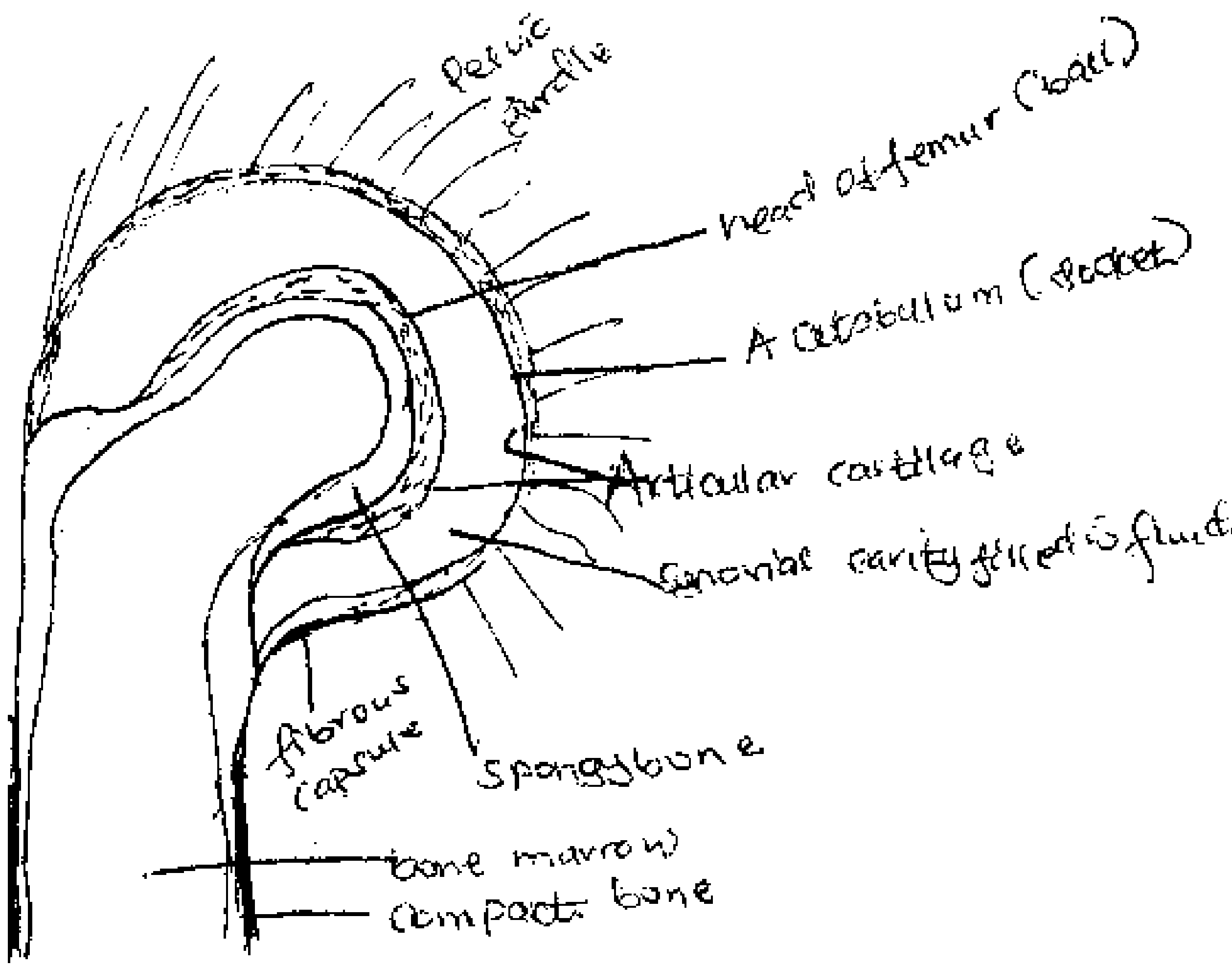
By synovial membranes which secrete synovial fluid. The synovial fluid lubricates the joint and nourishes the cartilage.

The synovial membranes also prevent escaped of the synovial fluid.

The synovial fluid contains phagocytic cell that remove debris produced at the joint.

BALL AND SOCKET JOINT (BETWEEN FEMUR AND PELVIC GIRDLE)



MUSCLES AND LOCOMOTION

The bones of the skeleton are moved relative to each other by a system of muscles. Muscles are attached to bones by tendons.

Muscles have their organisms on one bone (attachment to stationary bone) and their insertion on a different bone.

In a moving tetrapod, the bones are subjected to compression and adapted to withstand these forces.

Shaft is composed of a central cavity surrounded by a layer of hard compact bone. Most stress occurs on the outside of the shaft.

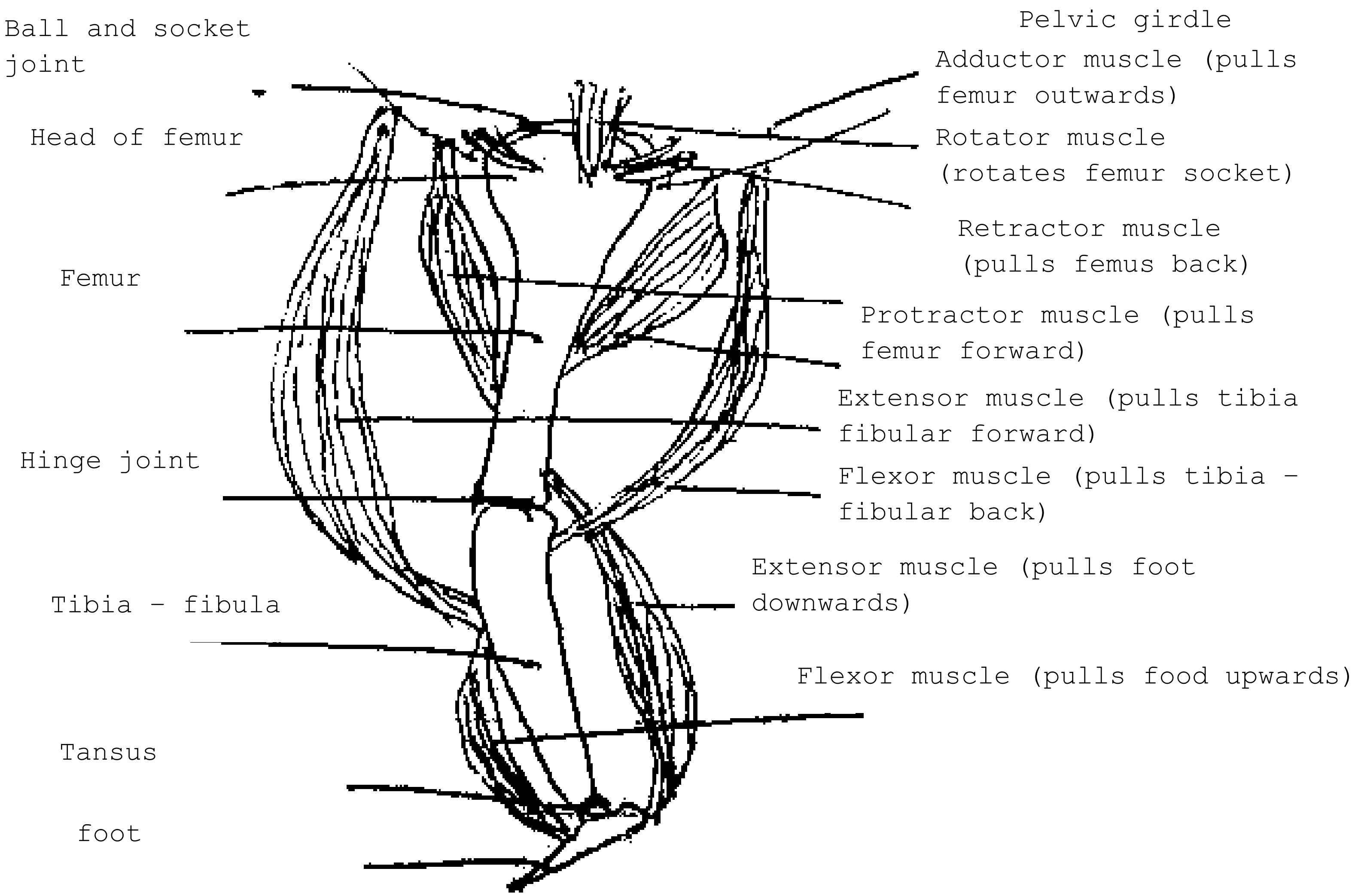
- The head (epipysis) of the femur is covered by a super ficial layer of compact bone but is composed of mainly spongy bone.
- The spongy bone consists of criss – cross network of bony trebaculac corresponding to the main direction of compression and ogension to which the limb is subjected.
- Limb combines lightness with strength.

The leg of land living vertebrates cntain numerous muscles most of which are directly or indirectly involved in locomotion. The muscles can be divided into seven groups according to the effects they produce.

1. Protractor: pulls the base of the limb forward
2. Retractors: pull the limb backwards
3. Adductors (depressors): pull the limb inwards towards the body.
4. Abductors (elevators): Pull the limb outward soway from the body.
5. Rotators: swivel the whole or part of the limb at one of its…………………………
6. Flexors: Pull two parts of the limb towards each other
7. Extensors: pull two parts of the limbs away from each other i.e. open joints

Some of the muscles are extrinsic i.e have their origins outside the limb itself (on the limb girdle).

The rest are intrinsic having both their rigim and insertion join the limb.



Some of the muscles are synergistic, contracting together to produce a particular action e.g raise foot and bend knee, protractor and flexor contract together.

Other muscles are antagonistic i.e oppose each other in their action e.g protractor and retractors e.t.c.

