UNIT-2: MUSCULOSKELETAL SYSTEM

Unit Structure

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2.1 Learning Outcomes

After studying this unit, you would able to

- Know about the bones type and their location
- Explain different types of human muscles and joints
- Describe the effect of yoga practice on Musculoskeletal system

2.2 Introduction

The musculoskeletal system is a complex system in the human body that provides form, support, stability, and movement. It is composed of bones, muscles, joints, tendons, ligaments, and other connective tissues.The musculoskeletal system plays a critical role in maintaining posture, balance, and enabling daily physical activities. Proper care, including exercise, nutrition, and rest, is essential for its health and function.

2.3 Bones

Bones are the hard, strong parts inside your body that make up your skeleton. They give your body shape, protect your organs (like the brain and heart), and help you move by working with your muscles. Bones are like the body's framework, and without them, we'd be soft and unable to stand or move properly.

For example, your skull protects your brain, your ribcage protects your heart and lungs, and the bones in your legs and arms help you walk, run, and pick things up. Bones are also where blood cells are made, and they store important minerals like calcium.

2.3.1 Types of Bones

There are mainly four types of bones in human body depending upon each with different shapes and functions.

Long Bone: These bones are longer than they are wide, and are found in the arms and legs. Examples include the femur (thigh bone), Humerus (upper arm bone), tibia (shin bone), and fibula (calf bone). Long bones act as levers, moving when muscles contract.

Short bones: These bones are roughly cube-shaped, and are found in the hands and feet. Examples include the carpal bones of the wrist and the tarsal bones of the ankle. Short bones provide stability and support, and allow some limited movement.

Flat bones: These bones are wider and less round than other bones, and are made up of a layer of spongy bone between two thin layers of compact bone. Examples include the skull, ribs, and clavicle (collarbone). Flat bones have marrow, but they do not have a bone marrow cavity.

Irregular bones: These bones have a shape that does not conform to the other three types, and often have a complex shape. Examples include the vertebrae, coccyx, sacrum, temporal, ethmoid, sphenoid, zygomatic, mandible, maxilla, inferior nasal concha, palatine, and hyoid. Irregular bones protect internal organs, such as the spinal cord and the organs in the pelvic cavity.

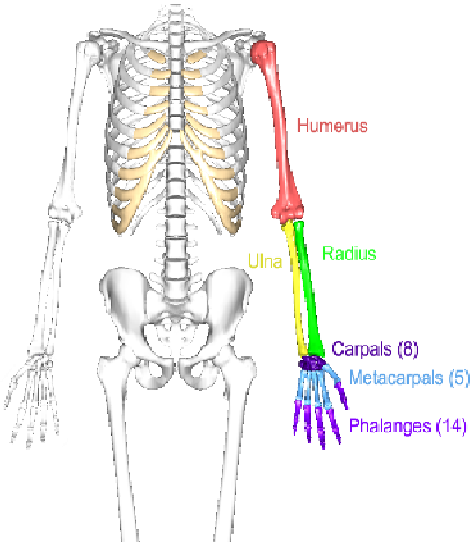
2.3.2 Name and location of the Bones in the Body

There are total 206 bones are in human body. We can have divided total body structure in two part:

1. **Appendicular Skeleton:** Total 126 bones are come in this part. These bones are helping our body in movements. Those bones don't protect our body internal parts.
2. **Axial Skeleton:** Total 80 bones contain Axial skeleton. This bones are protecting our internal body parts but don't involve in body movements.

Appendicular Skeleton Bones

A) There are 30 bones in each human arm. So, total 60 bones are in two arms.



