Chapter 37 - The Skeletal and Muscular System:

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<th>3.5</th>
<th>Learning Objectives</th>
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<td>3.5. Responses in the human</td>
<td>1. Description of the structure and functions of the skeleton.</td>
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<td>2. Label the component parts of the axial and appendicular skeleton.</td>
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<td>3. Detail the component parts of the axial skeleton.</td>
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<td>4. Give the position and function of discs in relation to vertebrae.</td>
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<td>5. Detail the component parts of the appendicular skeleton.</td>
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<td>6. Describe the macroscopic anatomy of a long bone.</td>
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<td>7. Give the function of the following: cartilage, compact bone, spongy bone (red and yellow).</td>
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<td>8. Classify and give location and function of joints.</td>
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<td>10. Explain the role of cartilage, ligaments and tendons.</td>
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<td>11. Give the general relationship of muscles to the skeleton.</td>
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<td>12. Name and detail one example of antagonistic muscle pairs.</td>
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<td>14. *Discuss the role of calcium in bone.</td>
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The Skeletal and muscular systems work together to form the musculoskeletal system.

It is controlled by the nervous system.

5 Key functions of the skeleton are:

- 1. Support: The bones form the rigid system that keeps the body upright.

- 2. Protection: Different bones protect different delicate organs. The skull protects the brain.

  Ribs protect heart and lungs.

- 3. Movement: Bones act as levers against which muscles can pull to cause movement.

- 4. Shape: The size of the bones in the skeleton determines our overall shape and size.

  The length of bones determines our height.


The 206 bones of the skeleton are divided into the Appendicular and Axial Skeleton.

- **The Axial Skeleton** consists of the Skull, Spine, Ribs and Sternum.

- **The Appendicular Skeleton** is composed of the limbs (appendages), pectoral girdle and pelvic girdle.
THE AXIAL SKELETON

- THE SKULL (Cranium)
Consists of 20 bones, all fused together, protects the brain.

- THE RIBCAGE
Consists of the Sternum and 12 pairs of ribs.
All ribs are attached to the vertebrae of the spine.
The top 7 pairs are attached to the sternum, they are true ribs.
The next three are attached to each other at the front by cartilage, they are false ribs.
The bottom two pairs are not attached at the front, they are floating ribs.

- THE SPINE
Consists of 33 Bones called vertebrae.
The top 24 are joined by ligaments and enable movement.
The bottom 9 are fused together, thus do not move.
The top 24 vertebrae move, thus they need to be separated by discs, to ease the movement.
Discs have a hard outer layer, which surrounds a jelly-like inner layer.
They reduce friction, act as shock absorbers and protect the vertebrae.
THE APPENDICULAR SKELETON

- PECTORAL GIRDLE

Consists of the collarbone (clavicle) and shoulder blade (scapula).
It connects with the vertebral column and the arms.

- PELVIC GIRDLE

Consists of the hip bones and the sacrum.
The **sacrum** is the area where it is fused to the spine.
The hip bones are composed of two halves, joined at the front by cartilage.

- LIMBS

The arms and legs make up your limbs, they have very similar structures.

**Phalanges** are the individual bones in the fingers and toes (Digits).

Each finger and toe has 3 phalanges, except the thumb and big toe, which consist of 2.

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**Macroscopic Anatomy of a Long Bone**

Long bones such as the femur and radius are enclosed by a membrane called the **Periosteum**.
It contains blood vessels and nerves.

**Compact Bone**
- **Location**: Diaphysis of bone
- **Composition**: Made of Osteoblasts (Bone Cells) embedded in a matrix of in-organic salts such as calcium and collagen protein.
- Blood vessels and nerve cells run through the compact bone.
- **Function**: Calcium gives the bone strength, protein gives flexibility.

**Spongy Bone**
- **Location**: Epiphysis of bone
- **Composition**: Similar to compact bone but contains many more hollows.
- Hollows are filled with bone marrow which produces blood cells.
- **Function**: Gives strength and rigidity.

**Bone Marrow**
- **Location**: Within spongy bone and medullary cavity.
- **Composition**: Red marrow, found in young people, produces blood components.
- Hollows are filled with bone marrow which produces blood cells.
- **Function**: Gives strength and rigidity.

**CARTILAGE**
Cartilage is made of collagen (a firm, flexible protein).

It has no blood vessels or nerves, thus is slow to heal.

It is found in the pinna of the ear, the nose, the trachea and vertebrae discs.

**Function**: On the ends of bones, acts as a shock absorber allowing friction free movement.

**BONE GROWTH (H.L.)**
- During embryonic development, cartilage begins to be replaced by bones at week 8.
- **Osteoblast cells** produce collagen protein.
- Calcium phosphate and other salts form around the osteoblasts and collagen, making them dormant bone cells.
- In order for bones to grow they require a **growth plate**.
- The plate is made of cartilage and located between the Epiphrasis and Diaphysis.
• In the growth plate, cartilage is continually made and then **ossified** (turned to bone) by osteoblasts.

• When a person reaches adulthood, the growth plate stops functioning, terminating the development of adult height.

**BONE DEVELOPMENT/CELL REPLACEMENT (H.L.)**

• In life bone is constantly being dissolved, thus it needs to be renewed.

