BHARATHIDASAN UNIVERSITY
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Programme : Master of Physical Education

Course Title: PHYSIOLOGY OF EXERCISE.

Course Code : 21MPE12

Unit -I

Skeletal Muscles and Exercise

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INTRODUCTION

- *Exercise physiology is the study of how the body responds to physical activity and exercise.*
- *It examines the acute and chronic effects of exercise on various bodily systems.*

BODY SYSTEM

- Cardiovascular system (heart, blood vessels, blood flow).
- Respiratory system (lungs, breathing).
- Muscular system (skeletal muscles, movement).
- Nervous system (brain, nerves, control of movement).
- Metabolic system (energy production, fuel utilization).

SCOPE OF EXERCISE PHYSIOLOGY

- ✓ **Clinical Exercise Physiology**: Applying exercise principles to prevent and manage chronic diseases, such as heart disease, diabetes, and obesity.
- ✓ **Sports Performance Enhancemen**t: Optimizing training programs for athletes to improve performance and reduce injury risk.
- ✓ **Rehabilitation and Injury Prevention**: Designing exercise programs for rehabilitation after injury or surgery and preventing injuries in various populations.
- ✓ **Occupational Physiology**: Understanding the physical demands of work and developing strategies to reduce fatigue and improve productivity.
- ✓ **Pediatric Exercise Physiology**: Studying exercise responses and developing programs for children and adolescents.

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- ✓ **Geriatric Exercise Physiology**: Examining age-related changes and developing exercise programs for older adults.
- ✓ **Environmental Physiology**: Investigating how environmental factors (heat, cold, altitude) affect exercise performance.
- ✓ **Exercise and Mental Health**: Exploring the relationship between exercise and mental well-being.
- ✓ **Exercise Nutrition and Metabolism**: Understanding how nutrition and metabolism impact exercise performance.

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- ✓ **Public Health and Epidemiology**: Examining the impact of physical activity on population health and developing strategies for promotion.
- ✓ **Neuromuscular Physiology**: Studying the neural control of movement and exercise responses.
- ✓ **Cardiovascular Physiology**: Investigating the effects of exercise on the cardiovascular system.
- ✓ **Respiratory Physiology**: Examining exercise responses in the respiratory system.
- ✓ **Muscle Physiology**: Understanding muscle function, fatigue, and adaptation to exercise.

Importance of exercise physiology

- **Improving Athletic Performance**: Understanding how the body responds to exercise helps athletes optimize training and gain a competitive edge.
- **Preventing and Managing Chronic Diseases**: Regular physical activity, guided by exercise physiology principles, reduces the risk of developing conditions like heart disease, diabetes, and obesity.
- **Enhancing Rehabilitation**: Exercise physiology informs the design of effective rehabilitation programs for injuries, surgeries, and diseases
- **Promoting Healthy Aging**: Exercise programs based on physiological principles help older adults maintain functional capacity and independence.
- **Informing Public Health Policy**: Exercise physiology research guides recommendations for physical activity levels, contributing to population health initiatives.

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- **Understanding Human Adaptation**: Studying exercise responses reveals how the body adapts to physical demands, informing our understanding of human physiology.
- **Developing Exercise Programs for Special Populations**: Exercise physiology principles are applied to create safe and effective programs for individuals with disabilities, chronic conditions, or unique needs.
- **Improving Occupational Health and Safety**: Understanding physical demands and developing strategies to reduce fatigue and injury risk benefits workers and employers.
- **Advancing Medical Research**: Exercise physiology research contributes to our understanding of various diseases and conditions, informing treatment and prevention strategies.
- **Enhancing Quality of Life:** Regular physical activity, guided by exercise physiology principles, improves overall well-being, mental health, and life satisfaction.

MEANING OF MUSCLE

- Muscle is a type of tissue that has the ability to contract, producing movement or force.