Each Arm: **Humerus:** The single bone in the upper arm

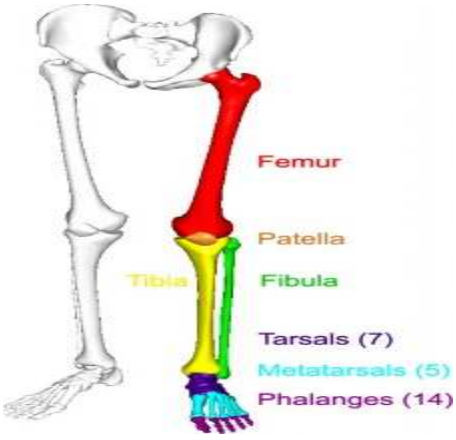
Radius and ulna: The paired bones in the forearm

Carpals: Eight bones in the wrist

Metacarpals: Five bones in the palm

Phalanges: Fourteen bones in the fingers and thumb

B) There are 30 bones in each human arm. So total 60 bones are in two arms.



Each Leg: **Femur:** The thigh bone

Patella: The kneecap

Tibia: The shin bone, which is the larger, weight-bearing bone on the medial side of the leg

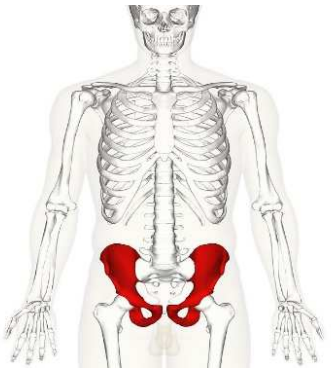
Fibula: The thin bone on the lateral side of the leg

Tarsal bones: Seven bones that form the posterior portion of the foot

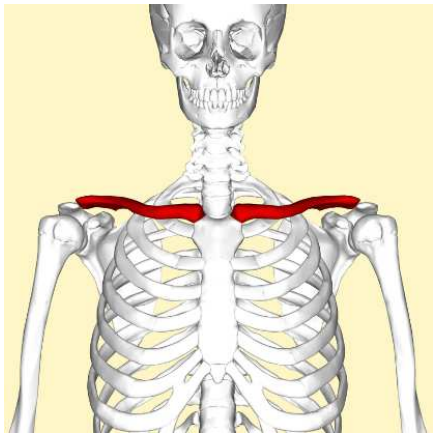
Metatarsal bones: Five elongated bones that form the mid-foot

Phalanges: Fourteen small bones that form the toes

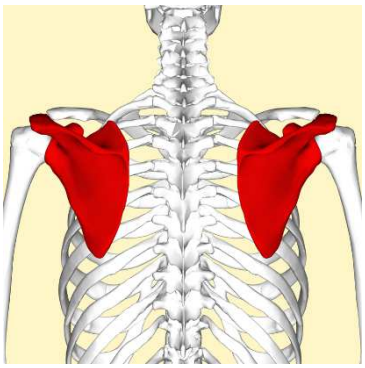
C) There are 2 (two) Pelvic bones in human body



D) Appendicular skeleton contains 2 (two) Clavicle bones



E) There are 2 (two) Scapula bones help human in movements.



Axial Skeleton Bones

A) **Vertebral column:**The spinal column, also known as the vertebral column, spine or backbone, is the core part of the axial skeleton in vertebrates. Total 26 bones consist in Vertebral column.

These bones are:

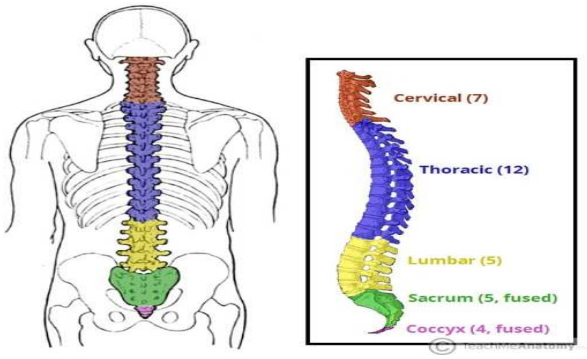
Cervical vertebrae (7 nos.)

Thoracic vertebrae (12 nos.)

Lumbar vertebrae (5 nos.)

Sacrum (1 no.)

