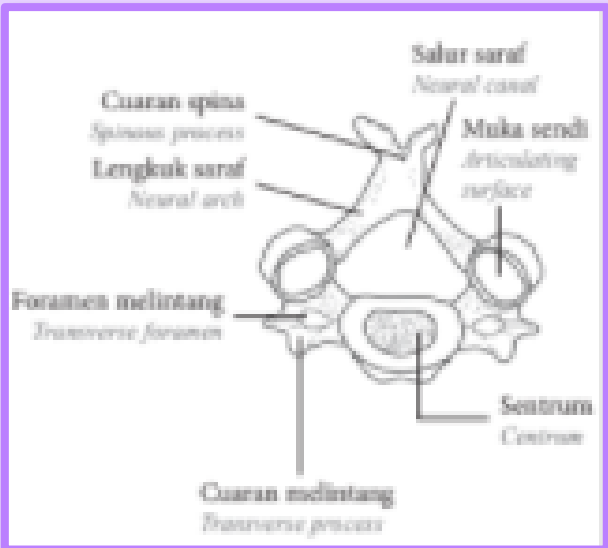


# AXIS (I)



- a) Odontoid process extends into ventral part of the neural canal of atlas and acts as pivot to allow the head to move side-to-side
- b) Has two vertebrarterial canals / transverse foramen
- c) Function:  
Side-to-side head movement.

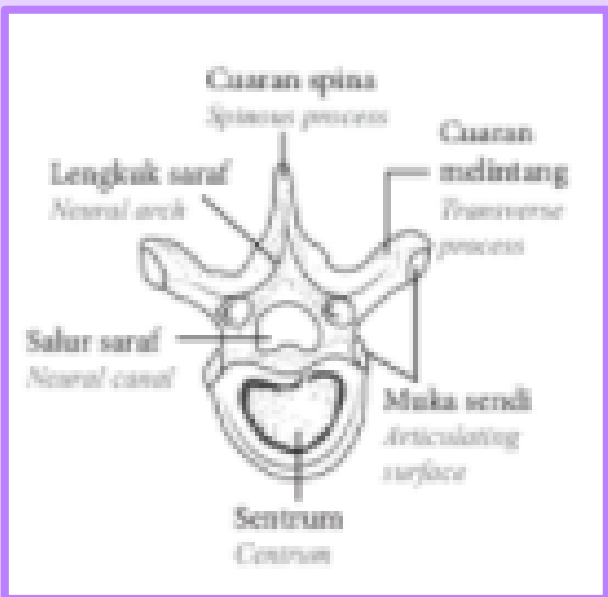
# CERVICAL (7)



- a) Broad and short transverse process
- b) Broad centrum
- c) Has two vertebrarterial canals / transverse foramen
- d) Functions:
  - Support head and neck
  - Attachment for neck muscles
  - Has a short spinous process

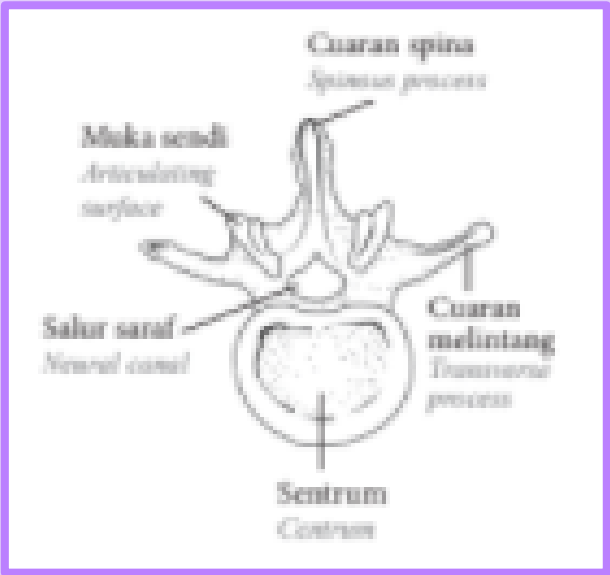


# THORACIC (12)



- a) Has long spinous process which points backwards
- b) Functions:
  - Support the rib bones to form the rib cage and provide surface for attachment of muscles to the transverse process and centrum
  - Muscle attachment to support head and neck
  - Large and thick centrum
  - Long transverse process