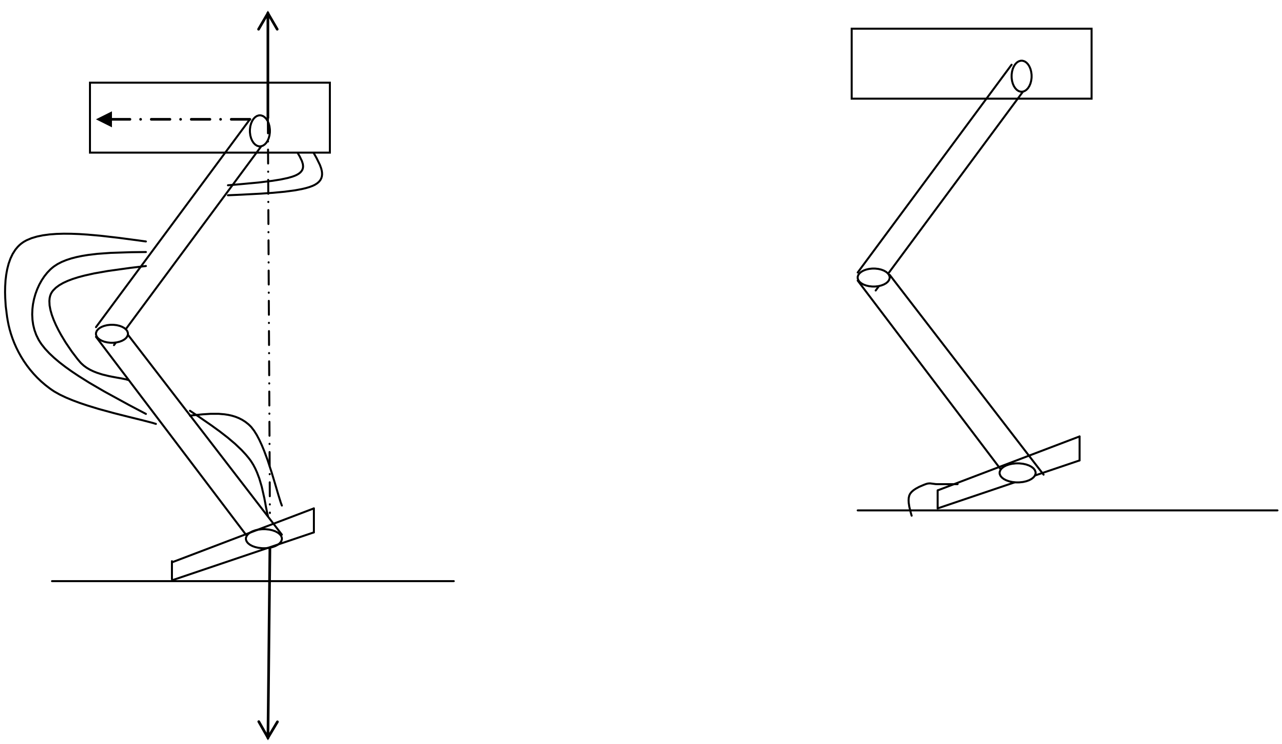
The different muscles are supplied by cosons from limb nerve the bronchial nerve in case of fore limb and sciatic nerve for hind limb.

The stimulus that initiates contraction of one muscle, simultaneously inhibits the motor neurons that serve the opposing antagonistic muscle. This is referred to as reciprocal innervations inhibitory reflex. It ensures that antagonistic muscles do not contract at the same time.

PROPULSION ON LAND (BOTH TETRAPODS AND BIPODS)

In propelling the body forward, the most important muscles are the retractors and extensors. The foot presses down wards and backwards against the ground. This results in an equal and opposite force which is transmitted along the length of the limb against the body. The force can be resolved into a vertical and horizontal component. The vertical force lifts the body off the ground and the horizontal force propels it forward (Illustrate)

PUSH OF FOOT AGAINST GROUND



The magnitude of the vertical and horizontal forces depends on the angle between the ground of the main axis of the limb (angle d). if the angle is 90^o,the point of contact of the foot with the ground directly below the centre of gravity there will be a lift but no forward force. This results into the whole body thrust upwards. This is what light jumpers try to achieve they leave the ground.

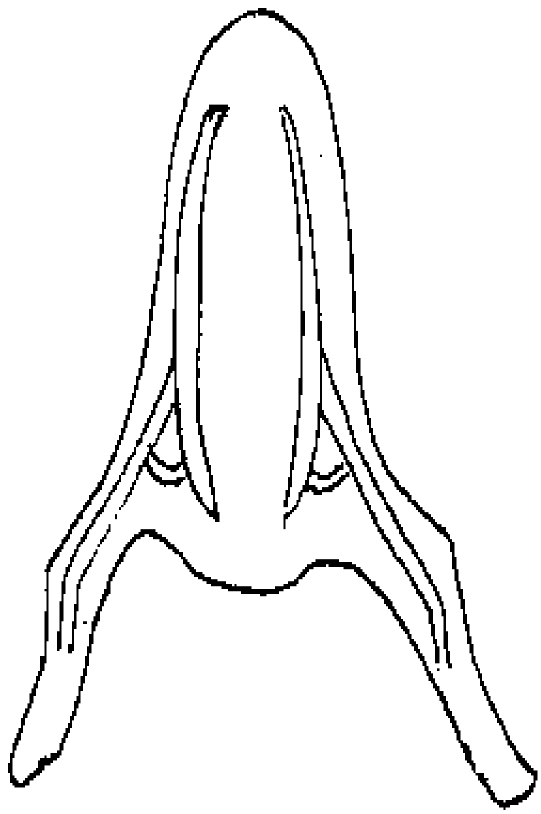
However if the angle is small and the foot is long way behind the OG, the forward force will be considerable but the upward force relatively small. This is what runners aim at achieving when they take their positions at the starting blocks.

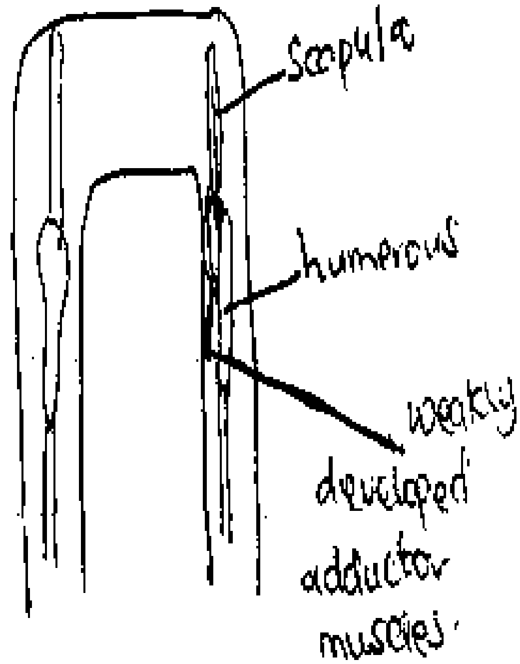
SUPPORT IN TETRAPODS

No support is provided by the medium (air) for land animals i.e limbs must / should not divided beneath the body for maximum deficiency as the limbs must hold the body off the ground.

Compare the for elimbs of a mammal e.g horse and a reptile e.g lizard

Reptile **Mammal**





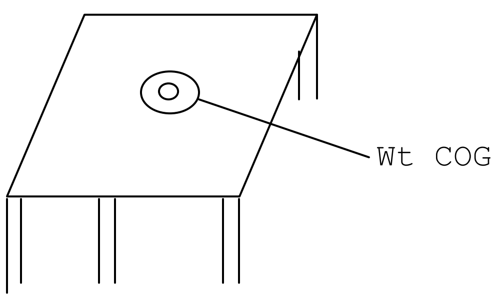
In the reptiles the limbs: splay out from the body giving the animal with logged appearance. Holding the body off the ground requires contraction powerful adductor muscles. This requires a lot of energy and is a strain heavy reptiles e.g the crocodile.

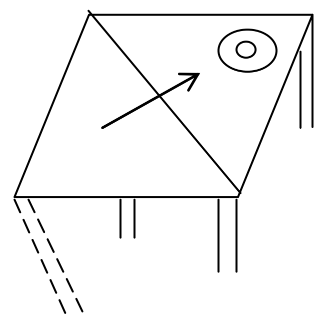
In mammals, the limbs are in a straight line beneath the body. The …………is transmitted along four straight limbs. The adductor muscles the woody developed. Less muscles effort is needed to lift the body off the …………… the <u>vertebral column</u> bridges the gap between the fore limbs and hind limbs facilitate support.

STABILITY

For a tetrapod at rest, stability is not a major problem. All four are on the ground. When the animal is in motion, atleast one must be taken off the ground. The tetrapod changes to a tripod. Remain stable, it must first shift its COG into the triangle …………by the 3 legs.

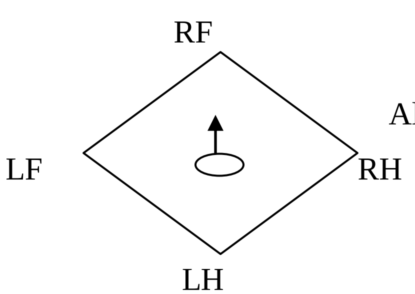
Compare a stationary table:



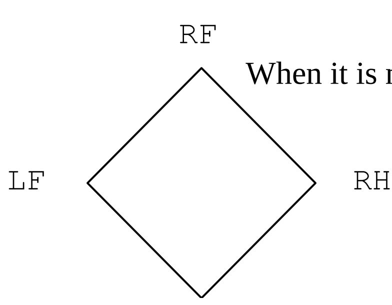


Sequence of event during tetrapod locomotion

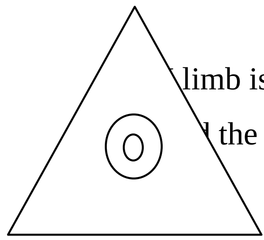
1. All legs on the ground



2. When it is moved forward such

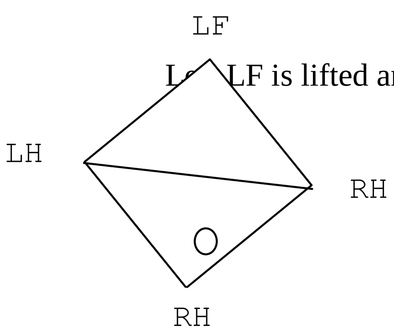


that the COG falls in the
triangle made.

