Locomation & Movements

Syllabus

Locomation & Movements

Muscles

Name : _____ Contact No. _____

MUSCLES

INTRODUCTION : :

Study of muscles known as Myology.
Myology also known as Sarcology.

Development of muscles : -

Except muscles of Iris & cilliary body all muscles of body develop from **mesoderm.**

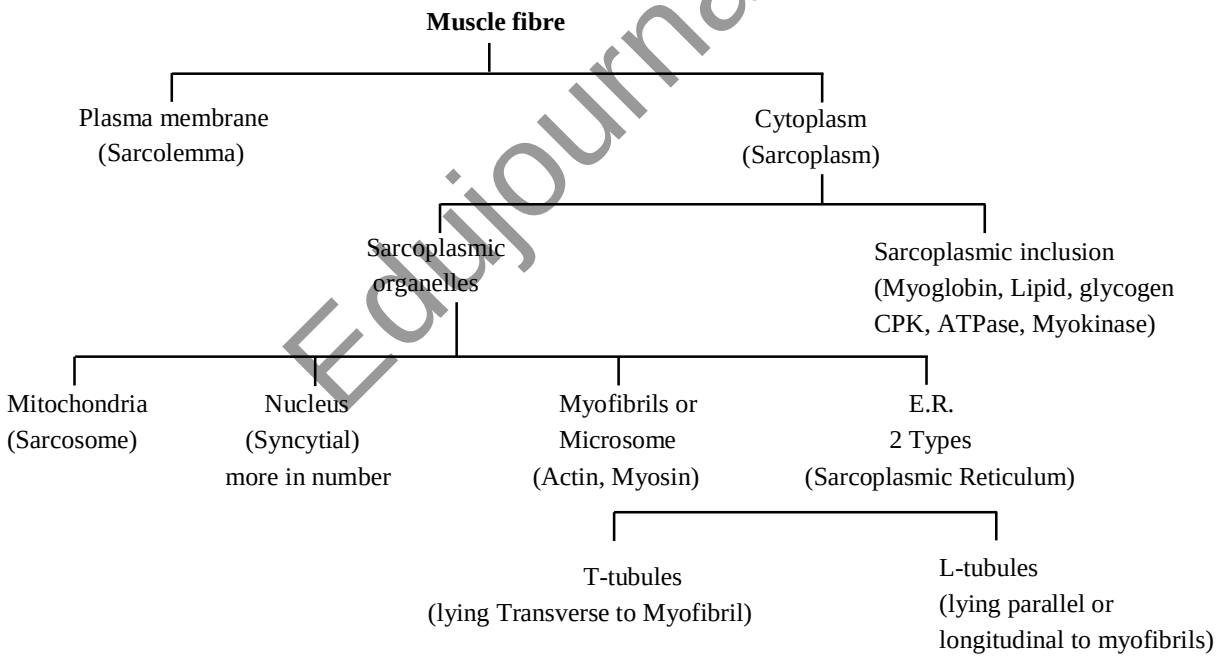
– Muscle of Iris, cilliary body & myoepithelial cell of sweat gland develop form **Ectoderm.** Conductivity & contractility are the two main characteristics of muscles.