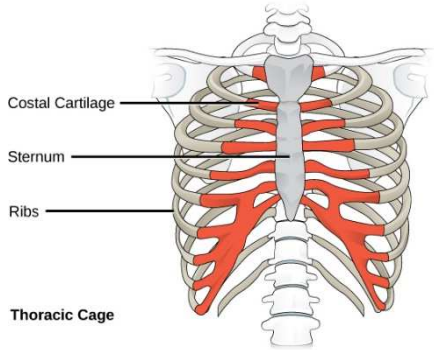
Coccyx (1 no.)



B) **Thoracic Cage:**The thoracic cage, also known as the rib cage, has 25 bones.

Sternum (1 nos.)

Ribs (24 nos.)



C) **Head:** Total 29 bones are in our head.

Skull: Skull consist of 22 bones (8-Cranial Bones and 14-Facial Bones)

Cranial Bones- 8 Nos.

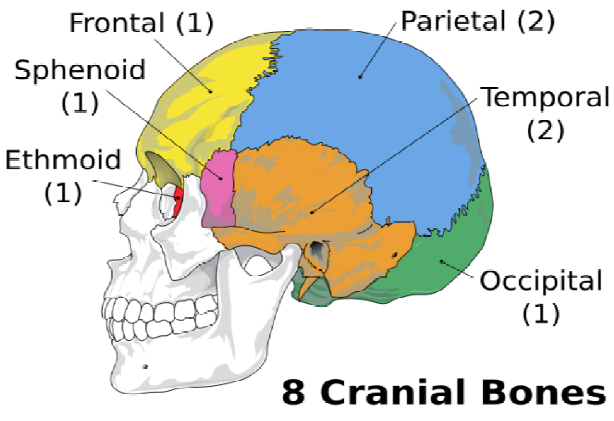
Parietal (2)

Temporal (2)

Frontal (1)

Occipital (1)

Ethmoid (1)



Sphenoid (1)

Facial Bones- 14 Nos.

Maxilla (2)

Zygomatic (2)

Mandible (1)

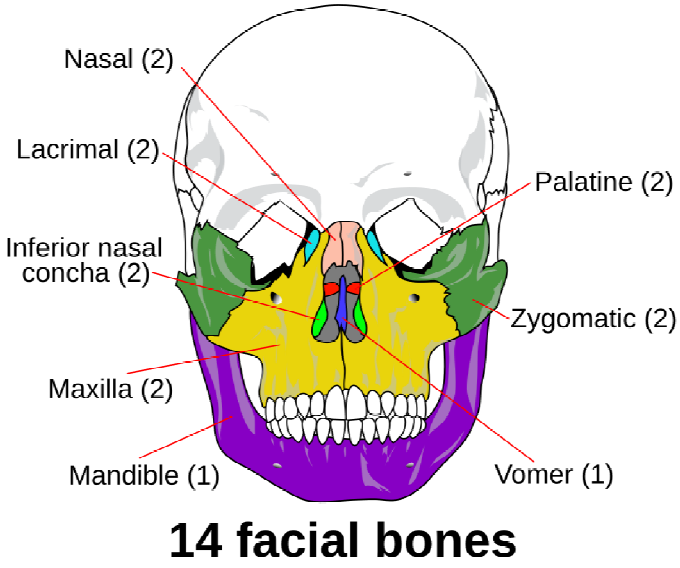
Nasal (2)

Palatine (2)

Inferior nasal concha (2)

Lacrimal (2)

Vomer (1)

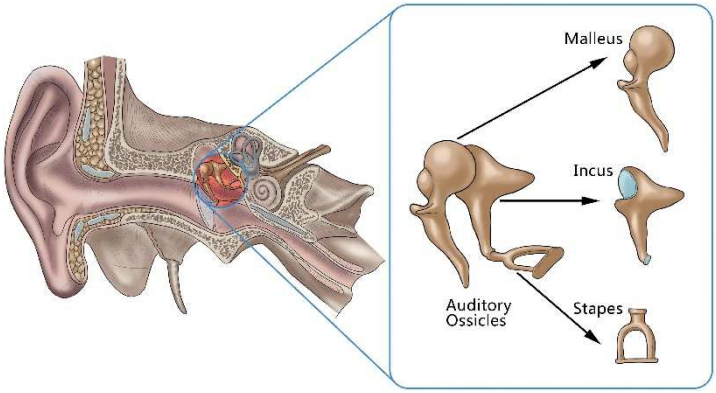


Auditory Ossicle: The auditory ossicle are three small bones in the middle ear that transmit sound vibrations from the outer ear to the inner ear. These are:

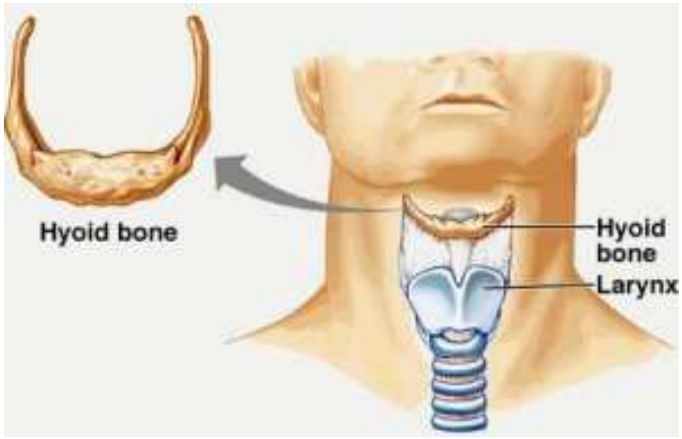
Malleus (2)

Incus (2)

Stapes (2)



D) **Hyoid Bone:** The hyoid bone is a small, U-shaped bone in the neck that's involved in many functions, including speech, swallowing, and breathing.



Important Points:

- **Longest Bones –** Femur
- **Smallest Bones –** Stapes
- **Strongest Bones –** Jaw
- **Weakest Bones -** The clavicle, or collarbone

2.4 Muscles

Muscles are a type of tissue that control movement in the body. They are made up of bundles of fibrous tissue that contract and relax to cause movement. The human body has over 600 muscles that work together with bones to perform a variety of functions, including:

Movement: Muscles allow you to move your body, eyes, and stand up straight.

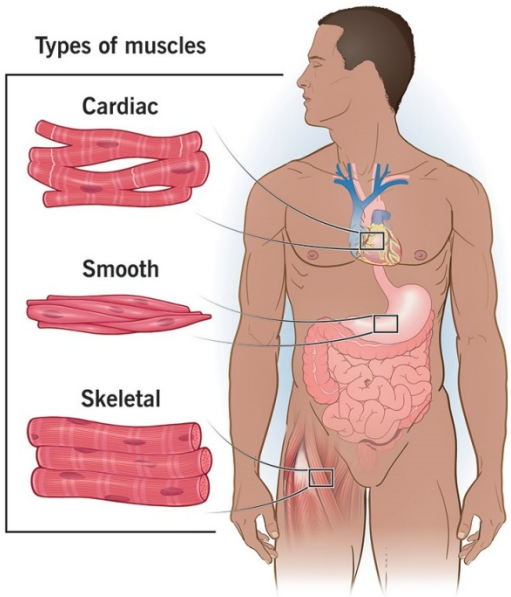
Digestion: Muscles help move food through your digestive system.

Blood circulation: Muscles pump blood through your heart and blood vessels.

Posture: Muscles help maintain posture.

2.4.1 Types of Muscles

Muscles are classified into three major types:



1. Skeletal Muscles

- **Location**: Attached to bones via tendons.
- **Control**: Voluntary (under conscious control).
- **Function**: Movement of the skeleton, posture, and joint stability.

- **Appearance**: Striated (striped appearance under a microscope).
- **Examples**: Biceps, triceps, quadriceps, and hamstrings.