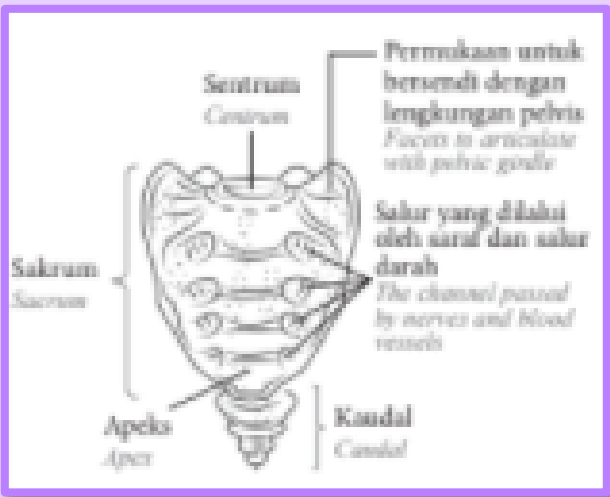
# LUMBAR (5)



- a) The largest and strongest vertebra in the vertebral column
- b) Large and thick centrum
- c) Transverse process is long and flat
- d) Spinous process is short
- e) Function:  
The large centrum supports the weight of the lower back



# SACRUM (5) AND CAUDAL (4)



- a) Five bones fused together forming a broad triangular structure known as sacrum
- b) Coccyx is formed by fusion of four vertebrae bones
- c) Function:  
Balances and supports sitting position

TYPES OF VERTEBRATE	CERVICAL VERTEBRAE	THORACIC VERTEBRAE	LUMBAR VERTEBRAE
Spinous process	Short	Long	pendek
Transverse process	Broad and short	Long	Short
Centrum	Small	Medium size	Large
Transverse foramen	Has a pair of transverse foramen	Absent	Absent




# Joint



## 1. Movement of human limbs can be done by:

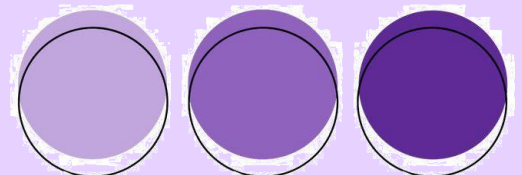
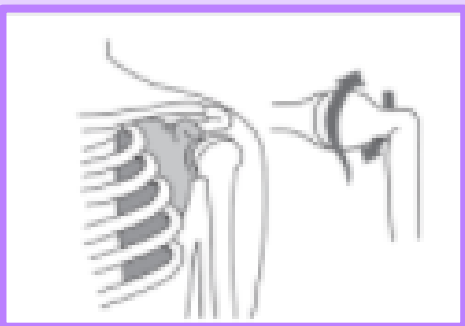
- (a) the presence of joints in which two or more bones meet.
- (b) the actions between skeletal muscles and bones.

## 2. There are three types of main joints found in humans.

TYPES OF JOINT	CHARACTERISTICS	EXAMPLES
Immovable joints	<ul style="list-style-type: none"><li>Bones attached together by fibrous connective tissue</li><li>No movement is allowed</li><li>These joints are categorised as sutures</li></ul>	<ul style="list-style-type: none"><li>Joints in skull</li><li>Joints in pelvic girdle</li></ul> 
Slightly moveable joints	<ul style="list-style-type: none"><li>Bones attached together by cartilage</li><li>Movement is limited</li></ul>	<ul style="list-style-type: none"><li>Sendi antara vertebra</li><li>Sendi antara tulang rusuk dengan Sternum</li></ul>
Freely moveable joints	<ul style="list-style-type: none"><li>Bones jointed together with synovial fluid</li><li>Movement in one plane or all planes</li><li>These joints are known as synovial joints</li></ul>	<ul style="list-style-type: none"><li>Hinge joints (humerus with ulna and radius, femur with tibia and fibula, between phalanges)</li><li>Ball-and-socket joints (humerus with scapula, femur with pelvic girdle)</li></ul>

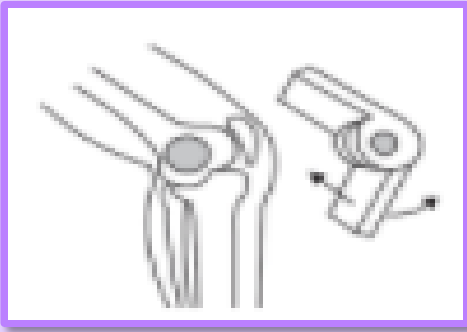
## 3. Examples of movable joint

### A BALL-AND-SOCKET JOINT



- Allowing 360° movements / all planes
- Examples:
  - Pectoral girdle ↔ Humerus
  - Pelvic girdle ↔ Femur