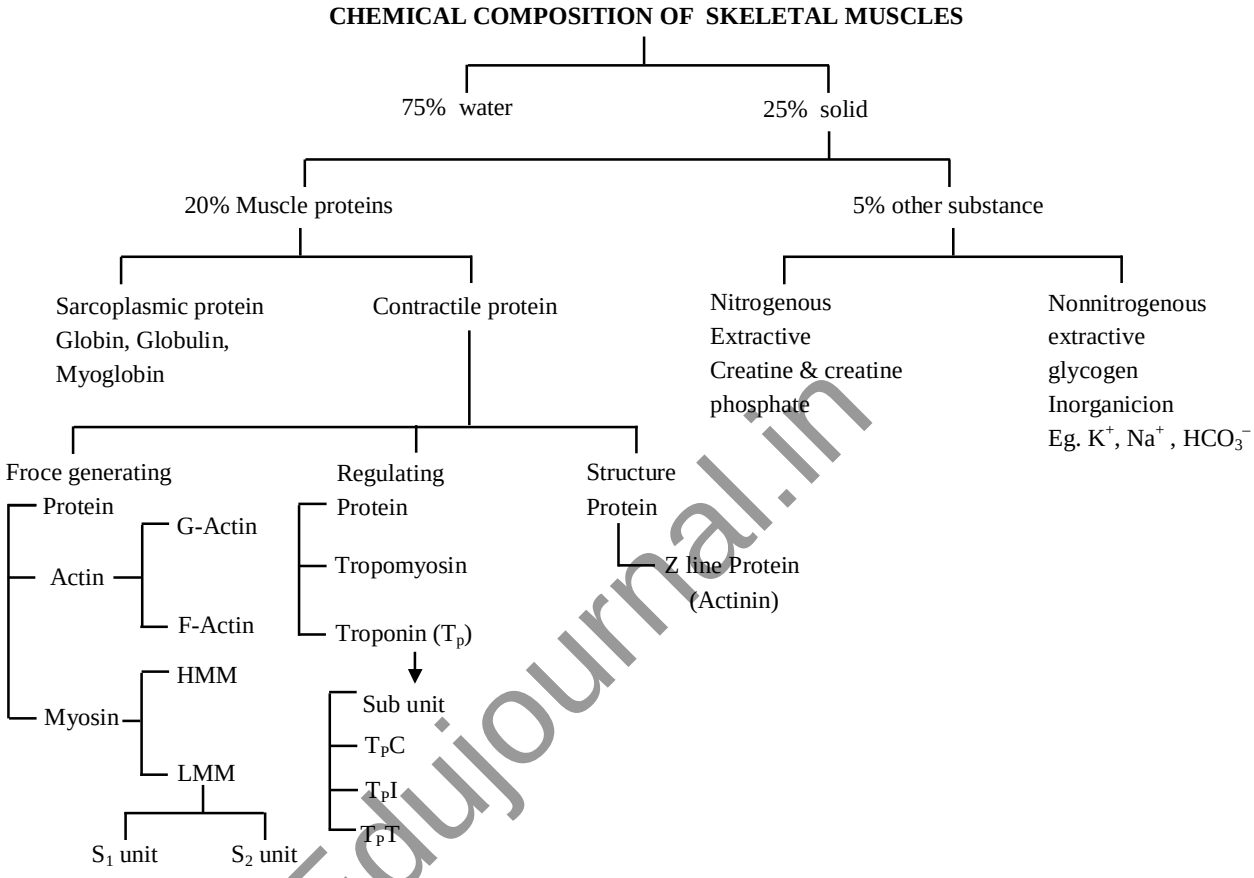
Three types of muscles are found in the body.

(i) Voluntary or skeletal muscles.

(ii) Involuntary or smooth muscles.

(iii) Cardiac muscles.

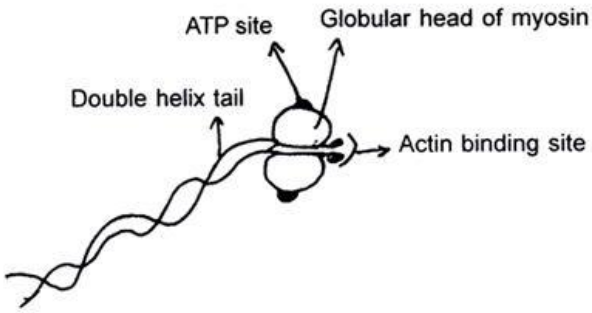




FORCE GENERATING PROTEIN ::

Actin –

The Actin or thin filament is a double helix made up of protein molecule called as. **G-Actin.** (Globular actin) Many G-actin combined to form a filament like structure, which is called as filamentous-actin. G-actin contain a active site where myosin head is attached.



Myosin –

Each myosin molecule consist of a tail & a head. Tail is made up of two chains interwined with each other like double helix.

The myosin head has sites for attachments with (i) The actin filament (ii) ATP molecules.

Each myosin (thick) filament is also a polymerised protein. Many monomeric proteins called Meromyosins constitute one thick filament. Each meromyosin has two important parts, a globular head with a short arm and a tail, the former being called the heavy meromyosin (HMM) and the latter, the light meromyosin (LMM)> The HMM component, i.e.: the head and short arm projects outwards at regular filament and is known as cross arm. The globular head is an active ATPase enzyme and has binding sites for ATP active sites for actin.

REGULATING PROTEIN : :

Tropomyosin –

It is one type of contractile protein. In the relaxed state of the muscle situated in **such a way**, that the active sites remain covered by the Tropomyosin & attached at the terminal end of actin.

Troponin –

It is one type of protein which attached with one of ends of the tropomyosin molecules.

Troponin is made up of three subunit.