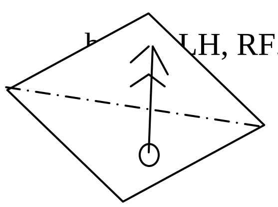


3. limb is lifted and brought
l the LF limb

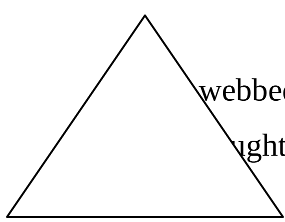
LF – Left fore limb
LH – Left Hind limb
RH – Right Hind limb



4. L LF is lifted and placed infront



5. COG is shifted into the triangle made
b LH, RF.



6. webbed hind limb can now be raised
ught up behind the RF limb.

The animals thus progresses sin a diagonal pattern. The order of leg raising LH, LF, RH, RF.

- Mechanical stability is reinforced by reflexes. From vascular apparatus in the ear (vestibular apparatus).
- From muscle spindles and pressure receptors in the soles of the feet (stretch rceptors)

- Information reaching the brain from the eye.

IMPORTANCE OF CENTRE OF GRAVITY

In other animals the COG lives towards the front so that the over limb is lifted off the ground without loss of stability. Such amids can sit on their haunches and survey their surroundings from a shafted point (this is of protective valve.)

The Kangaroo; its COG is far back that it would fall over it the muscular tail gives support.

LOCOMOTION IN BIPODS

Propulsion is similar to tetrapods, difference is in support and ability. When standing, the body weight is balanced by two height (modification of pelvic girdle to bear weight) short and broader.

In initiation of movement, the COF is 1^{st} swang away by the limbs to be moved, balance is aided by compensating arm movement.

In walking each leg is in turn moved foreward and background:

Alternate contraction extensor and flexor muscles. Each leg exerts a down and backward force on ground. This is resolved into a vertical lift and horizontal component. These are transferred to the body.

LOCOMOTION IN FISHES (WATER AS A MEDIUM)

Water being denser than air offers more resistance to movement of animals through it i.e high friction (disadvantage).

ADVANTAGES OF WATER

(1) High density makes water able to give more support than air.

(2) It also provides a medium against which muscles can thrust during swimming.

ADAPTATIONS OF FISH FOR LOCOMOTION (IN WATER)

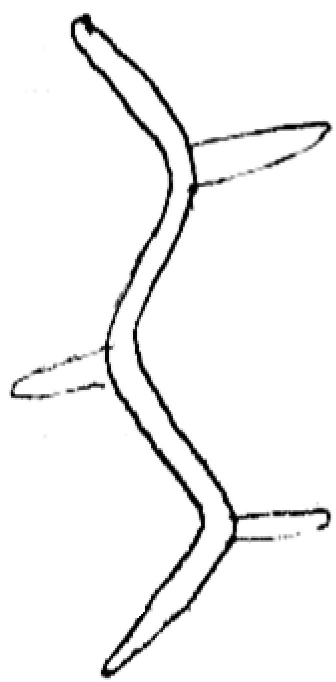
a) Body is stream lined so water flows smoothly over it.

b) Scales are slimy to reduce friction in water.

c) Flexible back bone.

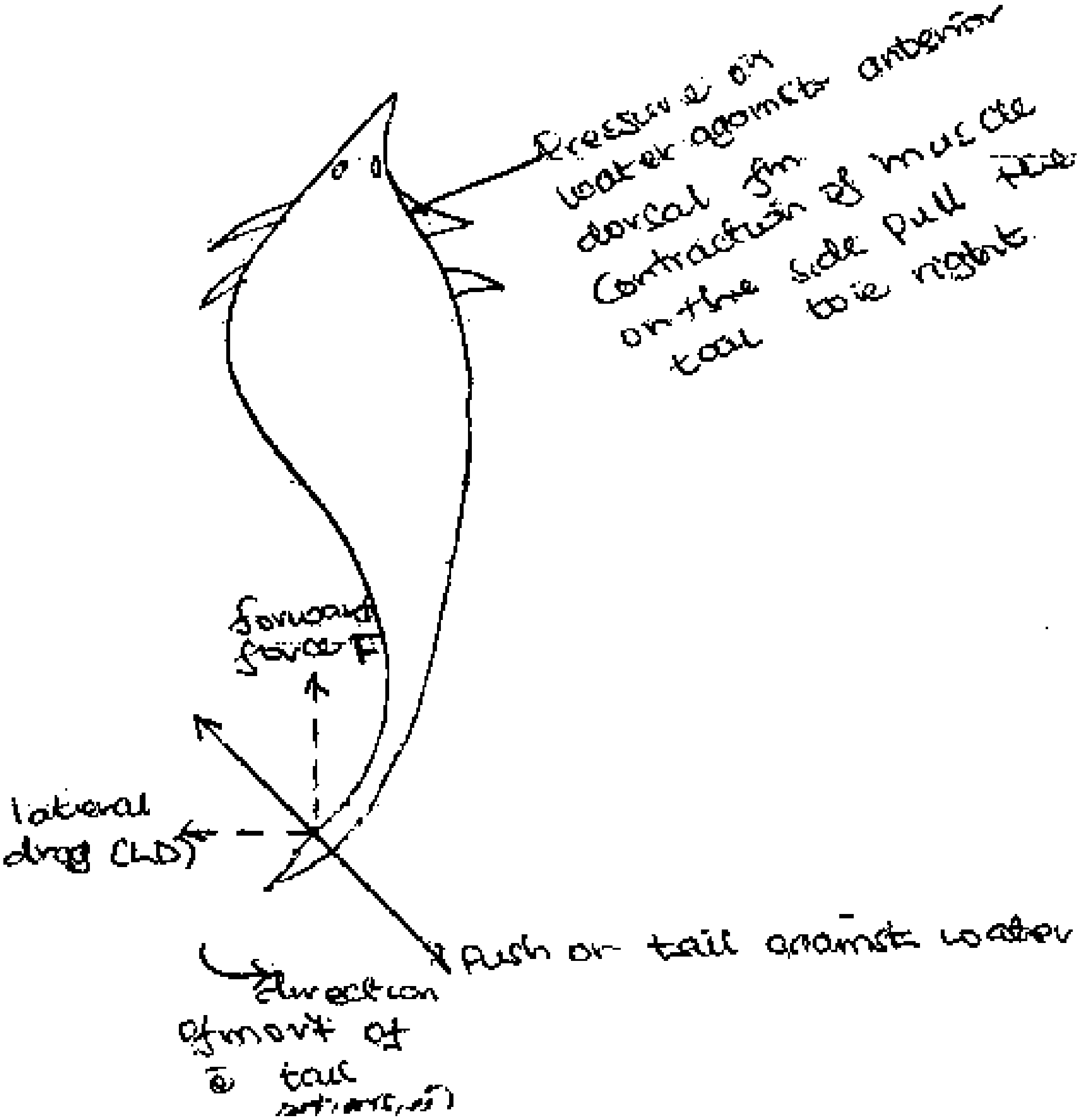
PROPULSION

Movement is brought about by sets of antagonistic muscles blocks called **Myotones.** They are located either sides of the vertebral column.



The myatones on either side of the vertebral column contract and relax alternatively. The contraction starts at the anterior end and travel towards the tail. This bends the body in a series of waves (undulation).

Note: Myotomes a non side is antagonistic to those on the other side.



As the tail pushes against the water, it experiences a force which can be resolved into a forward and sideways component. The forward force raises the fish through water and the sideways components, hears to owing to the left and the head to the right. This is lateral drag. This is over come by pressure of water against the head and anterior dorsal fin.

Significance and head size. The head give the fish a certain resistant against the lateral drag so that animal does not move sideways.

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Adaptations of fish for locomotion (in water)

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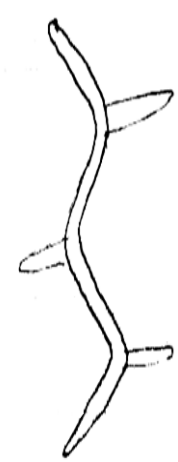
PROPULSION

Movement is brought about by sets of antagonistic muscles blocks called **Myotones.** They are located either sides of the vertebral column. The myotones posses a zig zag shape.



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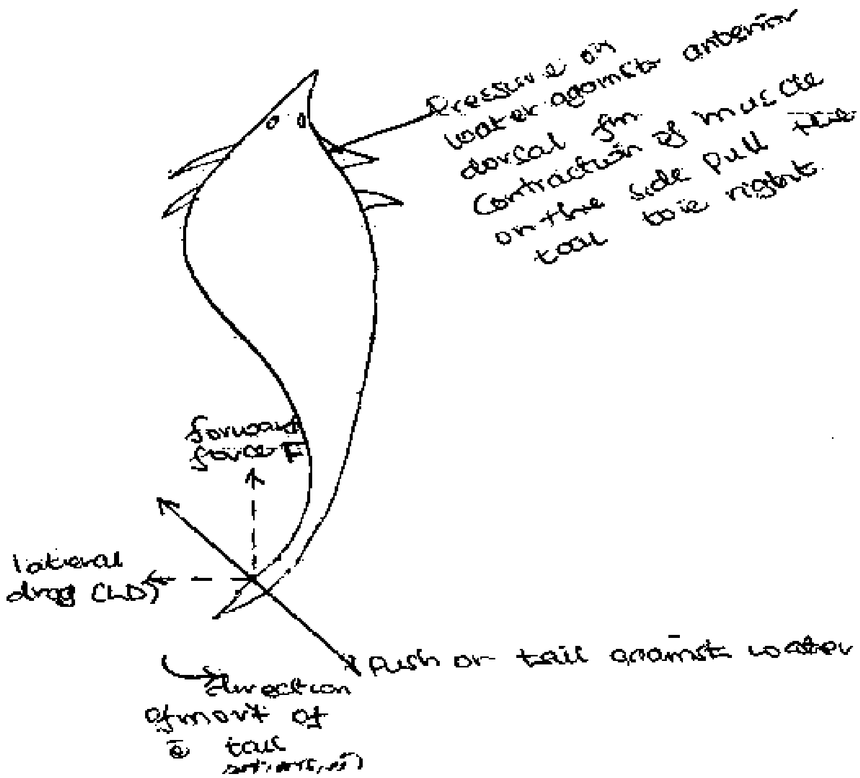