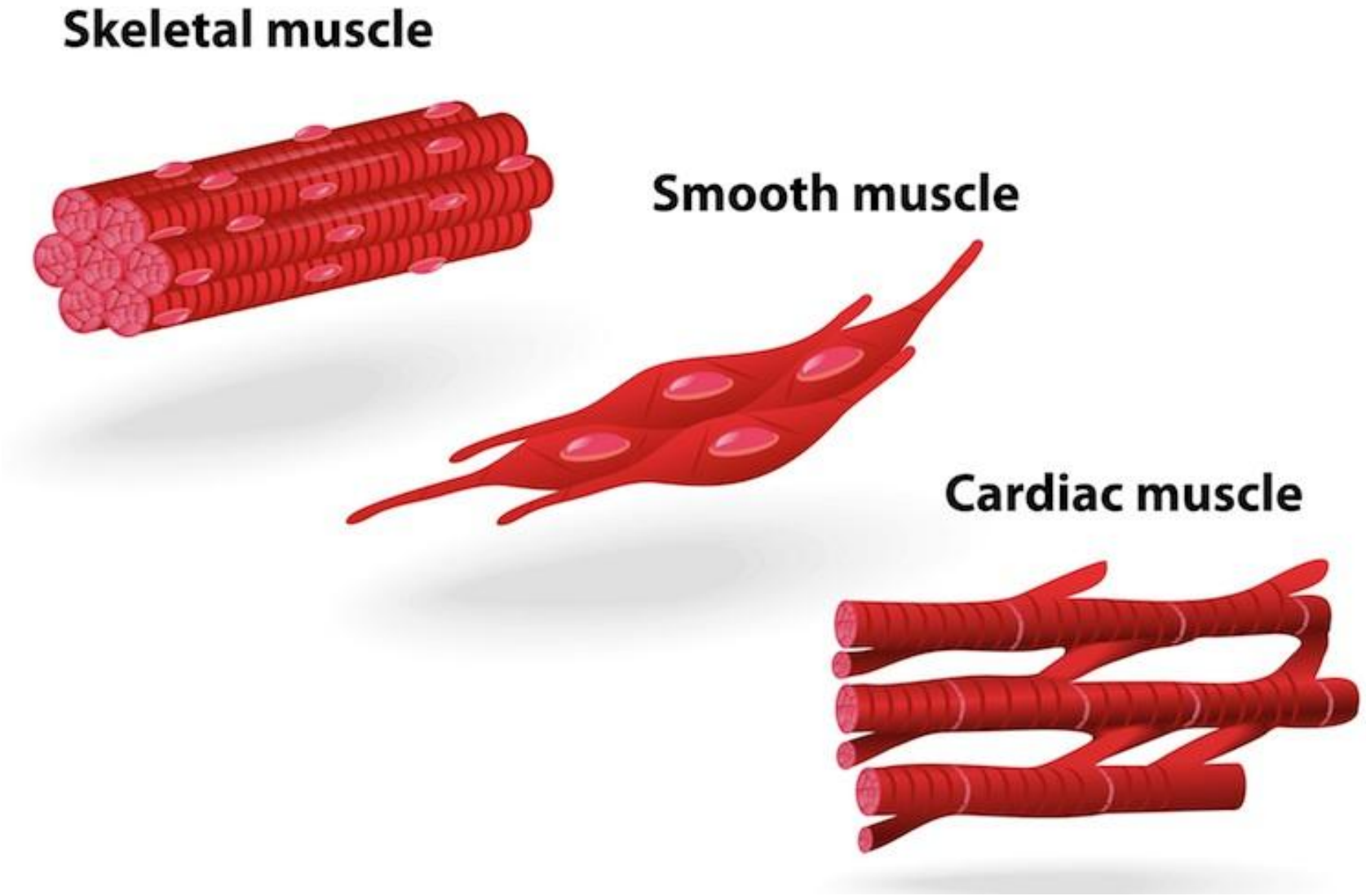
Three types muscle:

- Skeletal Muscle (Striated Muscle)
- Smooth Muscle (Non-Striated Muscle)
- Cardiac Muscle

Types of Muscle

- **Skeletal Muscle (Striated Muscle):**
  - Attached to bones, helps move the body's skeleton
  - Voluntary control (conscious movement)
  - Examples: biceps, quadriceps, hamstrings.
- **Smooth Muscle (Non-Striated Muscle):**
  -Found in walls of hollow organs (digestive tract, blood vessels, airways)
  - Involuntary control (automatic movement)
  - Examples: intestinal muscles, blood vessel muscles, airway muscles.
- **Cardiac Muscle:**
  - Found in the heart
  - Involuntary control (automatic movement)
  - Responsible for pumping blood throughout the body.