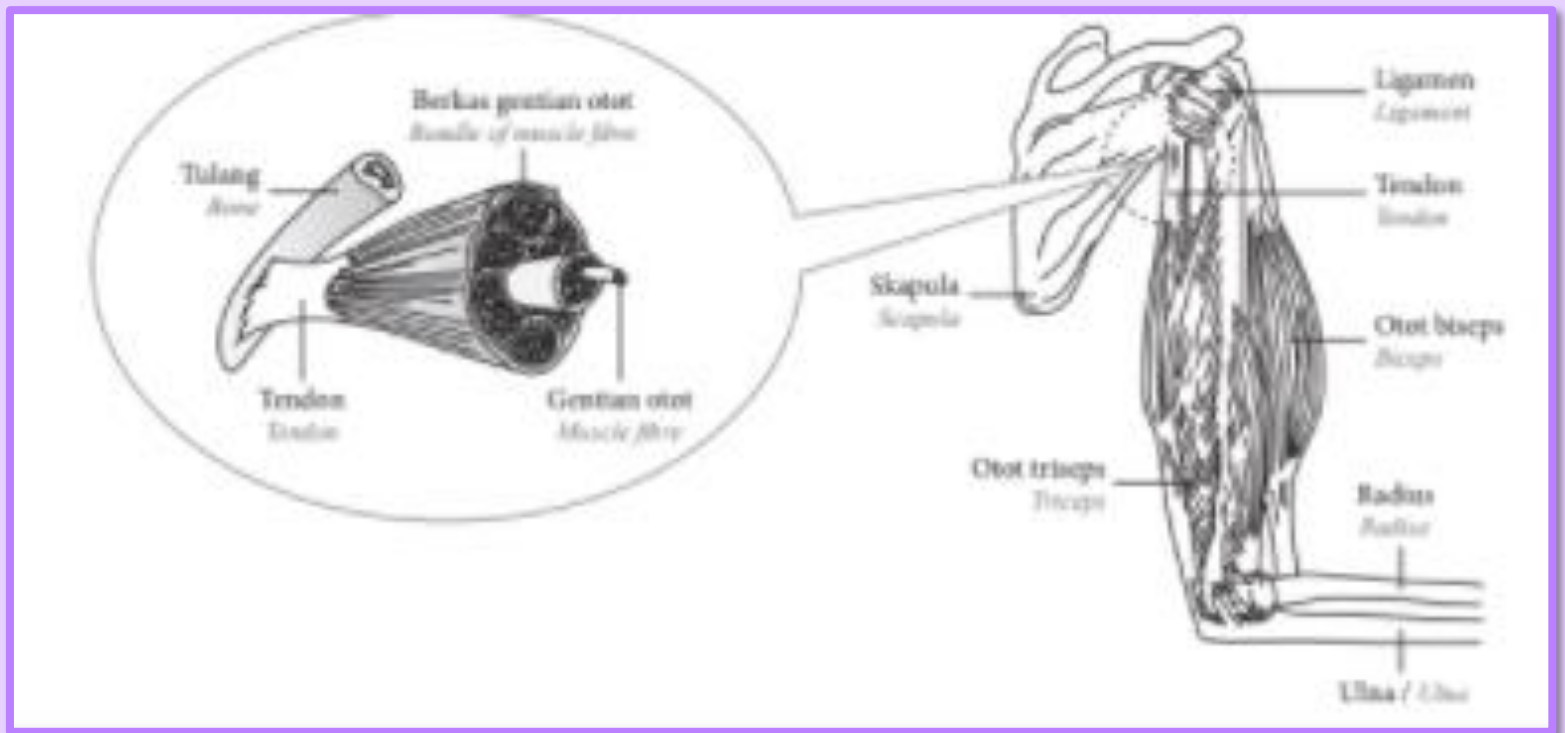
# A HINGE JOINT



- Allowing 180° movements / single plane
- Examples:  
Humerus ↔ Ulna and radius  
Femur ↔ Tibia and fibula



## ROLES OF THE SKELETAL MUSCLES, LIGAMENTS AND TENDONS IN MOVEMENT



STRUCTURE	CHARACTERISTICS	FUNCTIONS
Tendons	<ul style="list-style-type: none"> <li>• Not elastic</li> <li>• Strong</li> <li>• Connective tissues</li> </ul>	<ul style="list-style-type: none"> <li>• Joins muscles to bones</li> <li>• Transmits pulling force exerted by contraction of muscles to the bone and pulls it up</li> </ul>
Ligaments	<ul style="list-style-type: none"> <li>• Elastic</li> <li>• Strong</li> <li>• Connective tissues</li> <li>• Flexible</li> </ul>	<ul style="list-style-type: none"> <li>• Joins bone to bone / cartilage</li> <li>• Holds joints together</li> <li>• Prevents dislocation</li> <li>• Allows limited movements</li> </ul>
Muscles	<p>Antagonistic pairs:</p> <ul style="list-style-type: none"> <li>• A pair of muscles that When one contracts, the other relaxes</li> <li>• Example: Biceps and triceps of the arm</li> </ul>	<ul style="list-style-type: none"> <li>• Exert pulling force onto bones</li> <li>• Supports movement and locomotion</li> </ul>