(a) Troponin I (b) Troponin T (c) Troponin C

(Inhibitory site) (Tropomyosin site) (Ca^{+2} binding site)

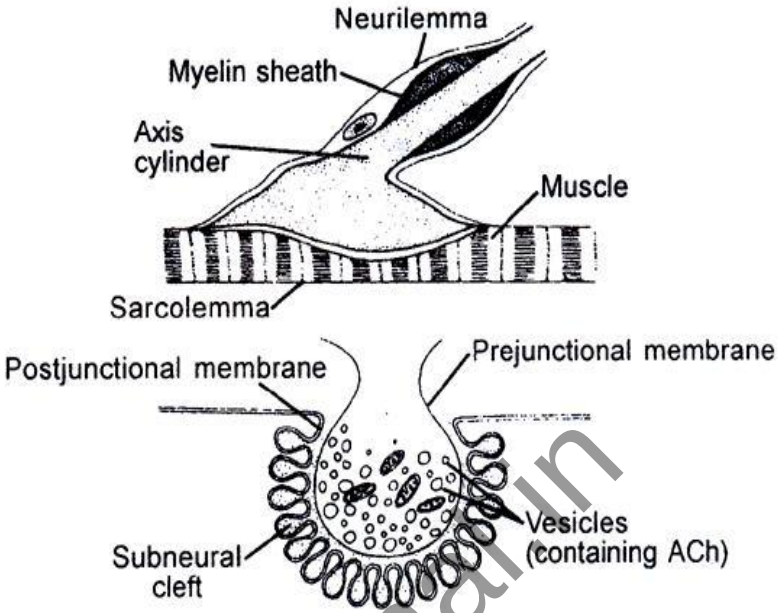
STRUCTURAL PROTEIN : :

Actinin –

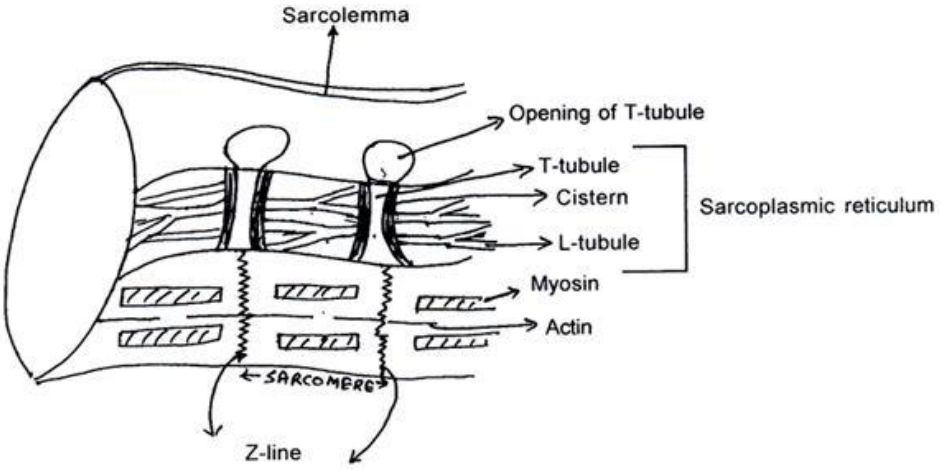
It is one type of protein which found in Z-line.

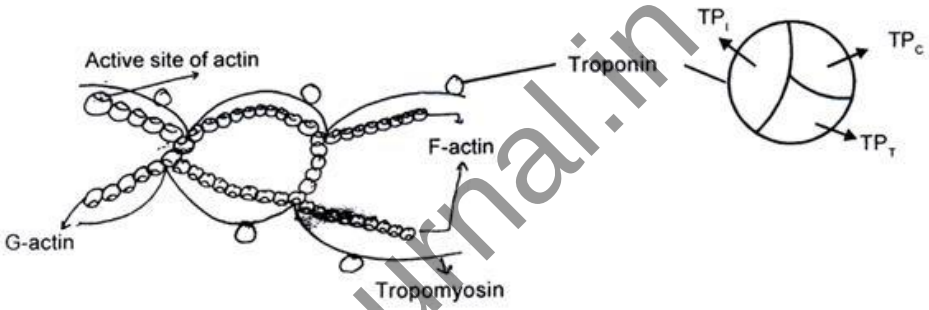
PHYSIOLOGY OF MUSCLES CONTRACTION

PHYSIOLOGY OF MUSCLE CONTRACTION



Neuromuscular Junction





SLIDING FILAMENT THEORY

This theory is given by A.F. HUXLEY, H.E. HUXLEY & HANSEN

The junction of Nerve & muscle is called as neuromuscular junction.

Terminal branches of Axon of motor nerve is embedded into sarcolemma.