MUSCLE



CHARACTERISTICS OF MUSCLES

- **Contractility**: Ability to shorten and contract.
- **Excitability**: Ability to receive and respond to stimuli.
- **Extensibility:** Ability to stretch and extend.
- **Elasticity**: Ability to return to original shape after contraction.
- **Tone**: State of partial contraction, maintaining posture and stability.

FUNCTIONS OF MUSCLES

- **Movement**: Muscles work together to move the body's skeleton.
- **Stability:** Muscles help maintain posture and balance.
- **Support**: Muscles provide support for joints and bones.
- **Protection**: Muscles protect internal organs and bones.
- **Heat Generation**: Muscles produce heat, contributing to thermoregulation.

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- **Blood Circulation**: Muscles aid in blood circulation through contraction and relaxation.
- **Maintenance of Posture**: Muscles work together to maintain upright posture
- **Regulation of Body Temperature**: Muscles help regulate body temperature through shivering and sweating
- **Assistance in Respiration**: Muscles aid in breathing and respiration
- **Expression and Communication**: Muscles facilitate facial expressions and non-verbal communication.

MUSCLE TONE

- Muscle tone refers to the continuous and passive partial contraction of muscles, which helps maintain posture and stability.
- It's different from muscle strength or bulk, as it involves the degree of tension in muscles at rest.