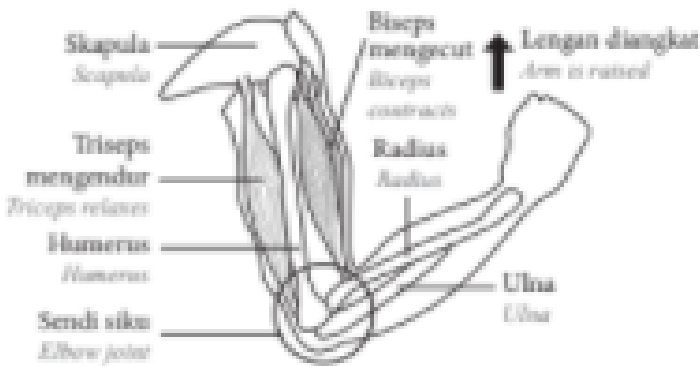


# 143 MOVEMENT AND LOCOMOTION

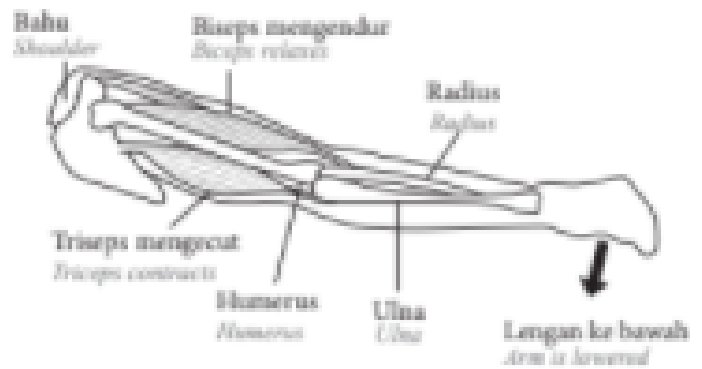
1. Actions between skeletal muscles and bones at joint causing movement.
2. Movements of arm and leg are due to the actions of antagonistic pair of skeletal muscles.
3. Movements of arm:



## BENDING OF THE ARM



## STRAIGHTENING OF THE ARM



Biceps contracts, triceps relaxes

*Action of  
muscles  
Tendon*

Triceps contracts, biceps relaxes

Transmits pulling force exerted by biceps to the radius

Transmits pulling force exerted by triceps to the ulna

Radius is pulled upwards

*Bone*

Ulna is pulled downwards

Holds bones together to form a joint

*Ligament*

Holds bones together to form a joint

Forearm moves upwards to bend the Arm

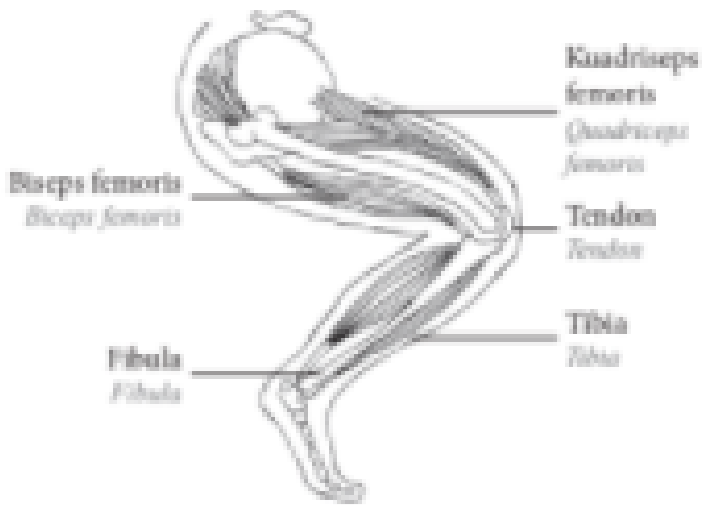
*Joint*

Forearm moves downwards to straighten the arm



#### 4. Pergerakan kaki:

### BENDING OF THE LEG



### STRAIGHTENING OF THE LEG



Biceps femoris contract and quadriceps relaxes.

*Action of muscles*  
*Tendon*

Quadriceps contract and biceps femoris Relaxes

Transmits pulling force exerted by biceps femoris to tibia and fibula

Transmits pulling force exerted by quadriceps to tibia

Tibia and fibula are pulled backward

*Bone*

Tibia and fibula are pulled forward

The leg is bent at knee joint.

*Joint*

The leg is straightened.

charcoal grey.