Its bulb like structure is called as **motor end plate.**

Sarcolemma invaginate inside & form a fimbriated structure which is called **synaptic gutter or subneural cleft.** The cell membrane of the bulbous terminals is called as the **pre junctional membrane** where as the cell membrane of muscle fibre which invaginates called **post junctional membrane.**

In motor end plate large number of vesicles & mitochondria are present. Each vesicle contains Ach in high concentration. In post junctional membrane, Ach receptor are presented.

(Ach = Acetylcholine, it is a neurotransmitter chemical)

Neuromuscular Transmission –

- When motor nerve fibre stimulated it develops an **Action potential** (Resting potential 50 to 100 mV)
- AP reaches in the neuromuscular junction & goes to bulbous expansion of the nerve terminal.

- Than it increases permeability of Ca^{++} in the Pre junctional membrane & Ca^{++} enter from E.C.F. in to the cytosol of motor end plate by penetrating the prejunctional membrane.
- Ca^{++} ions causes bursting of the vesicles & releases the Ach.
- These Ach now cross the prejunctional membrane. via subneural cleft reach the post junctional membrane attach the **Ach receptor** also called as **End plate receptor.**
- End plate receptor stimulate & develop end plate potential by opening of Na^{+}– K^{+} channels in post synaptic membrane.
- When end plate potential sufficiently higher than A.P. develop on sarcolemma & myofibril.
- Sarcolemma invaginates inside & form transvers & longuituidnal tubules which are also called as T-tubul and L-tubule
- T-tubules are parallale = to Z-line whereas L-tubule is perpendicular to the Z-line.
- T-Tubules communicates with ECF.
- T & L system of tubules together called as **endoplasmic reticulum.**
- L-Tubules dilated on both side of T-Tubules this dilated part called **cisterns.**
- A.P. proceeds along the sarcolemma & A.P. contact with T-Tubules & further proceeds via T-tubules & enter with in muscle fibre & now this AP called as **T-tubule potential.**
- T-tubule potential come in close contact of L-tubules at region of the **Triads** (T + L-tubules).
- L-tubules in very rich source & store house of Ca^{++} ion in higher concentration release of Ca^{++} ion in large amount.
- Released Ca^{++} ion combine with troponin C.
- In Relaxed state tropomyosin covers the active site of actin.
- But troponin-C combines with Ca^{++} ion some physiochemical changes occur in tropomyosin & Tropomyosin move away from active site of actin.
- Myosin have strong tendency to bind the actin molecule & Actomyosin complex
- Myosin head attach on active site of actin with the help of cross bridges.
- Now the myosin head twists in the groove of the active site of actin-F. This causes movement of actin toward H-zone.
- Contraction is caused by overlapping of actin filament over myosin – **sliding filament hypothesis.**
- All the cross bridges move simultaneously in one direction so the actin filaments move vigorously towards H-zone.
- When cross bridge disrupted than myosin molecule detached & reattach the new active site of actin.
- **After muscle contraction H-Zone disappears & length of sarcomere & I-band decreases by 20%. The length of A-band remains unchanged.**

All process are reversible, at the time of relaxation Ca^{++} are goes into **L-tubules.**

Role of ATP –

(i) The Rotational movement of myosin head with in the groove.

(ii) Deattachment of myosin head form the actin.

Depolarisation

↓

Sarcoplamic reticulum

↓

Ca^{2+} (Cistern)

↓

Myosin ATPase

↓

Cross-bridges

↓

Actin-Myosin Complex

↓

Muscle Contraction

Chemical reaction in Muscles :

1. $ATP + H_2O \xrightarrow{\text{Creatine kinase}} ADP + P_1 + \text{Energy}$ (For contractile muscle)
2. Creatine phosphate + ADP $\longrightarrow$ Creatine + ATP (Muscle contraction)
3. Gycogen $\xrightarrow{\text{Glyocysis}}$ Lactic acid + Energy
4. 80% Lactic acid + Water $\xrightarrow{\text{ATP}}$ Glycogen (Liver cell)
5. 20% Lactic acid + Oxygen $\longrightarrow$ $CO_2 + H_2O$ + ATP (Liver cell)
6. Creatine + ATP $\longrightarrow$ Creatine phosphate + ADP (Resting Muscle)

PROPERTIES OF MUSCLES : :

Terminology

1. **Origin** – Fixed end of muscle (Proximal end)
   Insertion – Distal end of muscle which is attach to bone (Movable end)

2. **Excitability** – Muscles responds to stimuli which can be nervous, chemical, electrical & thermal mechanical.

   Conductivity – Stimulus acting in one region of muscle fibres propagated to all parts within no time.

   Contractility – On being stimulated the muscle fibres contract & shorten followed by Relaxation.