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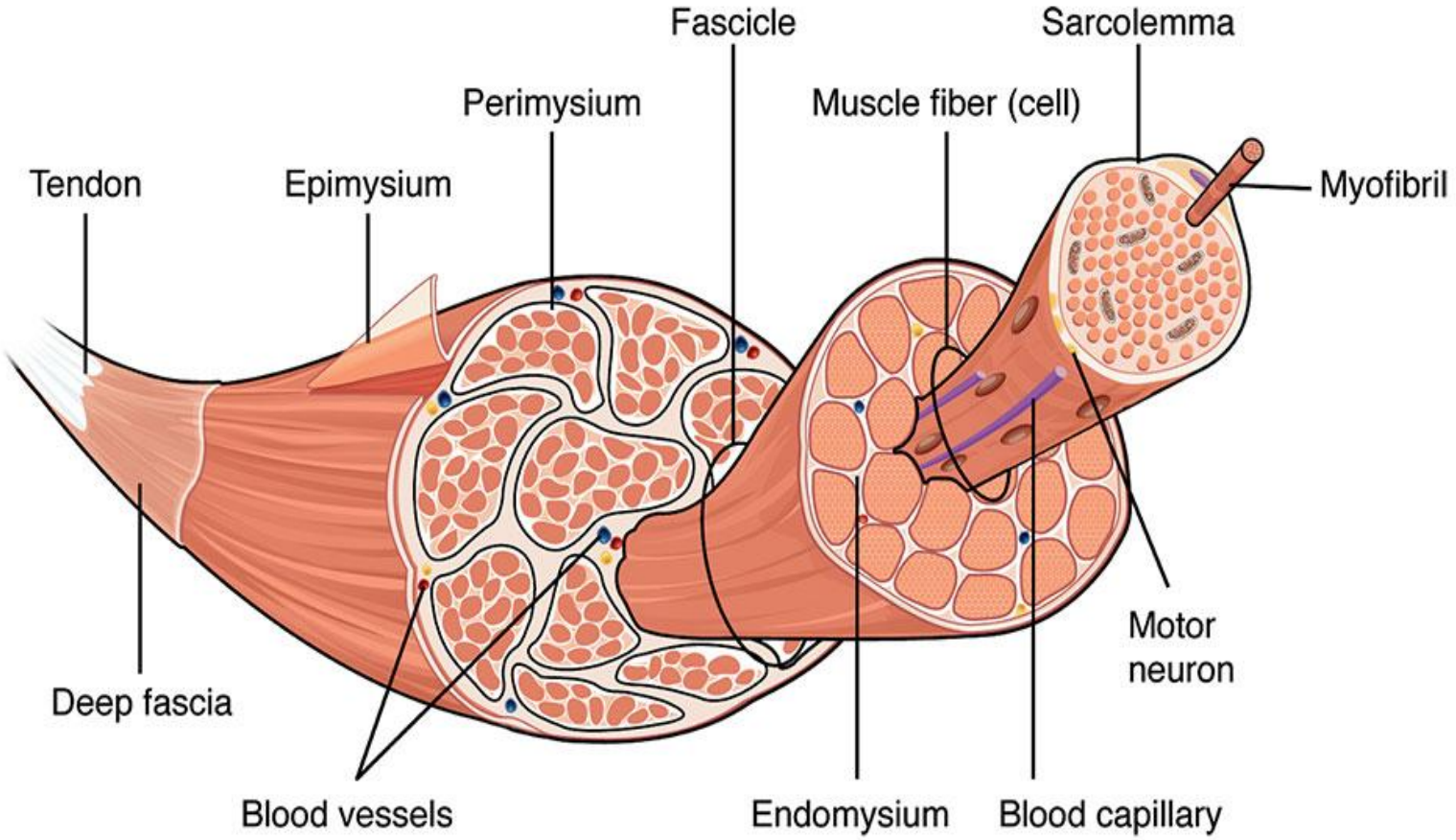
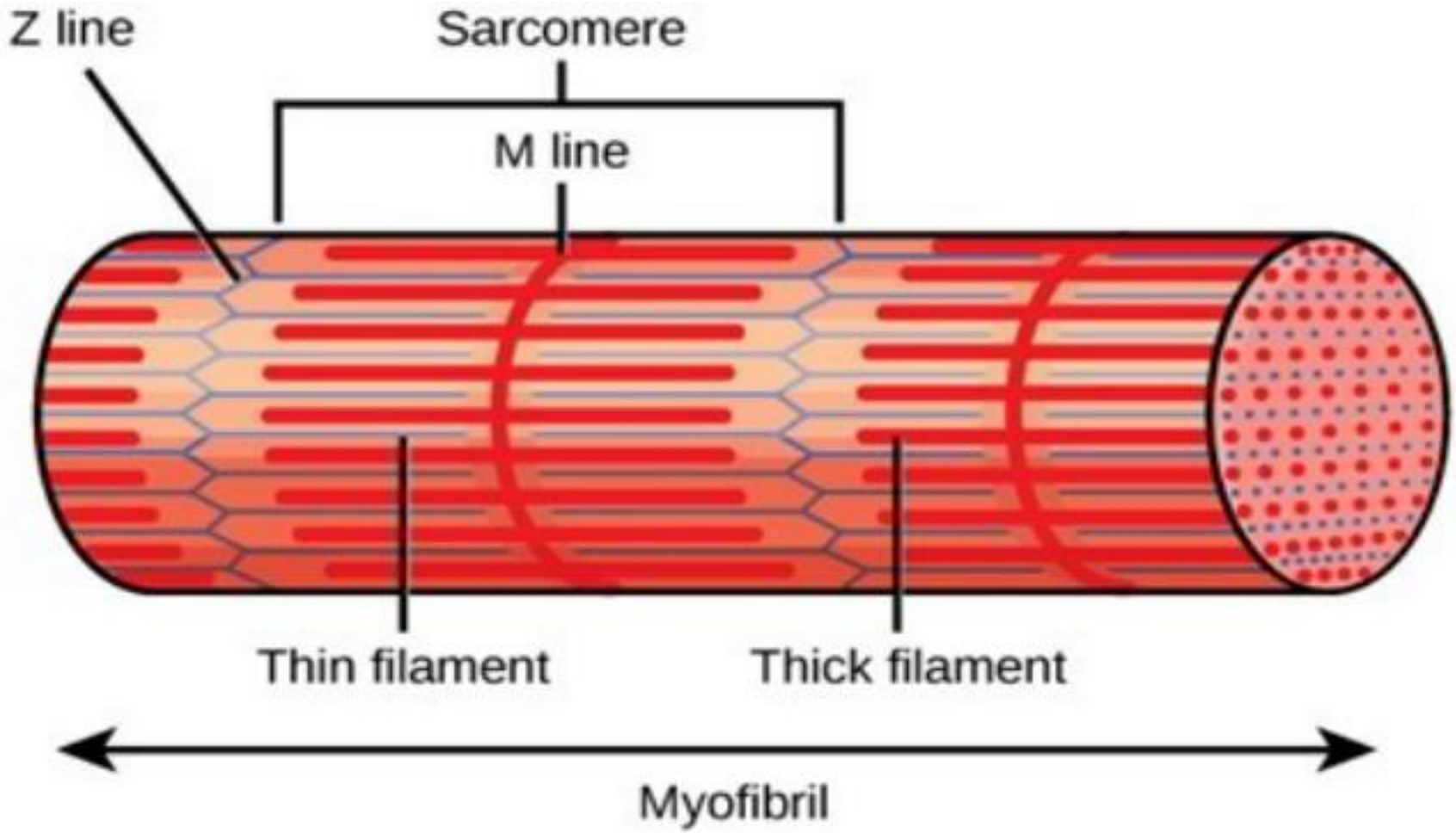
1. **Normal Muscle Tone**: In a healthy individual, muscle tone is balanced, providing enough tension to keep the body upright and support movement without being too tight or too relaxed.