# Mechanism of locomotion in animals

## Locomotion in fish

- The fish vertebral column is flexible and can be moved from side to side by the contraction and relaxation of myotome, W-shaped muscle segments.
- These antagonistic muscles act in opposite directions. This enables a fish to whip its tail. As the myotome on the right contracts, the one on the left relaxes.
- The tail will be whipped to the right
- On the contrary, when the right myotome contracts, the left relaxes and the tail is whipped to the left.
- Alternating waves of contraction and relaxation occur along the myotome.
- The action causes parts of the body to move from side to side, pushing water backwards and sideways, and hence moving the fish forward.
- The fins are used to control a fish's movement and direction



FIGURE 14.16 (a) Cross section and (b) longitudinal section of a fish

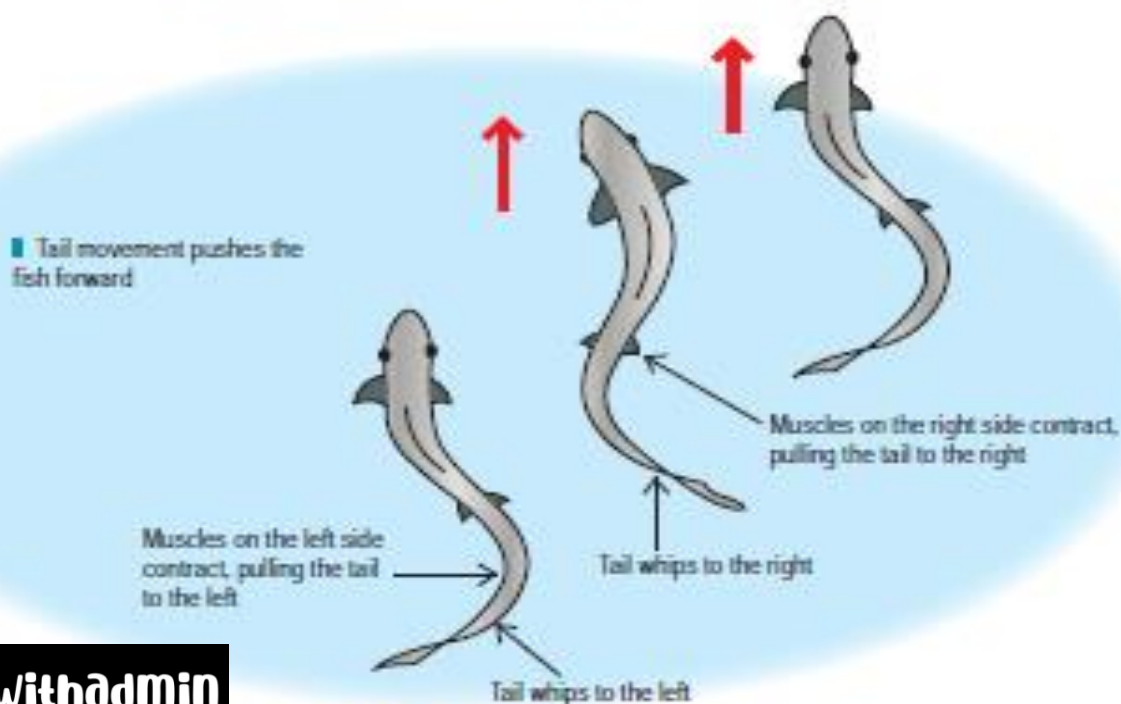
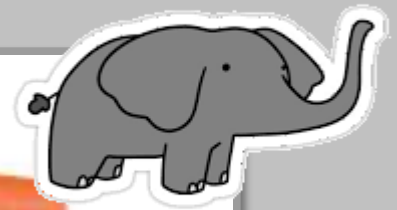