3. **Threshold stimulus** – Intensity of stimulus below the threshold value does not produces contraction in muscle fibres is called.

   Sub threshold Stimulus shambles stronger than threshold one is called suprathreshold stimulus.

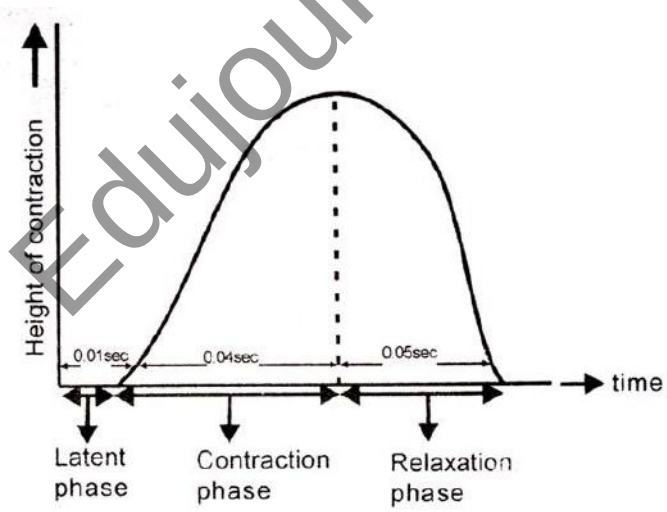
4. **All or none law** – Response of muscle fibre is maximum whether the stimulus has threshold value or suprathreshold value. Response is absent when intensity is subthreshold. (Below threshold value)

5. **Muscle twitch** – It is single isolated contraction of Muscle fibres due to single stimulus. Muscle curve or kymograph indicates three phases.

   (a) Period of latent excitation (Latent period) Interval between the application of appropriate stimulus & initiation of contraction

   It is 0.01 sec. in skeletal muscle. 3sec. in smooth muscle.

   (b) Contraction phase – Duration for which muscle remain contracted state. It is 0.04 sec. in skeletal muscle. 20 sec. in smooth muscle.



   (c) Relaxation phase – Interval for contracted muscle to regain its original/Relaxed state 0.05 sec. in skeletal muscle 23 sec. in smooth muscle.

6. **Refractory Period** – It is period between two twitched during this muscle does not respond to second stimulus after single twitch.

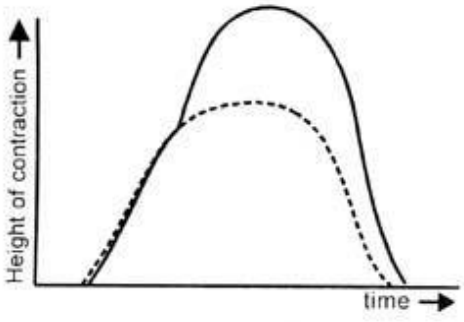
   It is 0.002 – 0.005 second in skeletal muscles and 0.1 – 0.2 second in visceral muscles.

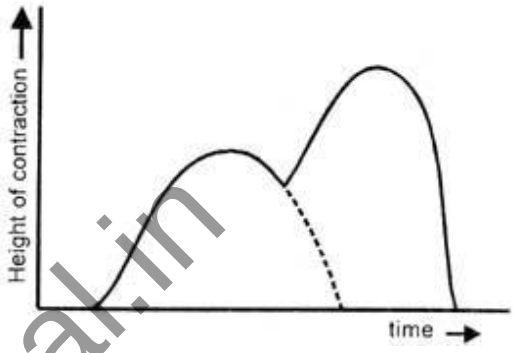
7. **Summation of stimuli** – Two subliminal stimuli Applied simultaneously get added up & Evoke the response

Muscle response = (1^{st} stimulus +2^{nd} stimulus ≥ threshold value)
Subliminal subliminal

Howerver a muscles consist of large no. of muscle fibres with different threshold value so in intensity of stimulus increases contraction of muscle although individual fibres obey all/none law.

Summation of IInd stimulus during contration phase





8. **Muscle tone** – In relaxed muscles, a few fibres always undergoing contraction alternately so maintain the health of muscles. It is known as Muscles tone

9. **Tetanic condition** – It is sustained muscles contraction due to rapid series of impulse, during this relaxation of muscles does not take place.

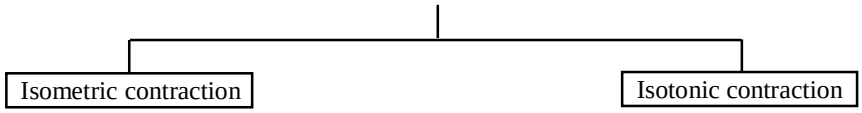
It is due to hypocalcaemia
It is hormonal deficiency disease

It is bacterial disease
(Clostridium tetani) **Lock jaw disease** during this abnormal muscles contraction of jaw muscle take place.