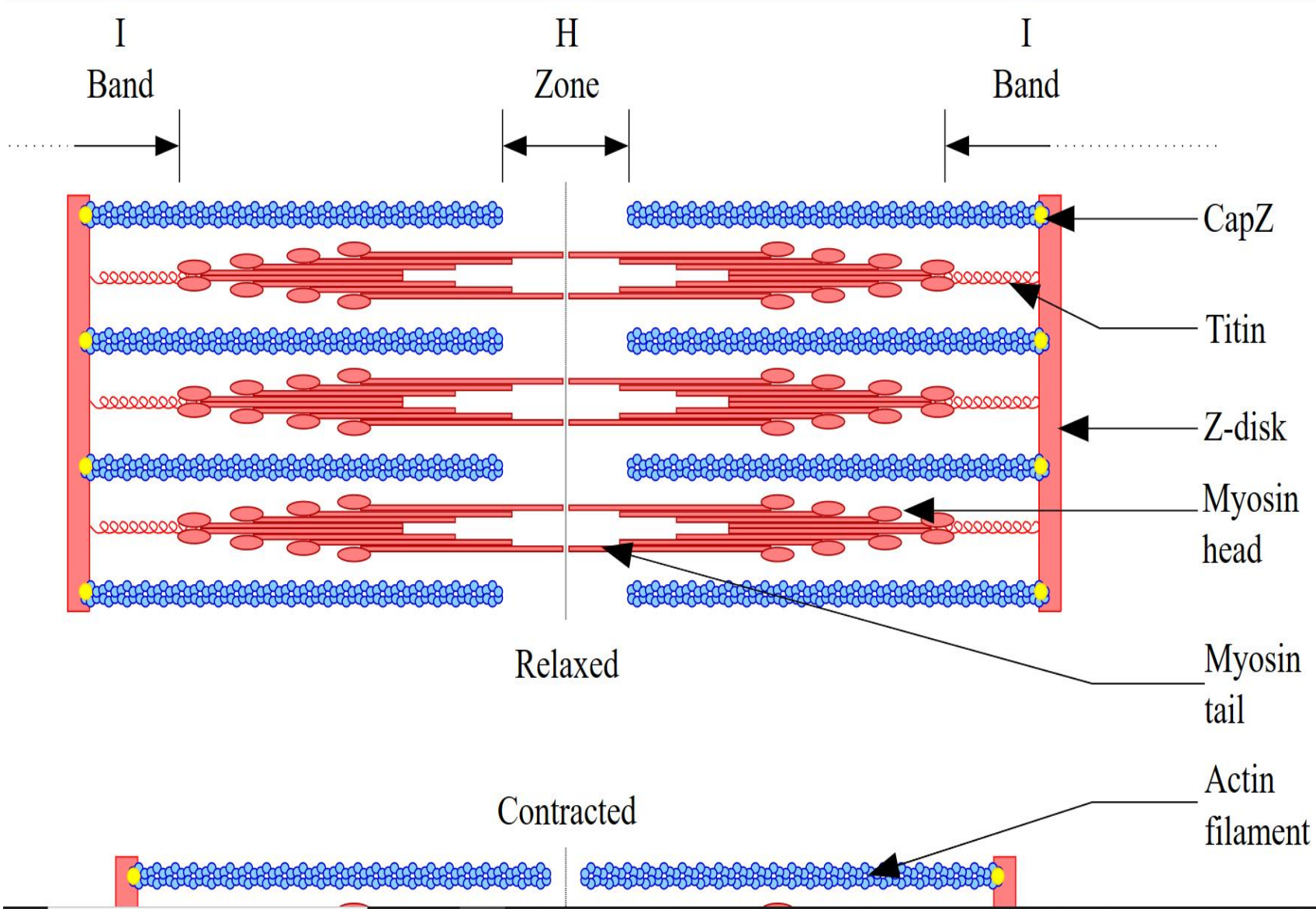
2. **Hypertonia**: This is a condition where muscle tone is higher than normal, leading to stiff or tight muscles. It can be caused by conditions like cerebral palsy or neurological disorders.