FIGURE 14.17 Fish locomotion mechanism



# Locomotion in earthworm

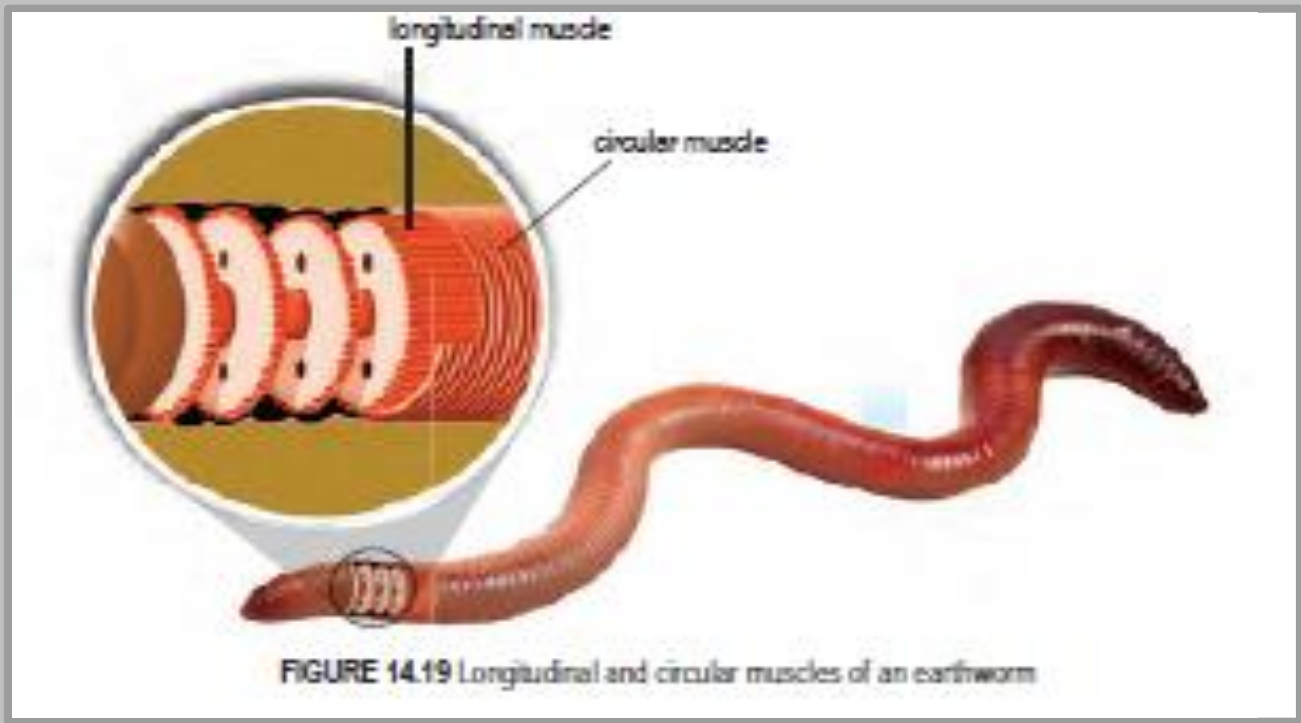


FIGURE 14.19 Longitudinal and circular muscles of an earthworm

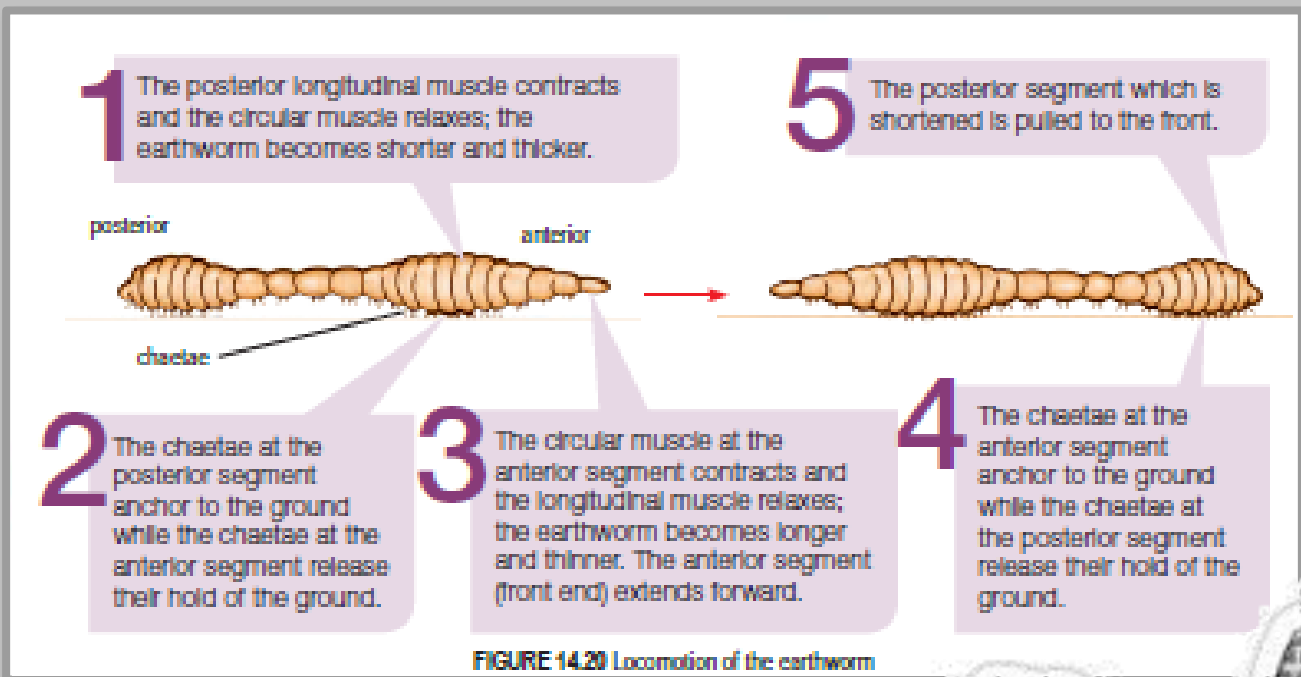


FIGURE 14.20 Locomotion of the earthworm

the darker  
the night  
the brighter  
the stars



# Grasshopper (jump/leap)

- The antagonistic muscles of a grasshopper, that is the flexor and extensor are attached to the inner surface of the exoskeleton
- The flexor bends a joint while the extensor straightens it.
- The muscular and long hind legs of a grasshopper are adapted for jumping/leaping