10. **Paralysis –** Supply of motor nerve impulse completely cut off. So function of muscle contraction is stoped.

11. **Shivering –** Involuntary contraction of muscles to make body warm.

12. **Muscle tension** – force produced during contraction of muscle is known as muscle tension.



Length same but tone changed
Eg. Pushing against an immovable object.

Length changed but tone same

Isometric –

Contraction occur when a muscle is stimulated adequately but is prevented to shorten.

eg. applying too heavy load against the muscle so that the muscle but cannot lift the at all ext. work done is zero **Isotonic –**

When muscles is stimulated adequately & is allowed to shorten, then the contraction is called Isotonic some external work is done. Technically called a load is lifted

13. Antagonistic muscles–

They are pair of muscles which causes opposite movement at the same site when one muscle is contracting, the other is relaxes & viceversa.

e.g. – Biceps (flexor) & Triceps of arms (extensor)

14. Motor unit – Groups of mucles fibres supplied by single motor neuron. It is a functional unit of muscles because all the muscle fibres of motor unit contract & relax simultaneously.

15. Cori cyles – Lactic acid accumulated in muscles during sustained contraction. formed lactic acid transported in blood as blood lactate to liver where is changes into liver glycogen which is changed in to glucose.

$$\text{Glycogen} \xrightarrow{\text{Muscle}} \text{Lactic acid} \xrightarrow{\text{Liver}} \text{Glycogen}$$

16. Speed of – Skeletal muscle = 0.1 sec. per contraction per cycle
Cardiac muscle = 0.8 sec. per contraction per cycle
Smooth muscle = 46 sec. per contraction per cycle

17.

Red muscle fibres	**White muscle fibres**
– Slow & Tonic muscles fibres	Fast & twitch muscle fibres
– Dark red b/o myoglobin +	Pale
– Mitochondria ++	Mitochondria+
– Slow sustained work from long period without getting fatigue	Perform fast, strenuous work for short duration & get fatigued quickly accumulation of lactic acids.
Sarcoplasmic reticulum – less	More
Eg : Extensor muscles of back, flight muscles	**Eg :** eyeball muscles

18. Fatigue : Marathian athelets develops red fibers in thigh muscles due repeated contraction

Due to sustained contraction initially muscle give beneficial effects of contraction (warm ups) but after it ATP is exhausted & muscle is as state of permanent contraction & no relaxation because no fresh ATP Available for detachment of actomysosin complex.

– B/o 1. Accumulation of lactic acids

2. Consumption of stores glycogen. ATP, CTP (Creatinine phosphate)

Infatigue–

(i) Increase latent period and phase of relaxation

(ii) decrease height of contraction

19. Rigor Mortis

After death fresh supply of ATP. become impossible so one the local store of ATP molecule are exhausted. Due to non availability of ATP/C.P. deattachment of myosin from actin cannot take place resulting in permanent state of contraction of muscle. This phenomenon is called rigor mortis. This condition helps fixation of the hour of death.

20. E.D.T.A (Ethylane diamine tetra acetic acid) injected inside muscle combined with Ca^{+} and stops contraction

21. Muscle and nerve exitability is reduced by K^{+}.

22. During muscle contraction chemical energy changed into mechanical energy.

23. Over stretching of tendon is called sprain.

MUSCLE TYPES ON BASIS OF MOVEMENTS

1. **Flexor** = Fore arm move in upward direction. (Bend)
   Bending of part over one another **Eg. biceps brachii**
   Extensor – Fore arm move in downward direction. Straighting of bending part
   Eg. Triceps
2. **Adductor** - Toward body axis. Towards the body
   Lattissimus dorsi brings the arms towards body
   Abductor-upper & lower limb move away from body axis. Away from the body (midline) **deltoids.**
3. **Pronator** – Palm state in down. Rotate downward eg **pronater teres**
   Supinator – Palm state in upward Rotate upward eg **brachioradialis**
4. **Dilation** – Diameter increases, widening of Iris (radial muscle of iris)
   Constrictor – Diameter decreases, Closing an aperture–sphincter ani closes anus
5. **Depressor** – Lower Jaw move in downward direction. Lowering part depressor mandibularis
   Elevator–Lower Jaw move in downward direction.Raising the part **eg. Massetar.**
6. **Median Rotation** – Upper & lower limb rotate in inward direction.
   Lateral Rotation – Outward direction rotation
7. **Inversion** when sole of foot turn toward body axis.
   Eversion - Away from body axis

Aryeiglotticus muscle is called Hilton muscle.