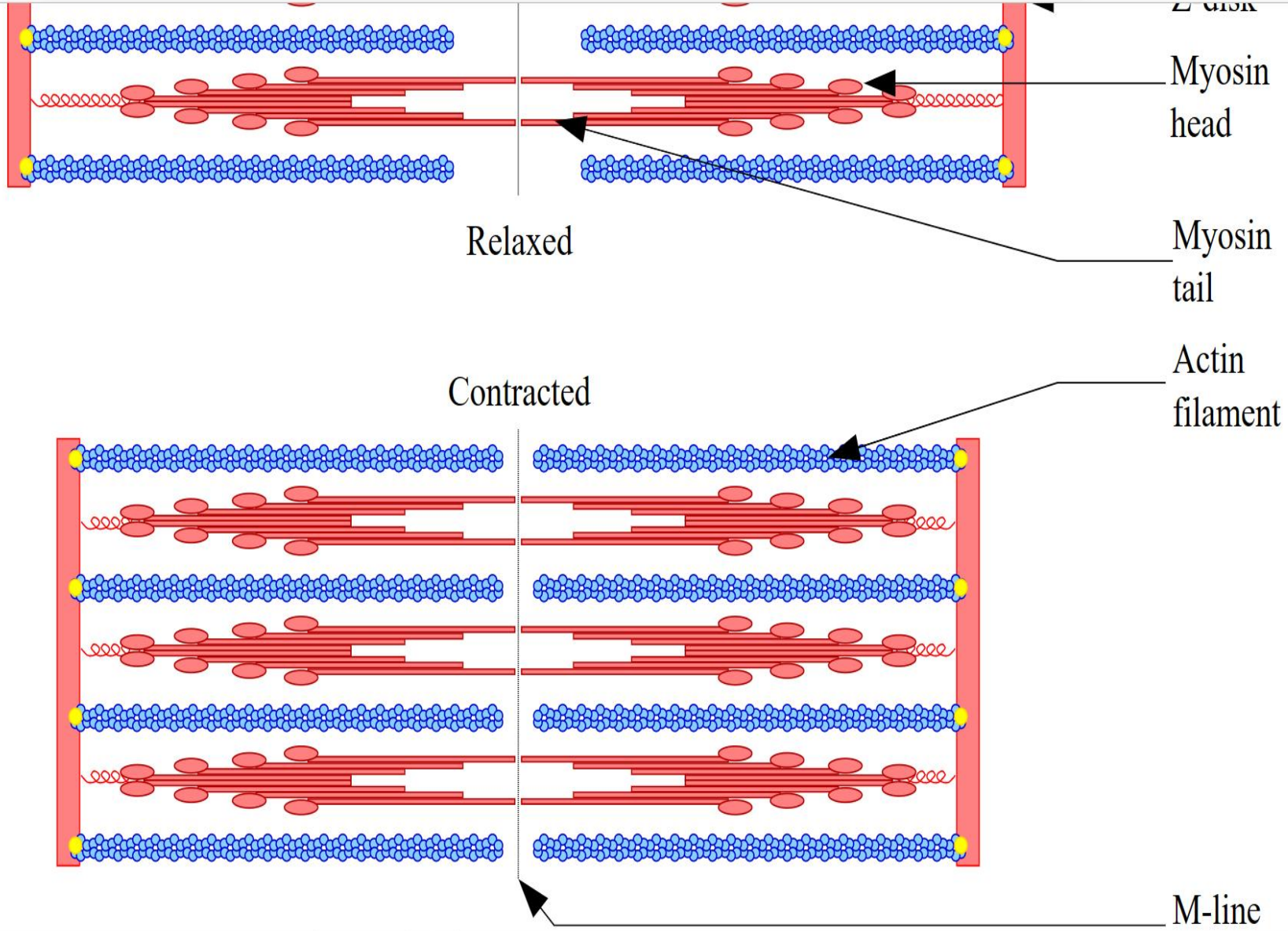
3. **Hypotonia**: Conversely, hypotonia refers to lower than normal muscle tone, which can result in loose, floppy muscles. This can be seen in conditions such as Down syndrome or certain genetic disorders.