2. Smooth Muscles

- **Location**: Walls of internal organs like the stomach, intestines, blood vessels, and bladder.
- **Control**: Involuntary (not under conscious control).
- **Function**: Movement of food through the digestive system (peristalsis), regulation of blood flow, and control of other automatic internal processes.
- **Appearance**: Non-striated (smooth under a microscope).

3. Cardiac Muscle

- **Location**: Only found in the heart.
- **Control**: Involuntary.
- **Function**: Pumping blood throughout the body.
- **Appearance**: Striated and branched to facilitate efficient contraction and relaxation.

Each muscle type has a distinct structure and function suited to its role in the body. In terms of energy use, muscles require ATP (adenosine triphosphate) for contraction and rely on different energy systems based on the intensity and duration of the activity.

2.5 Joint

Joints in the human body are where two or more bones meet, allowing movement and providing mechanical support.

Functions of Joints

- **Facilitate Movement**: Joints work with muscles to allow different types of body movements, such as flexion, extension, rotation, and more.
- **Support Weight**: Weight-bearing joints like the knees, hips, and spine provide support and stability to the body.
- **Absorb Shock**: Joints like the intervertebral discs in the spine help cushion impacts and reduce strain on the skeleton.

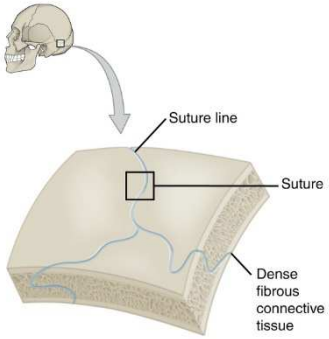
2.5.1 Types of Joint

There are two different types of joints- Structural and Functional classification of joints.

Structural Classification of Joints

This classification is based on how the bones are connected to each other. It categorizes joints into three types:

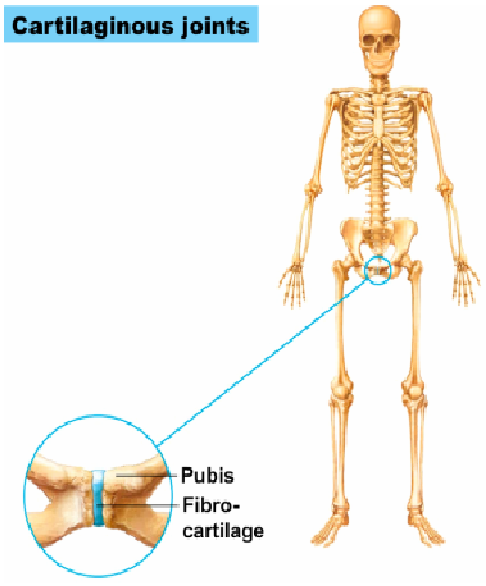
1. **Fibrous Joints**
    - These are immovable or "fixed" joints where the bones are tightly fused together and cannot move. The lack of flexibility in fibrous joints provides structural stability to the body.



    - **Examples**:
        - The **skull**, where several bones fuse to protect the brain.

2. **Cartilaginous Joints**

- These joints allow slight movement and consist of bones connected by cartilage. There are two types:

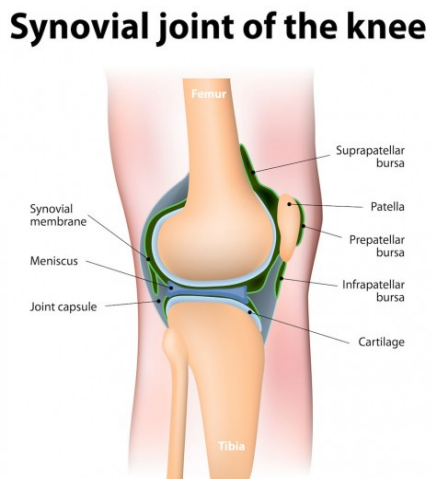


- **Synchondrosis** joints are temporary and mainly found in children. They allow bone growth and eventually disappear after puberty, like the **epiphyseal plates** at the ends of long bones.
- **Symphysis** joints are permanent and slightly movable, such as the **pubic symphysis**.