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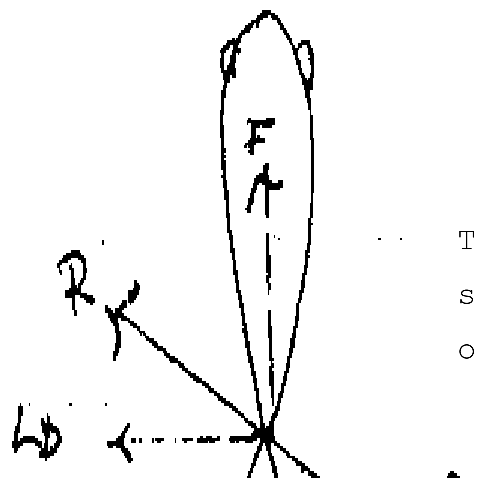
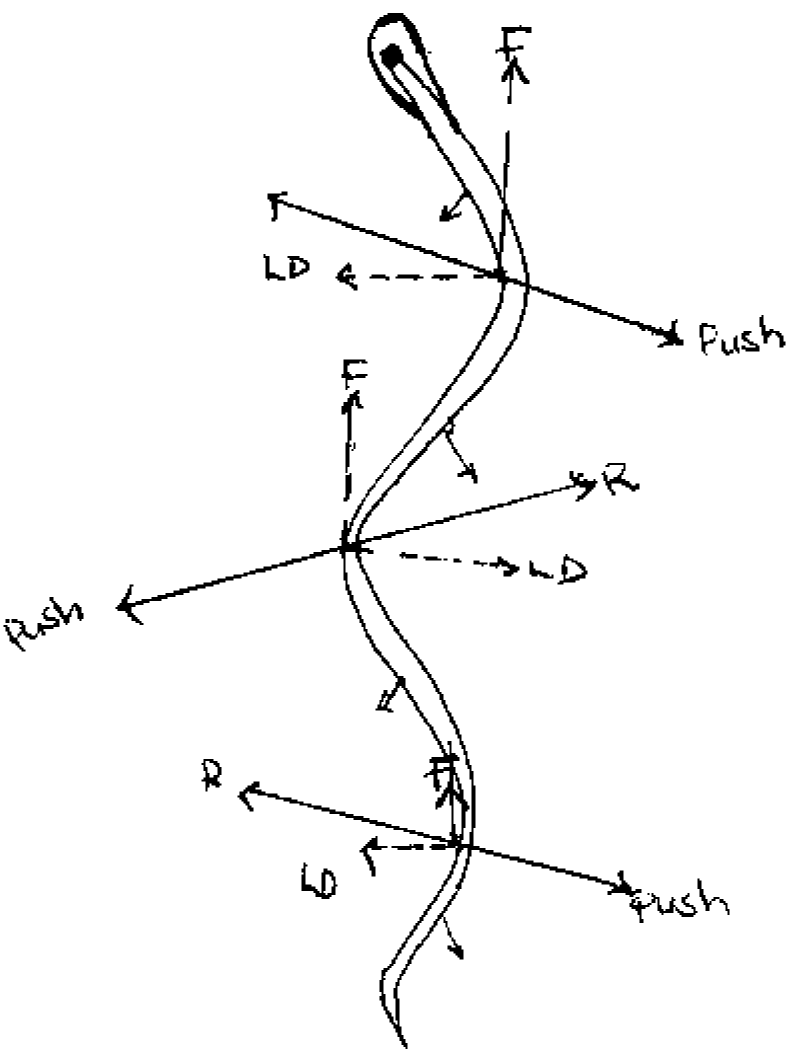
Significance and head size. The head give the fish a certain resistant against the lateral drag so that animal does not move sideways.

OSTRACIFORM LOCOMOTION (BS NEW EDITION)

In some compact fish e.g trunk fish (ostracision) propulsion is achieved by a very small tail. Pg 328 Rbts.



Tail moves right resting from side to side vigorously. This ostraciform locomotion.



CARANGIOFORM LOCOMOTION

The posterior half is thrown into series of leaves e.g bony fish, dogfish waves start from the anterior to the posterior (less fast than Ostraciform)

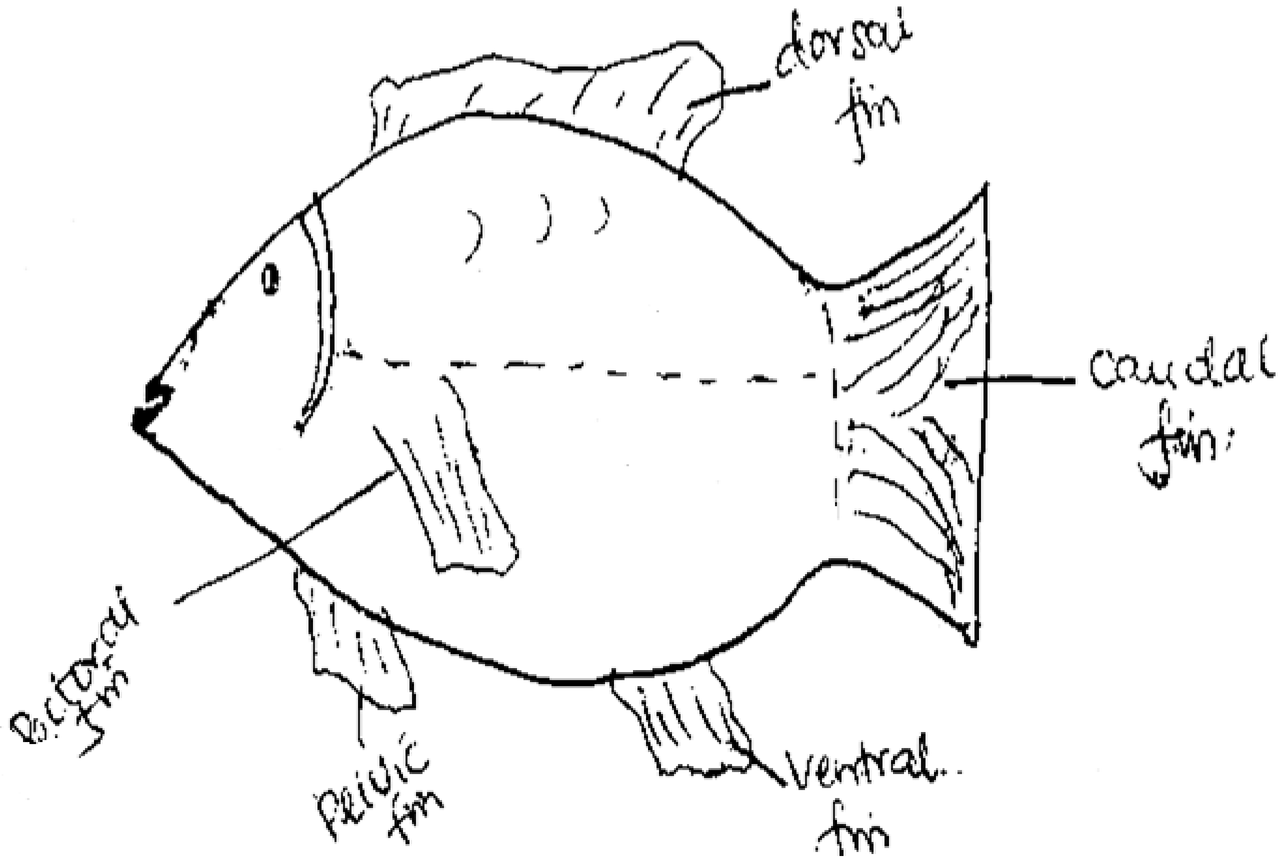
Anguiliform locomotion e.g eels

The body is very long, it is thrown into many waves so the different parts of the body are moving simultaneously to the left and right.

N.B: Snakes move by lateral undulation of which pass along the body from front to rear as in ells. Solid objects needed frequently for the body to move against e.g grass, stones i.e not smooth surface.

Contractor of mainly mystomes.

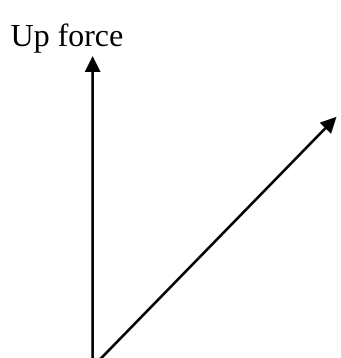
SUPPORT IN FISHES



A dog is heavier than water and inks if it stops swimming actively. Support comes from locomotion itself. Anteriorly, support is derived from large pectoral and pelvic fins (paired fins). They are held at an angle and altered to allow the fish to swim up and down in the water.

Support at the posterior end depend on Letero cercal (more caudal from on the ventral side of the body than dorsal side). It generates an up thrust as well as forward force as it swims from side to side.

The first experience a force which can be replaced into an upward and down ward components. The upward component provides support (lift).



Back force

Push of the fins against H_2O

IN TELEOST (BONY) FISHES

Bony fish have an air filled bladder to keep them up in water (caudal fin is symmetrical), above and below the body) i.e homocereal does not have to provide lift.

There are two types of swim bladders

Open swim bladder – close swim bladder

OPEN SWIM BLADDER

It is connected to the pharynx by duct. Air is taken and expelled through the mouth. This increases or decreases relative density of the fish respiration.

Closed swim bladder: Gas is secreted into it (gas gland) of accordingly. It is under nervous control.

The swim bladder enables the fish to maintain posh in H2O (support) without spending energy. The dog fish has to keep swimming to maintain support.

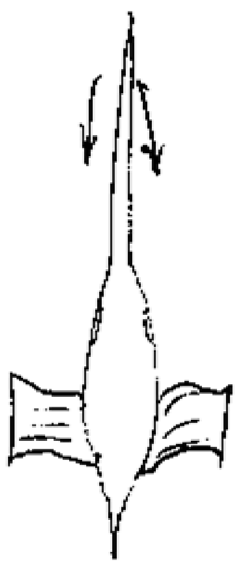
The paired fins of bonny fish are smaller than those of a dog fish. They free to be used for stearing and braking if can more relatively faster.