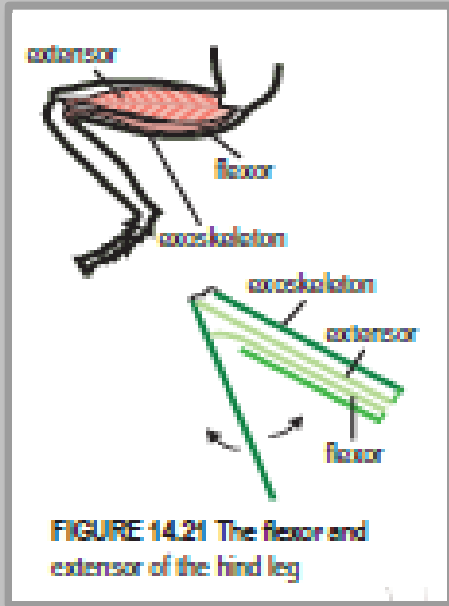
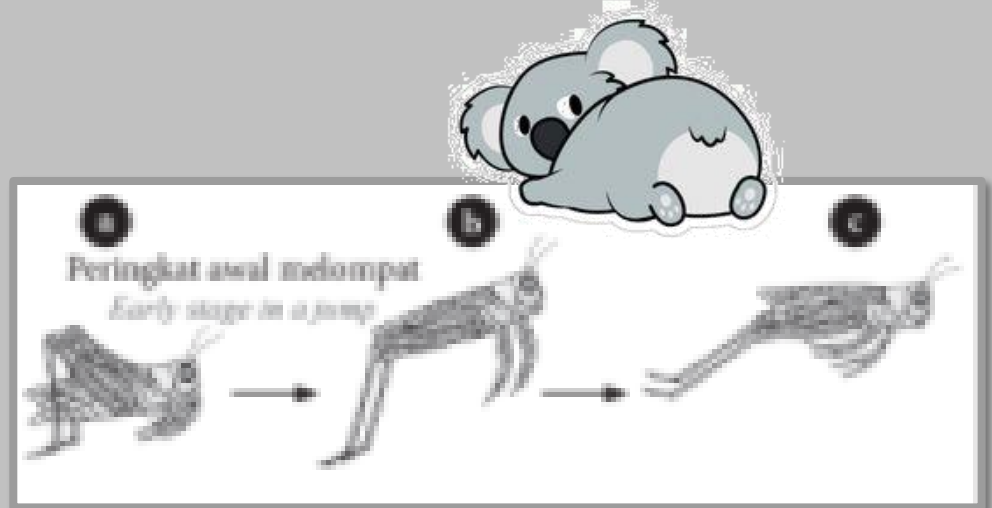
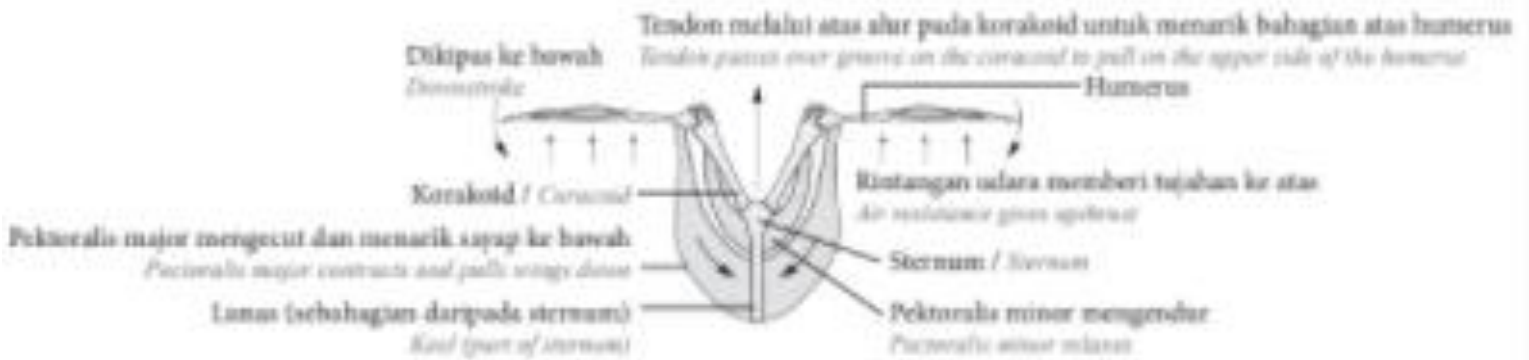