Examples: Joints in the **spinal column** and **ribcage** also belong to this category, providing

flexibility while still supporting the body's weight.

3. **Synovial Joints**



These are the most common and flexible joints in the body, allowing a wide range of movements. Synovial joints are surrounded by a joint capsule filled with synovial fluid, which lubricates and reduces friction between bones.

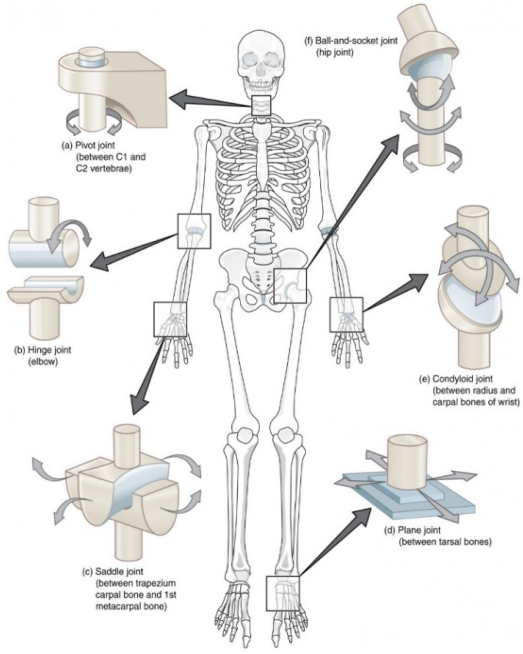
- **Examples**:

- The **shoulder joint** allows for rotation and movement in all directions.
- The **knee**, **wrist**, and **neck** joints provide a variety of movements like flexion, extension, and rotation.

Functional Classification of Joints

This classification focuses on the range of movement allowed by the joints. There are six types of freely movable joints (synovial) based on the movement they permit:

1. **Hinge Joints**: These joints allow movement in one direction, like a door hinge.
   Example: The elbow and knee joints.
2. **Ball-and-Socket Joints**: These allow rotational movement and movement in multiple directions.
   Example: The shoulder and hip joints.
3. **Pivot Joints**: These joints permit rotational movement around a single axis.
   Example: The joint between the first and second vertebrae of the neck, allowing the head to turn.



4. **Saddle Joints**: These joints allow movement in multiple directions but no rotation.
   Example: The joint at the base of the thumb.
5. **Plane (Gliding) Joints**: These joints allow sliding movements between flat surfaces of bones.
   Example: Wrist and ankle joints.
6. **Condyloid (Ellipsoidal) Joints**: These joints allow movement with no rotation, like flexion, extension, abduction, and adduction.
   Example: The joints between the metacarpals and phalanges (fingers).

In summary, structural classification is based on how bones are connected (fibrous, cartilaginous, and synovial), while functional classification is based on the range of movement the joints allow (hinge, ball-and-socket, pivot, saddle, plane, condyloid).

2.6 Effect of Yogic Practices on the Musculo-Skeletal System

Yogic practices, including asanas (postures), pranayama (breathing exercises), and meditation, have a profound impact on the musculo-skeletal system. These effects can improve flexibility, strength, posture, and overall musculo-skeletal health.

1. Improved Flexibility

- Yoga stretches and lengthens muscles, tendons, and ligaments, improving overall flexibility. Regular practice of yogasanas helps reduce stiffness in the joints and muscles, increasing the range of motion.
- **Examples**: Forward bends, backbends, and twists (like Paschimottanasana and Ardha Matsyendrasana) help release tension in areas like the spine, shoulders, and hips.

2. Strength Building

- Many yoga poses require sustained muscle engagement and balance, which gradually builds strength in the muscles and joints. Yogasanasenhances muscular endurance and tone, especially in weight-bearing postures.

- **Examples**: Poses like Plank (Phalakasana), Warrior (Virabhadrasana), and Chair Pose (Utkatasana) strengthen the core, legs, and arms.