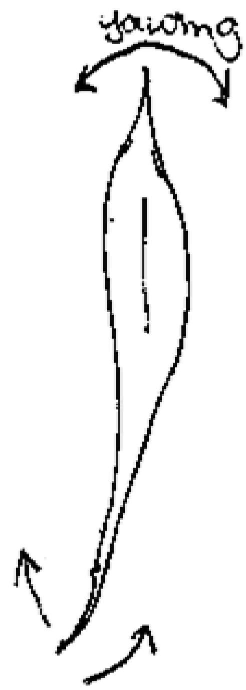
STABILITY IN FISH

There is a tendency of a fish to become unstable during swimming due to

(1) **Yawing:** This is lateral deflection of anterior part of the body. It results from propulsive action of the tail.

Roll



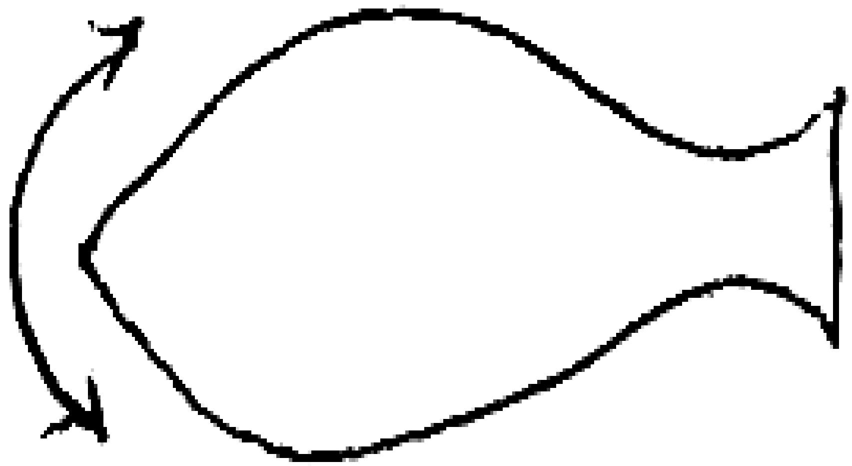


Rolling – falling over

Yawing resisted by:- general massiveness and initial of the head.

- Pressure of water besides that of the body.
- The medi dorsal and ventral fins
- Lateral flattering of the body.

(2) **Pitching:** The tendency of the nose to plunge vertically downwards.



This is resisted by:-

Paired fins (pelvic and pectoral e.g in dog fish it is resisted by dorsal, ventral flattening of the body and large flap like horizontal fins).

(3) **Rolling:** Total rotation of the body about the longitudinal axis. It is counteracted by medium and paired fins.

BIRDS

LOCOMOTION IN AIR

Air has a low density and viscosity: It provides little support to the animals moving through it. And little stronghold for propulsive devices.

Thus flighting involves for more muscular effort than swimming or walking.

To generate sufficient force to take off from the ground and remain air borne, an organism must have wings.

ADAPTATIONS FOR FLIGHT IN BIRDS

(1) Fore limbs are modified into limbs to provide large S. a fore flight.

(2) Presence of large pectoral muscles which move the wing. Pectoval major and pectoral is minor.

(3) A light skeleton made up of hollow and mainly small bones which can easily be moved in air. No teeth therefore there is no need for heavy muscles.

(4) A rigid skeleton made up of fused bones reduces on the weight with a deep keel like extension of the sternum which provides a large S.A for attachment of flight muscles. Vertebral column fused to the pelvic girdle to transmit force of wings to body lift. (Provide lift).

(5) An efficient breathing system attached to the lungs needed for respiration and removed of CO2 the for gaseous exchange.

(6) A high metabolic rate for providing the high amount of energy required for muscles contraction. It has good insulation by feathers.

(7) Have an efficient circulatory system for transport of respiratory gases at the speed suitable for the body needs. High number of RBCs for transporting O2 large well developed heart with mitching membrane.

(8) A keen eye sight to enable them judge distances accurately especially on landing. Eyes covered by mictating membrane which prevents drying out of the eyes as bird – flies.

(9) The feather covered body is smooth and stream lined to reduce air resistance during flight (smooth movement through the air)triple external ears and the legs are folded away during flight. This further enhances smooth flow of air.

(10) Well developed pectoral girdle with coracoids with scapula and clavicle bones. The coracoids provides firm base for the wing, transims the lift (upthrust) with the wing to the rest of the body.

(11) The central axis of the body is short and modified to allow the body weight to be carried either on lungs or on legs i.e presence on sternum with extension and pelvic girdle.

(12) Lengthened hind limbs so that wings do not flap against with the ground during takeoff.

(13) Well developed powers of muscular coordination. Review; structure of bird's wings and attachment of feathers. Feather structure and function, bird's skeleton.

FLIGHT IN BIRDS

The wing is or slightly curved structure, convex above and concave below. The front (leaching edge) is the widest part tapering behind to the thin trailing edge. The wing acts as an aerofoil.

When a wing is moved forward through the air, the air flow is faster ovet the longer upper surface than the concave / short lower surface. i.e less resistance over the upper surface.

Air pressure above the wings is reduced and that of the wing is increased.

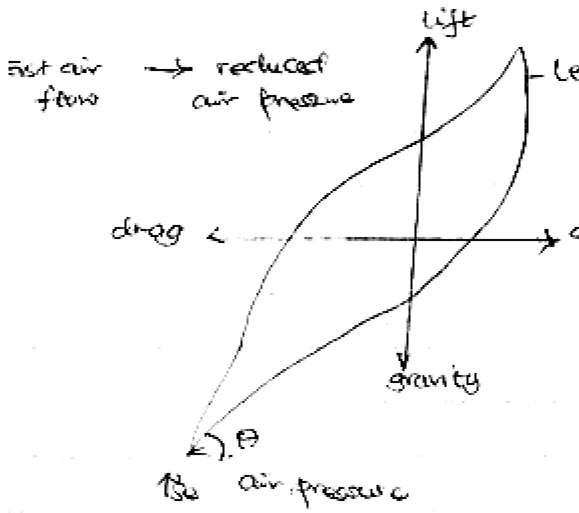
This generates a lifting force upwards a slight drag force downwards.

For flight, the mean lift force must be equal or exceed the weight of the bird. The power of the lifting force depends on

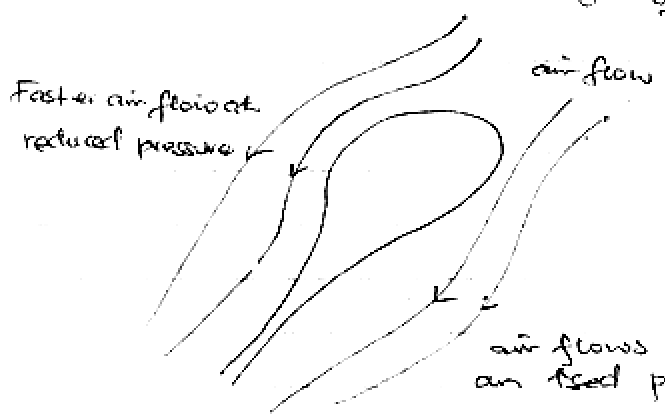
- Size and shape of the wing
- The angle at which (the wing) it is inclined to in relation to the air stream i.e angle of attack the bind air speed.
- As, the angle of attack is increased, lift is increased but at certain critical angle, air seizes to flow smooth over the upper surface of the wing. At and above an angle of 15o air flow species form the wing and lift is reduced i.e there is turbulent air flow. This can be reduced;

- The bastard wing: it is held above and a head with main aerofoil (wing) separation of the flight feathers at the end of the wing, the smooth the flow of air above the wing.

Fast air $\longrightarrow$ reduced

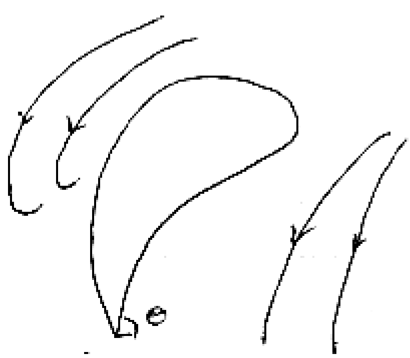


The wing is moved thru ē air with leading edge above ē trailing edge lift ē generated
θ = angle of attack at low angle of attack.



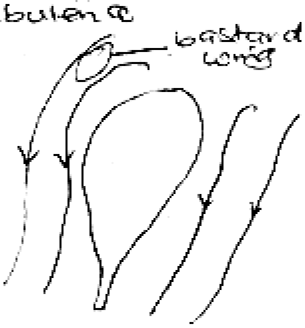
air flows more slowly at an ↑sed pressure ∴ lift is generated

At high angle of attack



lift is counteracted by the drag due to turbulence & ē aerofoil falls

Avoiding turbulence



Emphysema:- Breakdown of the alveoli. The action of one or more substances in tobacco smoke weakens the walls of the alveoli smaller cough and coughing bursts some of the weakened alveoli.