FIGURE 14.21 The flexor and extensor of the hind leg

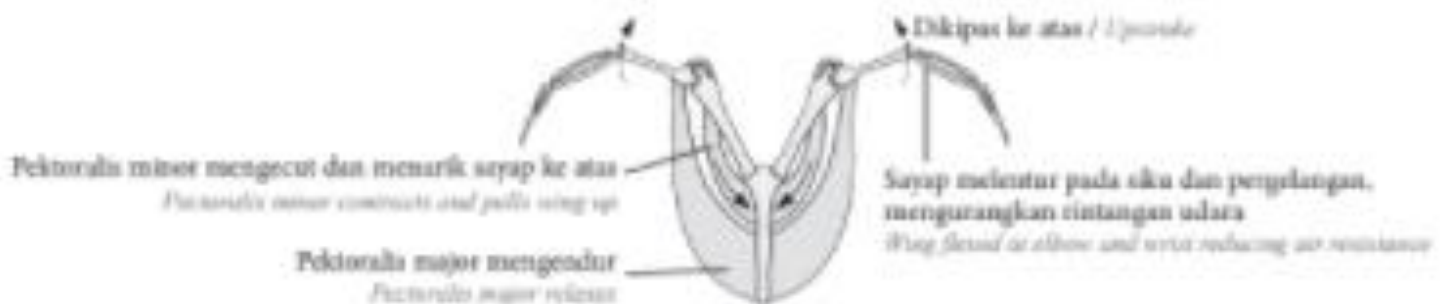


# Bird (flight)

## DOWNWARDS AND BACKWARDS MOVEMENT OF WINGS



## UPWARDS AND FORWARD MOVEMENT OF WINGS



## 14.4 HEALTH ISSUES RELATED TO THE HUMAN MUSCULOSKELETAL SYSTEM

### Health issues related to the human skeletal muscle system

HEALTH ISSUE	EXPLANATION	ADVICES AND TREATMENT
Osteoporosis	<ul style="list-style-type: none"><li>• Is caused by deficiency in the uptake of calcium, phosphorus and vitamin D or women experienced menopause</li><li>• Less calcium is used to form bones</li><li>• Bones become weak and easy to fracture especially at pelvic girdle, wrist and backbone</li></ul>	<ul style="list-style-type: none"><li>• Consumption of sufficient calcium, phosphate and vitamin D through daily diet to increase bone mass</li><li>• Exercise regularly to strengthen the muscles and bones</li><li>• Go through hormone replacement therapy for women experienced menopause</li></ul>
Osteomalacia	<ul style="list-style-type: none"><li>• Is caused by the deficiency in the uptake of calcium, phosphorus and vitamin D</li><li>• Bones become soft</li><li>• Occur in adult, especially pregnant women</li><li>• Osteomalacia that occur in children is known as rickets</li><li>• In children, bone defects may occur</li></ul>	<ul style="list-style-type: none"><li>• Consumption of sufficient calcium and phosphate through daily diet to increase bone mass</li><li>• Consumption of sufficient vitamin D through daily</li><li>• Exercise regularly to strengthen the muscles and bones</li></ul>



<p><b>Arthritis (Osteoarthritis)</b></p>	<ul style="list-style-type: none"> <li>• Cartilages in the joints of knee, pelvic girdle and backbone become wear off</li> <li>• Less synovial fluid secreted</li> <li>• Usually occurs in senior citizens</li> <li>• The joints experience inflammation, pain, swollen and hard</li> </ul>	<ul style="list-style-type: none"> <li>• Exercise regularly to strengthen the muscles and joints</li> <li>• Go through physiotherapy to strengthen the joints</li> <li>• Undergo surgery operation to replace with artificial joint</li> </ul>
<p><b>SCOLIOSIS</b></p>	<ul style="list-style-type: none"> <li>• Backbone of an individual is sideways curvature from the spine axis</li> <li>• Can be caused by genetic factor, tumour, bacterial infection, osteoporosis, rickets or injury</li> </ul>	<ul style="list-style-type: none"> <li>• Comprises three "O": observation, orthosis and operation</li> </ul>

# The practice of maintaining the health of the skeletal muscle system



## Exercise

- Exercise regularly
- Exercise with correct techniques
- Precautions during exercise

## Balanced diet consumption

- Diet rich in calcium, phosphate and vitamin C and D

## Suitable clothes

- too tight
- Wearing suitable shoes, low heels and has cushion

## Correct body postures

- Good standing posture
- Correct sitting posture
- Good lifting posture