Gastrocenemius muscle present in shank.

Sartorius the **longest** muscle of body

Gluteus maximus (Buttock muscles) – **Largest** muscle of body

Stapedius – smallest muscle of body.

In Human beings 639 muscle are found 634 muscle are paired and 5 muscle are unpaired. 400 muscles are striated & most of muscles are found in back region & number of back muscles are 180. Jaw muscles are strongest. Longest smooth muscles is present in present in uterus of pregnant lady.

MUSCULATURE OF LIMBS EXERCISE # I

Q.1 Functionally cardiac muscles are similar to
(1) Involuntary muscles
(2) Unstriped muscles
(3) Striped & Unstriped muscles
(4) None

Q.2 Covering of striped muscle
(1) Epimysium
(2) Perimysium
(3) Endomysium
(4) Plasma lemma

Q.3 Myofibrils contain
(1) Actin
(2) Myosin
(3) ATP
(4) All of above

Q.4 Cross bridge are formed during
(1) Muscle contraction
(2) Nervous contraction
(3) Tissue regeneration
(4) All the above

Q.5 Time B/W two successive contraction
(1) Refractory period
(2) Total period
(3) Break period
(4) Lag period

Q.6 During contraction of muscles
(1) Actin Filament slide over actin
(2) Myosin filament slide over actin
(3) Actin filament slide over myosin
(4) Myosin filament slide over actin

Q.7 Purkinje fibres
(1) Muscle fibres
(2) Nerve fibre
(3) Axon
(4) Dendron

Q.8 Mitochondria in cardiac muscles
(1) More than other muscles fibres
(2) Less than other muscles fibres
(3) Equal than other muscles fibres
(4) None

Q.9 SA Node is
(1) Group of specilised muscle fibres
(2) Cartilage in node of heart
(3) Connective tissue node
(4) None

Q.10 Rigor mortis is–
(1) Contraction of muscles after death
(2) Contraction of muscles befor death
(3) Shivering of muscles
(4) None

Q.11 Red muscle fibre are more in –
(1) Smooth muscles
(2) Skeletal muscles
(3) Cardiac muscles
(4) None

Q.12 Unstriped muscle are also known as
(1) Visceral
(2) Smooth
(3) Involuntary
(4) All

Q.13 Myofibres also known as
(1) Sacro axis
(2) Sacro mysium
(3) Sacrostylets
(4) None

Q.14 Contractile unit of muscle fibre
(1) H line

(2) Sarcomere
(3) H zone
(4) None

Q.15 One of following has contractile properties
(1) Actin (2) Myosin
(3) Troponin (4) None 7

Q.16 Epimysium of mucles are made up of
(1) White fibrous connective tissue
(2) Adipose connective tissue
(3) Reticular connective tissue
(4) Aerolor connective tissue

Q.17 Myosin filament appear dark under microscope due to
(1) Dark colour
(2) Melanin colour
(3) Black colour
(4) Double refractive index

Q.18 Isotonic contraction takes places during
(1) Running
(2) Simple Walking
(3) Exercise
(4) All

Q.19 Largest muscle is
(1) Gluteus maximus
(2) Gluteus medius
(3) Triceps
(4) Biceps

Q.20 Coricyle relation ship between the
(1) Muscle glycogen & liver glycogen
(2) Muscles pyruvate & liver Lactic-Acid
(3) Muscles glycogen & blood glucose
(4) All of above

Q.21 Papilary muscle found in
(1) Heart (2) Live
(3) Kidney (4) Lung

Q.22 Flight muscles of bird
(1) Biceps & Triceps
(2) Gastro memius
(3) Pectoralis major & Minor
(4) Papillary & ciliary

Q.23 Contraction of shortest duration is of
(1) Heart (2) Eye lids
(3) Arm (4) Jaws

Q.24 ATP ase activity found in
(1) Myosin filament
(2) Actin filament
(3) Both
(4) None

Q.25 Total no. of muscles in our body is
(1) 256 muscles (2) 639 muscles
(3) 400 muscles (4) 421 muscles

Q.26 Longest smooth muscles are
(1) Intestine
(2) Stomach
(3) Uterus (Pregnant)
(4) Urinary bladder

Q.27 Strongest muscles
(1) Thigh muscle (2) Leg muscle
(3) Arm muscle (4) Jaw muscle

Q.28 Muscles of Iris & Ciliary body originate
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) All of above