There are three major types of flight

(1) Flapping

(2) Gliding and soaring

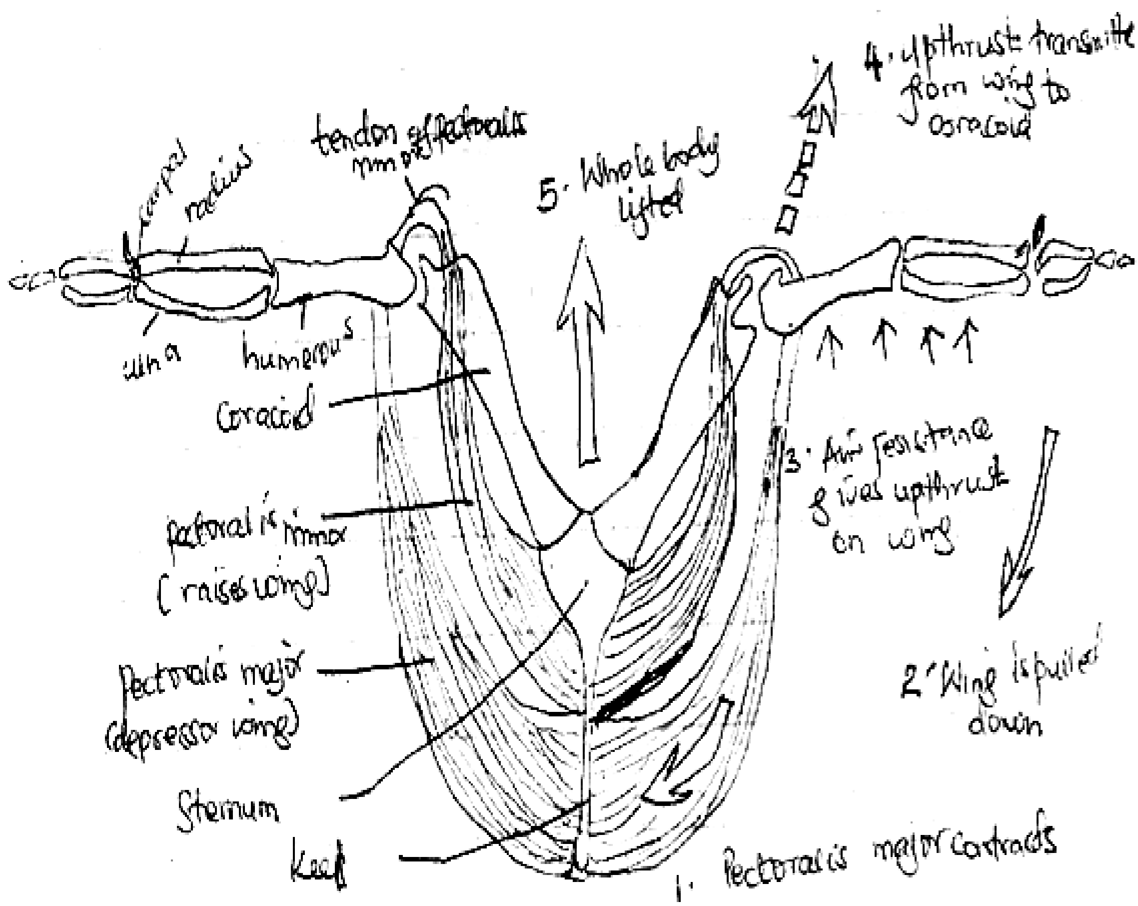
(3) Hovering

FLAPPING FLIGHT (ACTIVE FLIGHT)

The wings generate propulsion (forward thrust) as well as providing the lift. To do so, the wings are moved up and down rhythmically. The main power for flapping is provided by contraction of large pectoral muscle.

Cross section of chest to show flight muscles

Down stroke



Pectoral major contracts to pull wing down. Pectoralis monor relaxes, air is forced backward and downwards. The feathers are maintained in an overlapping posh and the full surface of the wing is presented to the air.

They give max resistance to air and max lift. The lifting effect of the air tends to separate the feathers and bend them outward drag.

Clipstroke

It starts before completion of the down stroke. The P minor muscles contract. The inner part of the fore arm is moved sharply upwards and backwards with its front edge inclined above the trailing edge. This also provides lift to the body. The wing is bent at the wrist as it moves up, the primary feathers are separated permitting air to pass through them.

This implies minimum air resistance.

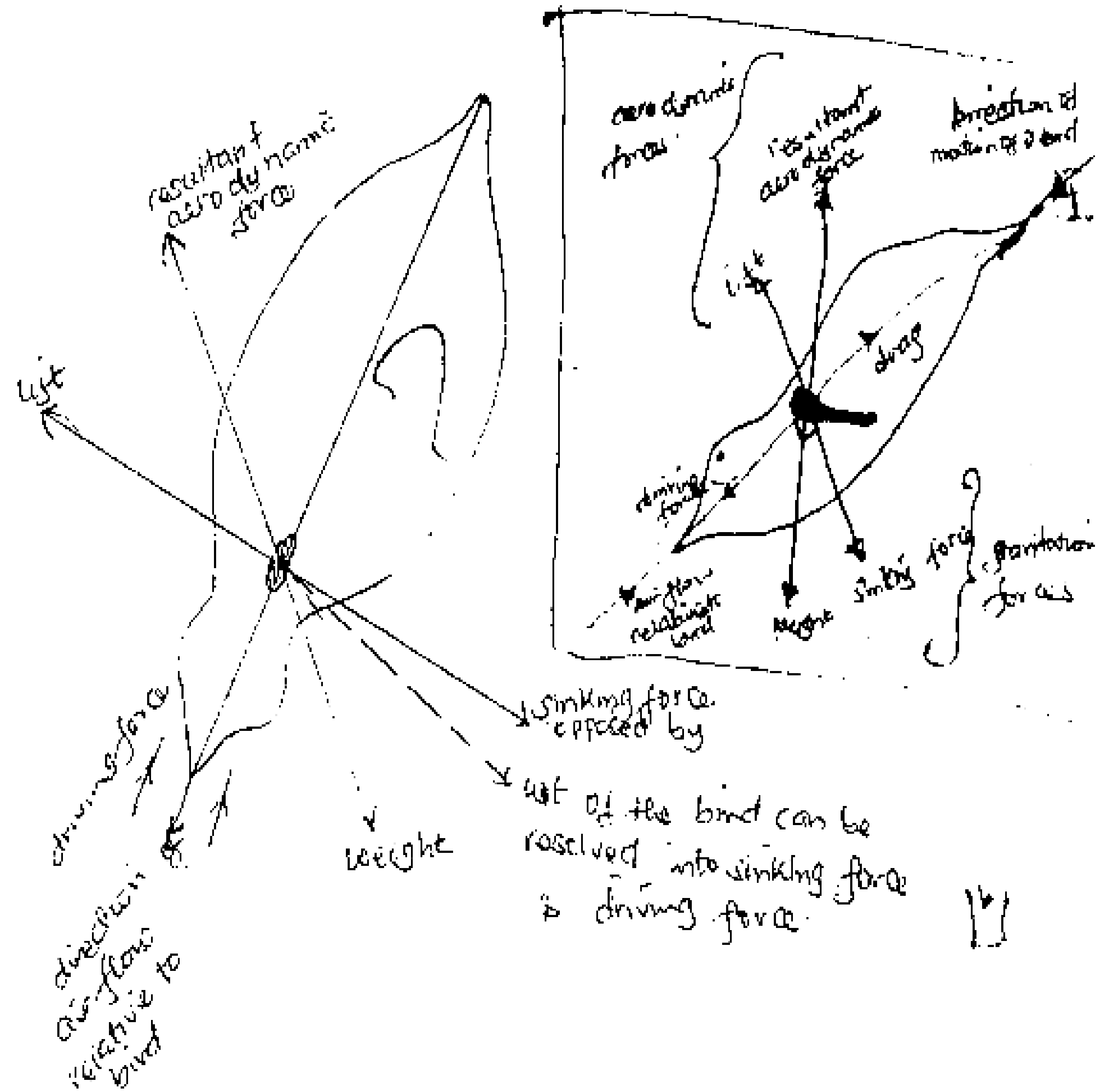
The backward movement of the wings provide forward propulsive force .During sustained flapping flight, the wrings do not flap so hard. Less energy is needed compared to that at take off.

At the end of flight, the bird lands by lowering to spreading out its trail, this acts as a brake. Legs absorb landing impact.

NOTE; The trail is also used for stirling during flight .stability is achieved by nervous control via the semicircular canals.

GLIDDING AND SOARING FLIGHT

During gliding the bird holds its wrings at an angle about 90 to the body and gradually loses height .As it descends ,the force acting on it is called during force .The pull of gravity in a downward direction is the sinking force .Although the air is still, the forward motion of the bird creates a flow of air over the wrings .As a results , the above forces are developed.



As the gridding spread increases , the lifting force also increases .When lift sinking force and during forces = drag force, the bird drives through the air at constant velocity . The speed of griding depends on; bird sand weight; heavy birds drive faster

Size of wings; those with small wrings grid faster.

Shape of wings; narrow one grid faster

Angle of attack of the wings.

Land bird s make use of raising thermal currents when gridding .The y can also make use of fast moving wind .when it…….. an obstruction it is deflected upwards .Birds grid along the air current raising in air without flapping is called soaring.

HOVERING

This is flapping of wrings while staying in one place .The up thrust developed counter balances the birds weight . Birds that hover produce enormous flight muscles. Majority of their wrings are………………. For providing up thrust.

NB; Muscles of the birds that fly are rich in myoglobin. They are red in colour while those of flight less birds are white.

DIFFERENT TYPES OF MUSCLES

There are three main types of muscles

1. **Cardiac muscle**
   If forms a bulk of the heart. Its muscle fibres are light , stripped and branched forming one like arrangement .Each cello has one nucleus and are joined to each other by joints called intercalary discs. Cardiac muscle is myogenic and contracts rhythmically; even when

removed from the body, it never suffers fatigue. The muscle fibres will stop contracting, if there are starved of O2 or bathed in wrong chemical composition.

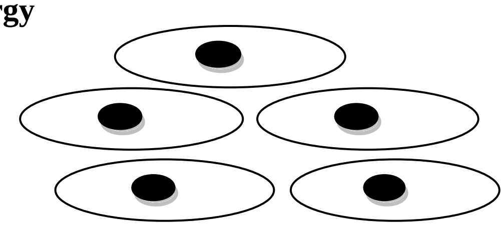
2. **Smooth muscle**

This consist of numerous slenger muscle fibres. Each cell has a single nucleus. They are found in lining of the gut, blood vessels, tubes and ducts, respiratory, urinary systems i.e spincter and ciliary body of the eye iris e.t.c.

Smooth muscle is unstraited, contracts and fatigues slowly. It is supplied (innervated) by autonomic nervous system.