3. Enhanced Joint Mobility and Stability

- Yogic movements ensure that joints are taken through their full range of motion, which lubricates them with synovial fluid and promotes mobility. It also strengthens the muscles around joints, improving joint stability and reducing the risk of injury.
- **Examples**: Surya Namaskar (Sun Salutation) is a dynamic sequence that moves multiple joints, including the shoulders, hips, knees, and ankles.

4. Improved Posture

- Poor posture, often caused by modern sedentary lifestyles, can lead to imbalances and pain in the musculo-skeletal system. Yogasanas helps correct postural misalignments by increasing awareness of body alignment and reinforcing the spine's natural curves.
- **Examples**: Tadasana (Mountain Pose) and Bhujangasana (Cobra Pose) emphasize spinal alignment, strengthening the muscles that support good posture.

5. Increased Bone Density

- Weight-bearing yoga postures apply gentle stress to the bones, stimulating the bones to retain calcium and other minerals, which can improve bone density and reduce the risk of osteoporosis.
- **Examples**: Standing poses like Tree Pose (Vrikshasana) and Triangle Pose (Trikonasana) help maintain bone strength.

6. Relief from Muscular Tension and Pain

- Yoga practices, especially those focused on relaxation and mindful breathing, can relieve tension in muscles caused by stress, overuse, or injury. By improving circulation and increasing oxygen flow, muscles relax and heal more effectively.
- **Examples**: Gentle forward folds like Balasana (Child's Pose) and reclining poses like Savasana (Corpse Pose) are restorative and help release built-up tension.

7. Alignment and Correction of Musculo-Skeletal Imbalances

- Yogasanas encourages symmetry in the body by balancing strength and flexibility on both sides. Over time, this can correct muscular imbalances caused by habitual movements, sports, or poor posture.
- **Examples**: Asanas like Dandasana (Staff Pose) help build awareness of spinal alignment, while balancing poses like Natarajasana (Dancer Pose) engage and strengthen weaker muscles.

8. Injury Prevention and Rehabilitation

- Yogasanas strengthens stabilizing muscles, increases flexibility, and improves proprioception (awareness of body position). This reduces the risk of injuries during physical activities and supports faster recovery from musculo-skeletal injuries.
- **Examples**: Gentle yoga postures, such as supported backbends and hip openers, are often used in rehabilitation to strengthen muscles around injured joints without placing excessive strain on them.

9. Improved Spinal Health

- Yoga promotes the health of the spine by elongating and decompressing the vertebrae, enhancing blood circulation around the spinal discs, and preventing conditions like herniated discs or back pain.
- **Examples**: Poses like Cat-Cow (Marjariasana-Bitilasana) stretch and strengthen the spine while providing relief from stiffness.

10. Balance and Coordination

- Yogasanas enhances neuromuscular coordination by integrating balance, strength, and flexibility, thereby improving overall coordination and body control.
- **Examples**: Balancing poses such as Vriksasana (Tree Pose) and Garudasana (Eagle Pose) challenge the body’s balance system and enhance coordination.

Conclusion

Incorporating yogic practices into one's routine can significantly benefit the musculo-skeletal system by improving flexibility, strength, posture, and balance, while reducing the risk of injuries and aiding recovery. Over time, regular yoga

practice fosters a harmonious relationship between the muscles, bones, and joints, contributing to long-term musculo-skeletal health and wellness.

2.7 LET US SUM UP

From this chapter, we discussed the following topics –

- **Bones** form the structure of the body, protect vital organs, support movement, and store minerals like calcium.
- The **206 bones** in the human body are divided into the **appendicular skeleton** (helps with movement) and the **axial skeleton** (protects vital organs).
- **Muscles** allow movement, maintain posture, and contribute to essential functions like blood circulation and digestion.
- **Three types of muscles** (skeletal, smooth, and cardiac) work in different parts of the body to perform various tasks.
- **Joints** connect bones and allow for a range of movements. Structural and functional classifications of joints highlight different movement capabilities.
- **Yogic practices** improve flexibility, strength, joint mobility, and posture, while reducing muscular tension, promoting balance, and aiding injury prevention.
- Yoga enhances **spinal health** by elongating and decompressing vertebrae, fostering balance, coordination, and overall musculo-skeletal wellness.