Q.29 Multi unit musles Fibres found in
(1) Ciliary & Iris of eyes
(2) Arrector pilli of Dermis
(3) Wall of large blood vessels
(4) All of above

Q.30 Cardiac muscles Fibres
(1) Involuntary (2) Non-fatigue

(3) Striated like (4) All

Q.31 Belly is
(1) Upper part of muscle
(2) Middle part of muscle
(3) Lower part of muscle
(4) None

Q.32 Striated muscle fibres
(1) Trachea
(2) Lung
(3) Leg
(4) Gall bladder

Q.33 Smooth muscles fibres
(1) Spindle shaped
(2) Unbranched & Involuntary
(3) Uninucleated
(4) All of above

Q.34 Basic unit of muscle contraction
(1) Actin
(2) Myosin
(3) Sarcomere
(4) Actomyosin

Q.35 Each myfibrils has diameter of
(1) 0.1 to 0.2 μm
(2) 1–2 μm
(3) 0.001 – 0.002 μm
(4) None

Q.36 Chemical Ions responsible for muscles contraction
(1) Ca^{++} & K^{+} (2) Na^{+} & K^{+}
(3) Na^{+} & Ca^{++} (4) Ca^{++} & mg^{++} Ions

Q.37 Muscle length doesn't changes
(1) Isotonic contraction
(2) Isometric contraction
(3) Tetanic contraction
(4) None

Q.38 Tetanus is substained contraction of muscle is due to
(1) Parathyroid deficiency
(2) Ca++ deficiency
(3) Bacterial Disease
(4) Auto Immune disease

Q.39 Sliding theory muscle contraction proposed by
(1) hansen
(2) Huxley
(3) Bohr
(4) Huxley, Huxlay & Hensen

Q.40 Phosphogen in vertebrates
(1) Phospho creatine
(2) Phospho arginine
(3) ATP
(4) Phosphoric acid

Q.41 Smallest muscles in rabbit & man
(1) Gluteus minimus
(2) Stapedius
(3) Sartorius
(4) Gracilis

Q.42 Antagonistic muscles of biceps
(1) Quardrieps femoris
(2) Quadratus femoris
(3) Triceps
(4) Brachialis

Q.43 Red muscle fibres present over
(1) Extensors of backs
(2) Flight muscle of birds
(3) Atheletes of marathon race
(4) All of above

Q.44 White muscle fibres present
(1) Eyeball muscles

(2) Pectoralis major
(3) Deltoids
(4) All of above

Q.45 Which of following moveable part of muscles
(1) Belly (2) Origin
(3) Insertion (4) None

Q.46 When subminimal stimulus given then
(1) Muscle contract vigorously
(2) Muscle contract slowly
(3) Muscle never contract
(4) Muscle become Fatigue

Q.47 When supra liminal stimulus given than
(1) Muscle contraction more then normal
(2) Muscle contraction less than normal
(3) Muscle contraction below average
(4) Muscle contraction same as threshold stimulus

Q.48 The type of muscles present in our :
[AIPMT MAINS - 2011]
(1) upper arm are smooth muscle fibres fusiform in shape
(2) heart are involuntary and unstriated smooth muscles
(3) intestine are striated and involuntary
(4) thigh are straiated and voluntary

SKELETAL SYSTEM EXERCISE # 2

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion
(3) If Assertion is True but the Reason is False.
(4) If both Assertion and Reason are false.

Q.1 **Assertion :** On the basis of structure cardiac muscles are striated type.
Reason : Its contraction is depend on the will power.

Q.2 **Assertion :** Voluntary muscles is controlled by will power.
Reason : It is syncytial and myofibril arranged in special pattem.

Q.3 **Assertion :** When the muscle fibre contracts, sacromere length is reduced.
Reason : Sliding of myosin filament due to rotational movement of myosin head.

Q.4 **Assertion :** Dark-band is also called as A-band in striped muscles.
Reason : Dark band is made up of both actin and myosin filament.

Q.5 **Assertion :** When the threshold stimulus is applied on skeletal muscle continuously initially muscle give beneficial effects of contraction.
Reason : Initially latent period is short and height of contraction of muscle is increased.

ANSWER KEY

EXERCISE # 1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	4	1	1	3	1	1	1	1	3	4	3	2	1	1	4	2	1	1
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	2	1	2	3	4	1	4	4	2	3	4	3	2	4	2	3	4	1
Que.	41	42	43	44	45	46	47	48												
Ans.	2	3	4	4	3	3	4	4												

EXERCISE # 2

Que.	1	2	3	4	5
Ans.	3	2	3	1	1