Involuntary

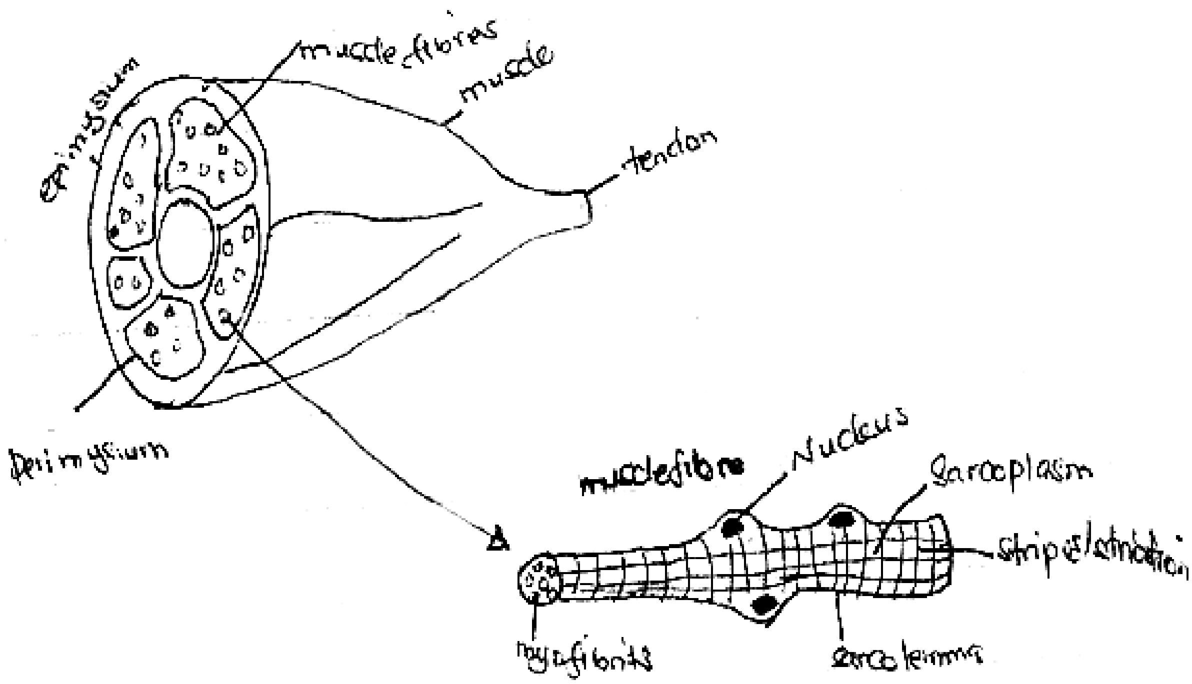
Clergy



3. **Skeletal muscles**

It is so named because they are attacked to bones. It is responsible voluntary of the body. It appears stripped / striated under the microscope. It consists of many muscle fibres wrapping connective tissue. It is supplied with blood vessels and nerve fibres. A single muscle fibre has many nuclei. It is innervated by voluntary part of the nervous system Voluntary muscle. It contracts and fatigue rapidly.

Groups of fibres ate bound into bundles by a thin firm of connecting tissue (perimysium) and the whole muscle is bounded by a sheath / penmysin. Each muscle fibre is enclosed by a membrane (sacolemma). It surrounds the cytoplasm known as sarcoplasma. The sarcop / asma contains numerous fibrils. Those show a pattern light and dark bands (known as I and A bands). The satcoplasma contains extensive endoplasma resrecticulum known as sarcoplasma neticulum together with numerous mitochondria.



PROPERTIES OF SKELETAL MUSCLES

If a single shock of sufficient strength is sent into the muscle, it responds by quick sharp contraction of twitch. It takes about 0.15 for contraction to reach its height, a further 0.25 for relaxation to be beneached a short delay (latent period) between duplication of stimulus and the onset of contraction is caused by the time taken for electrical response to be transmitted into action (contraction). A single contraction by a muscle is a muscle twitch. This implies skeletal muscle contracts and relcoles when stimulated.

SUMMATION

Consider two shocks delivered in succession. If the interval between the chocks is known, then two twitches fuse or summate to give on smooth contraction. It is larger and takes longer than a single twitch. Each impulse initiates contraction, but the second contraction starts before the muscle begins to relax. This implies response of muscles shows summation if stimuli are applied simultaneously.

If a continuous stimulus of high frequency is applied to muscle, i.e muscle gets into maintained contraction e.g tetanus; it relaxes only if the stimulus is switched off.

If stimulation of muscle continues, for a long time, the response (contraction) gradually declines and disappears. The muscle is fatigued.

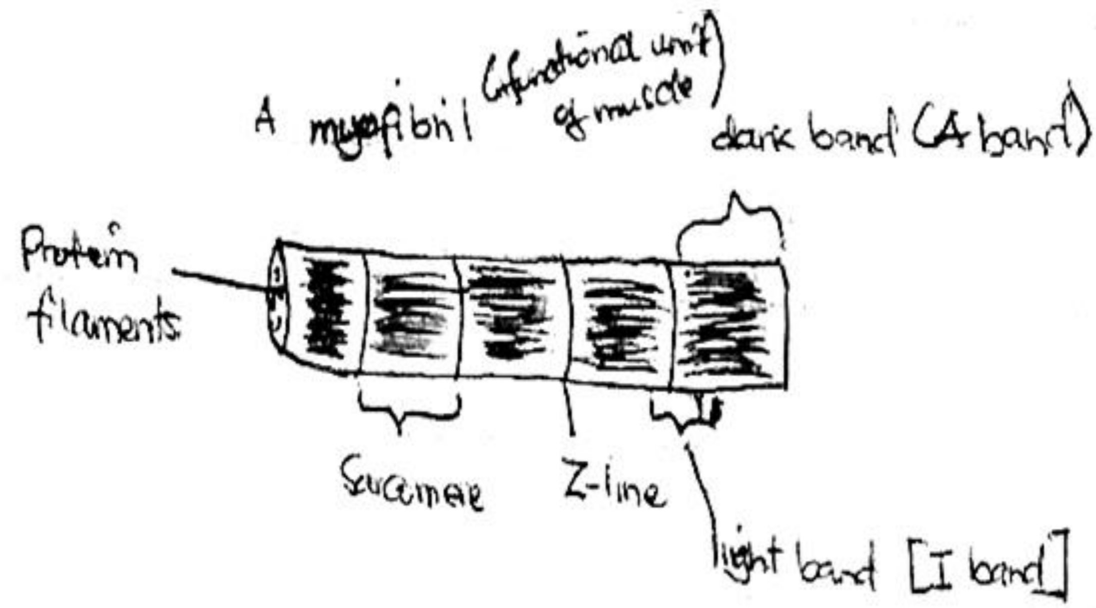
When the muscles are not active, they have a resting potential and Fabre is stimulated by an impulse it will only contract if the stimulus is at or above a certain threshold level. Contractions maximum and does not increase even if strength of stimulus is increased. Muscles obey the “all or nothing” law. Stimulus that is too weak to provoke a response (contraction) is subliminal stimulus.

- The muscle endures an absolute refractory period when no contraction is possible. I[1]
- It is followed by a relative refractory period.

SLOW TWITCH AND FLOST TWITCH MUSCLE FIBRES

Some muscles are referred to as fast twitch muscles. They contract rapidly and are suited for quick bursts of activity. Other muscles (of vertebrates) contract slowly i.e. slow twitch muscles (tonic). They are adapted for steady action over long periods of time i.e. sustained contraction. They have numerous initochoncria, a rich blood supply and abundant myaglobin(abundant o_2 store. They rely on fat for their energy supply. In man, such muscles are important for maintaining posture.

Fine structure of a muscle



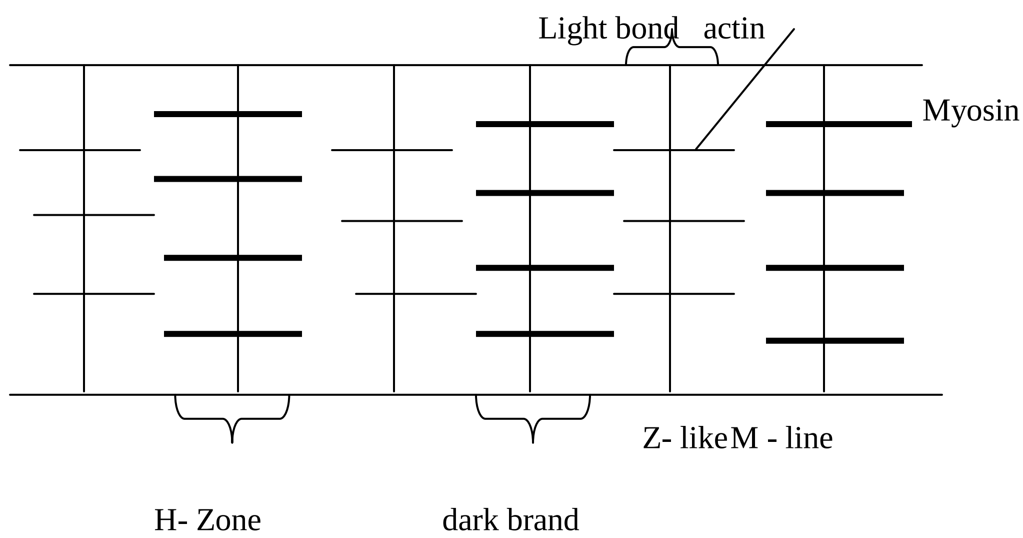
Myofibris are divided in compartments called sarcomeres by internal membranous partitions called Z- lines. There are several bands across. The light 0ones are I- bands and shaded in each Z- line. The dark band is the A- band. The alternating dark and light bands due to the system of interlocking filaments.

Two types of filaments exist.

Thick filaments, are made up proteins, myosri, they are short and are confined to the dark bands only.

Thin filaments are made of protein actm. They occur in the light bond and also extend between the thick filaments. Thin filaments are held together by transverse lines (bands), the z band/ line ie z – times anchors thin filaments. This implies length of hyofibrils from one z-time to another in a sarcomore.

BASIC UNIT OF MYOFIBRIL



H zone consists of thin filament only. It is relatively lighter region. In the middle of this zone is M- line.