• This occurs ~ten times throughout life.

• The restructuring process involves the removal of bone material from inside the medullary cavity, then extra bone material being deposited outside the bone.

• This exchange prevents bones from becoming heavier as they grow longer.

• The removal of bone material from the medullary cavity is carried out by **Osteoclast** (bone-digesting) cells.

• They digest the bone that lines the cavity and deposit it into blood vessels.

• Osteoblasts then form new bone on the outside of the bone.

• Osteoblasts and osteoclasts work opposite each other to enlarge the medullary cavity and thicken the compact bone lining it.

**BONE RENEWAL (H.L.)**

• The continual renewal of bone is dependent on: Physical Activity, Hormones and Diet.

• When bones are stressed by physical activity, they activate osteoblasts, which make them thicker and stronger (especially near where muscles attach).

• Lack of stress causes them to become thin.

• The main hormones affecting bone development include: growth hormone, sex hormones and parathormone.

  • **Growth and sex hormones** are active at puberty and increase bone mass rapidly.

  • **Parathormone** removes calcium from bone, this allows a constant supply of calcium in the blood for correct nerve and muscle function.

**ROLE OF CALCIUM (H.L.)**

• Calcium is required in the diet for a number of reasons:

  • It forms the solid structure of bone, giving it its strength.
  • It's essential for blood clotting.
  • It stabilizes blood pressure.
  • It contributes to normal brain function.
• It’s critical for communicating essential information among cells.

RELATED DISEASES

• **Osteoporosis** is the loss of collagen protein from bones. This results in a loss of flexibility and bones become brittle and easily broken.

• **Osteomalacia** is the loss of minerals including calcium from the bones, due to a lack of vitamin D in the diet. This causes bones to lose rigidity and strength.

JOINTS

A **Joint** is where two or more bones meet.

• They can be categorised as: 1. Immovable, 2. Slightly movable, 3. Freely movable (Synovial)

**Immovable Joints**

• Are fixed or fused into position.
• Function: provide strength, support and protection.
• Examples: Skull and Pelvic Girdle.

**Slightly Movable Joints**

• Allow limited movement.
• Example: The vertebrae of the spine, they are separated by discs of cartilage & held by ligaments.
• They protect the spinal cord.

**Freely Movable (Synovial) Joints**

• Allow a range of movements.
• The ends of the bones are covered with cartilage and separated by a small cavity.
• The bones are held in place by ligaments to prevent over movement.
• Inside the cavity is a synovial membrane which contains synovial fluid.
• This lubricates the joints reducing friction.
• There are two types of synovial joints: Ball and Socket and Hinge.

**Ball and Socket Joint**

• All movement in ALL directions, they cannot support high levels of weight.
• E.g.: Shoulder joint, hip joint.

**Hinge Joint**

• All movement in only one direction, they can support high levels of weight.
• E.g.: Knee and Elbow Joint
LIGAMENTS & TENDONS

Ligaments are strong, fibrous, slightly elastic tissues which connect bone to bone.

- They are more flexible when warm, hence you should warm up prior to exercise.

Tendons are strong, flexible, inelastic fibres that connect muscle to bone.

- They contain blood vessels and are made of collagen.

MUSCULOSKELETAL SYSTEM DISORDER

Arthritis is a skeletal disorder resulting from inflammation of a joint.

- There are over 100 types.
- Two most common: Osteoarthritis & Rheumatoid Arthritis.

Osteoarthritis

- Onsets at ~50
- Caused by cartilage at joints wearing down.
- The bones become enlarged and synovial fluid production increase.
- Joints become sore and stiff.

Rheumatoid Arthritis

- Most severe form. It is a genetic disorder, caused due to the immune system attacking the body (Auto-immune disease).
- The synovial membranes are attacked first, this causes joints to swell and become damaged and deformed.

Prevention – (Osteoarthritis)

- Caused by wear and tear on the cartilage in joints, can be reduced by avoiding wear and tear on joints (running on roads is a major cause).

Treatment

- No cure but treatment includes rest, exercise, weight loss, steroids, anti-inflammatory medications, immunosuppressant’s and surgery to replace joints (hip replacement).
MUSCLES

• The body contains three types of muscle: Skeletal, Smooth, Cardiac.

Skeletal Muscle

○ Can be called striated, striped or voluntary muscle.
○ There are over 600 in the human body, making up 50% of body weight.
○ Skeletal muscle is concerned with body movements and is under conscious control.

Smooth Muscle

○ Can be called unstriped or involuntary muscle.
○ It is found in internal structures such as the digestive system, blood vessels, bladder and uterus.
○ It is under unconscious control.

Cardiac Muscle

○ Is found in the heart and is slow to tire.
○ It is involuntary and has many, many mitochondria for a high energy input.

Antagonistic Pairs

• The contraction of muscles requires use of large amounts of energy (ATP).
• Tendons connect muscles to bones.
• When a muscle contracts it pulls on the bone, causing movement.
• Muscles can only pull (contract) so they need another muscle opposite to pull them back out.

• An Antagonistic pair is a pair of muscles that have opposing effects on each other.

• E.g. Bicep and Tricep