2.8 CHECK YOUR PROGRESS

1. What are the types of Human Bones?
   Answer: - The four types of bones in the human body are long, short, flat, and irregular.
2. How many boners are in human body?
   Answer: - 206 bones.
3. How many bones are in Appendicular skeletal?
   Answer: - 126 bones.

4. Which is the longest and smallest bone in human body?
   Answer: - The femur is the longest bone in the human body, and the stapes is the smallest bone.
5. What are the types of joints based on their structure?
   Answer: - The structural classification divides joints into fibrous, cartilaginous, and synovial joints.
6. Give any two example of Ball and socket Joint in human body.
   Answer: - The shoulder and hip joints are two examples of ball-and-socket joints in the human body.
7. How Yoga improve Flexibility?
   Answer: - Yoga stretches and lengthens muscles, tendons, and ligaments, improving overall flexibility. Regular practice of yoga helps reduce stiffness in the joints and muscles, increasing the range of motion.
8. Which Asana improve spinal alignment?
   Answer: - Dandasana (Staff Pose) help build awareness of spinal alignment.

2.9 FURTHER READINGS

1. Guyton, A.C. (1996). Textbook of Medical Physiology, 9th edition. Philadelphia: W.B. Saunders.
2. Blaisdall, A. (2001). Human Anatomy and Physiology. Delhi: Lokesh Thani Sports Publications.
3. "Yoga Anatomy" by Leslie Kaminoff and Amy Matthews
4. The Anatomy of Yoga by Abigail Ellsworth
5. Science of Yoga: Understand the Anatomy and Physiology to Perfect YourPracticeby Ann Swanson
6. The Key Muscles of Yoga: Scientific Keys, Volume I by Ray Long
7. The Key Poses of Yoga: Scientific Keys, Volume II by Ray Long
8. Functional Anatomy of Yoga: A Guide for Practitioners and Teachers by David

⍰ 2.10 MODEL QUESTIONS

Section 1: Musculoskeletal System

1. What are the main functions of the musculoskeletal system in the human body?
2. How many bones are present in the human body, and what are the two main divisions of the skeleton?
3. Explain the difference between the axial skeleton and the appendicular skeleton.
4. Name and describe the four types of bones in the human body, providing examples for each.
5. What is the role of the vertebral column in the human body? How many bones does it consist of?
6. Identify and explain the types of joints classified based on their structural properties. Provide examples of each type.
7. What is the function of synovial fluid in synovial joints, and why is it important?
8. Describe the role of muscles in movement and how they interact with bones.
9. Differentiate between skeletal, smooth, and cardiac muscles in terms of their location, control, and function.
10. How do hinge joints and ball-and-socket joints differ in terms of movement? Provide examples of each.

Section 2: Effects of Yogic Practices on the Musculoskeletal System

1. How does regular yoga practice improve flexibility in the musculoskeletal system?
2. Which yoga postures are particularly effective in strengthening muscles and building endurance?
3. Explain how yogic practices contribute to joint mobility and stability. Provide examples of poses that improve joint health.
4. What impact does yoga have on posture, and which specific postures help correct postural misalignment?

5. How do weight-bearing yoga postures influence bone density, and why is this important for preventing conditions like osteoporosis?
6. Which yoga poses are most beneficial for relieving muscular tension and pain? How do they help in recovery from overuse or injury?
7. Describe how yoga can correct musculoskeletal imbalances and promote symmetry in the body.
8. What are the benefits of practicing balancing yoga poses in improving coordination and neuromuscular control?
9. How does yoga help in the rehabilitation of musculoskeletal injuries? Provide examples of gentle poses used in recovery.
10. Explain how yoga improves spinal health and which poses are best for maintaining a healthy spine.

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