Structure of Skeletal muscle




Z line
Sarcomere
M line
Thin filament
Thick filament
Myofibril


I
Band
H
Zone
I
Band
CapZ
Titin
Z-disk
Myosin
head
Myosin
tail
Actin
filament
Relaxed
Contracted


Z disk
Myosin head
Myosin tail
Relaxed
Actin filament
Contracted
M-line

EFFECTS ON THE MUSCULAR SYSTEM

- Slow-Twitch (Type I): Endurance, aerobic, low-force contractions.
- Fast-Twitch (Type II): Power, anaerobic, high-force contractions.

➢ **Training-Specific Effects**

- **Resistance Training**: Increases muscle size, strength, and bone density.
- **Endurance Training**: Enhances cardiovascular fitness, increases muscle capillarization and mitochondrial density.
- **High-Intensity Interval Training** (HIIT): Improves muscle power, speed, and anaerobic capacity.
- **Plyometric Training**: Enhances muscle power, explosiveness, and jump performance.

Short-Term Effect

- Increased muscle temperature.
- Enhanced blood flow and oxygen delivery.
- Increased muscle contraction force and speed.
- Improved neuromuscular coordination.
- Temporary muscle fatigue and soreness (Delayed Onset Muscle Soreness, DOMS).

Long-Term Effect

- Muscle Hypertrophy (increased muscle size).
- Muscle Hyperplasia (increased number of muscle fibers).
- Increased muscle strength and endurance.
- Improved muscle tone and elasticity.
- Enhanced neuromuscular efficiency.
- Increased capillarization (more blood vessels).
- Improved muscle fiber type distribution (e.g., fast-twitch, slow-twitch).

Muscle Adaptations

- **Muscle Memory**: Improved neuromuscular coordination and movement patterns.
- **Muscle Imbalance**: Strengthening of dominant muscles, potentially leading to injury.
- **Overtraining**: Decreased performance, increased risk of injury and illness.

➢ **Factors Influencing Muscle Adaptations**

- Genetic, Age, Sex, Nutrition, Sleep and Recovery, Consistency and Progressive Overload.

➢ **Injury Prevention**

- Warm-up and Cool-down
- Proper Technique
- Gradual Progression
- Listen to Your Body
- Seek Professional Guidance

Types of Muscular Adaptations

- Muscle Hypertrophy: Increase in muscle size and number of muscle fibers.
- Muscle Hyperplasia: Increase in the number of muscle fibers.
- Neuromuscular Adaptations: Improvements in nerve-muscle communication and coordination.
- Metabolic Adaptations: Enhancements in energy production and storage.

Duration muscular adaptation

- Initial Adaptation (0-4 weeks): Muscle damage, inflammation, and repair.
- Acute Adaptation (4-12 weeks): Rapid strength gains, muscle hypertrophy
- Chronic Adaptation (12+ weeks): Long-term strength gains, muscle fiber type shifts.