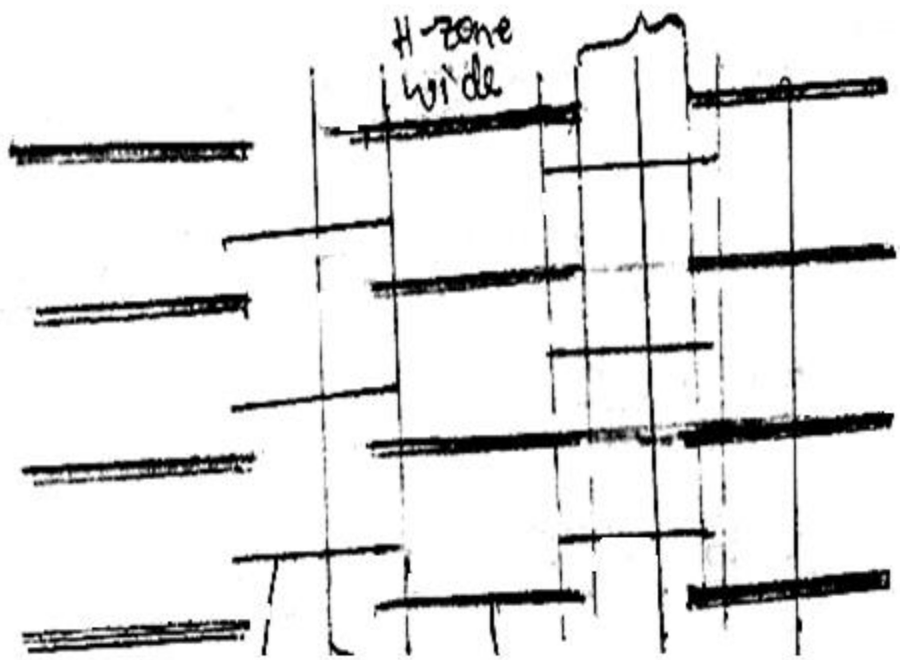
HOW MUSCLES CONTRACT

Muscle contraction is explained by spiding filament theory / hypothesis. Contraction by thick and thin filaments studding between each other.

The thin filaments in each light band are held together by the Z-lines and the thick flament by the m-lime. So they slide as a unit and their orderly arrangent is maintained during contraction process.

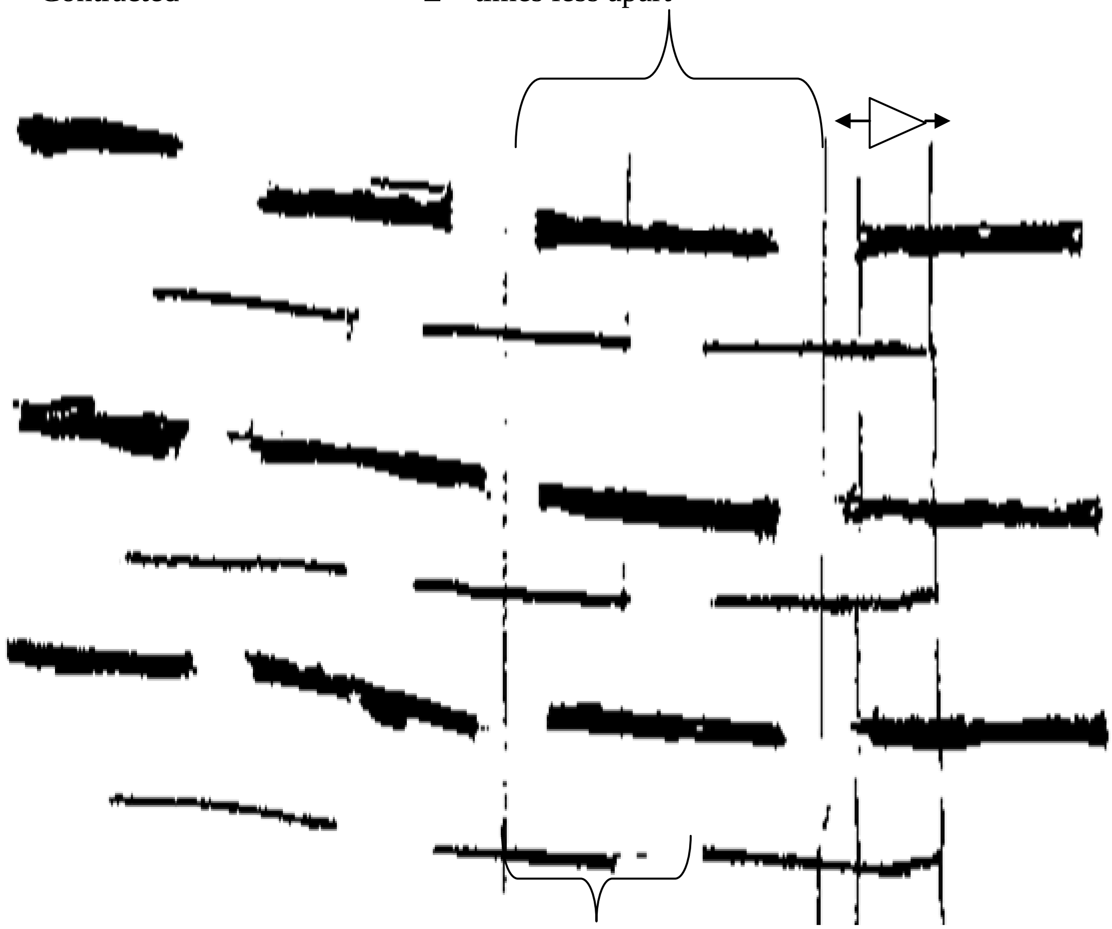
RELAXED MUSCLE

When muscles are fully relaxed (stretched) the light bands and H-zones are wide or should be long. The dark bond or shorter. Z-lines far apart (sarcomere long).



Contracted

Z – times less apart



D – darkens of the dark band become longed / wider

H – zone greatly reduced

Z – lines are close together, light band and H-zones are narrow (not wide). Dark ends of dark band are longer. In severe contracted muscles, the ends of the filament actually meet. Where they meet, the filaments example or overlap. The light bands and Z-ligies disappear altogether.

NB: Length of the filaments themselves do not change => dark band remains same size.

Skeletal muscle only contracts when stimulated by an impulse

It is androgenic

Connection between narrow fibres and muscles forms the neuro muscular junction.

HOW ARE THE FILAMENTS PROPELLED?

Cross bridges can be seen connecting thick and thin filaments where they overlap. The bridges project forms the thick filaments.

During shortening of the muscle (contraction) each bridge attacks itself to the thin filament act myosin being formed at the point of contact. The bridge then (from 90o to 45o) the movement of many bridges pulls the thin filament passed the thick ones S. After completing the movement, each bridge detaches itself from the thin filament and gets reattached at another site along thin filament. Thus shortening of muscles occurs.

For each bridge to go through a complete cycle, splitting of one molecule of ATP is required => energy is required explains presence of mitochondria in sarcoplasm.

The garcoplasmic reticulum has vesicles containing Ca^{2+} ions. The ions are necessary for hydrolysis of ATP to release energy.

When an impulse passes along the sarcolemna, the vesicles release their Ca^{2+} ions into sarcoplasm. ATP hydrolysis take place and hydrolysis occurs. After contraction, the ions are actively removed back to the sacroplasmic reticulum, Ca^{2+} ions fall below threshold.

How Ca^{2+} ions exert their effect

Each thin actin filament consists of many molecules of actin arranged in long threads that spiral around each other. Along each thread, there are many binding sites where myosin molecules bine attached to actin. On addition to actin, two other proteins; propomyosin and troponim are present.

When muscle is relaxed, tropomyosin preents myosin from binding the actin filaments. It blocks the binding site. Ca^{2+} ions activate the troporim enabling it to displace tropomyosin. Then binding can occur. Once the myosin bridge has become attached to actin filaments activates the enzymes ATPase. ATP is hydrolysed to release energy and the bridge goes through its cycle or are of movement.

Illustrations

N.B: After the movement, ATP is released i.e needed to release the myosin bridge from binding site. This implies that the myosin bridge can bind with other sites along the actim filaments.

RIGOR MORTIS

At death, the muscles remain contracted and rigid. This is known as rigor mortis. This is because the supply of ATP ceases (no respiration) so there is no further contraction of muscles.

The existing cross bridge (remain in place) myosin Ca^{2+} ions cannot be pumped away.

N.B: Energy from ATP is needed to break the link between myosin bridge the actim.

MUSCLES SPINDLE AND TENDON ORGAN

Muscles and joints (tendons) contain tiny sense receptors (proprio receptor). These muscles spindles send impulses and to the brain concerning the body's position (posture) and tension of the skeleton muscles.

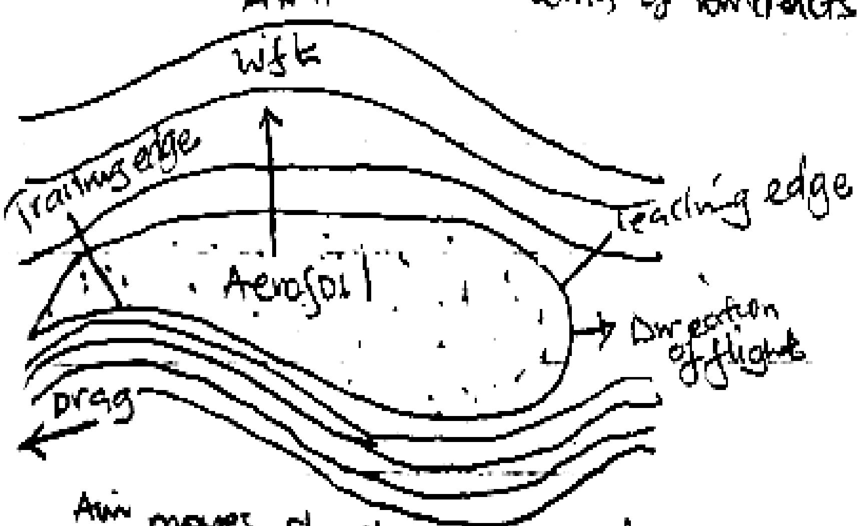
Stretch receptors located in the tension are known as tendon organ. A tendon organ has a very high threshold and will respond only when the tension (contraction) is extreme.

Excitation of the tendon organ reflex inhibits the muscles.

This prevents the muscle from contracting powerfully so that it is not damaged.

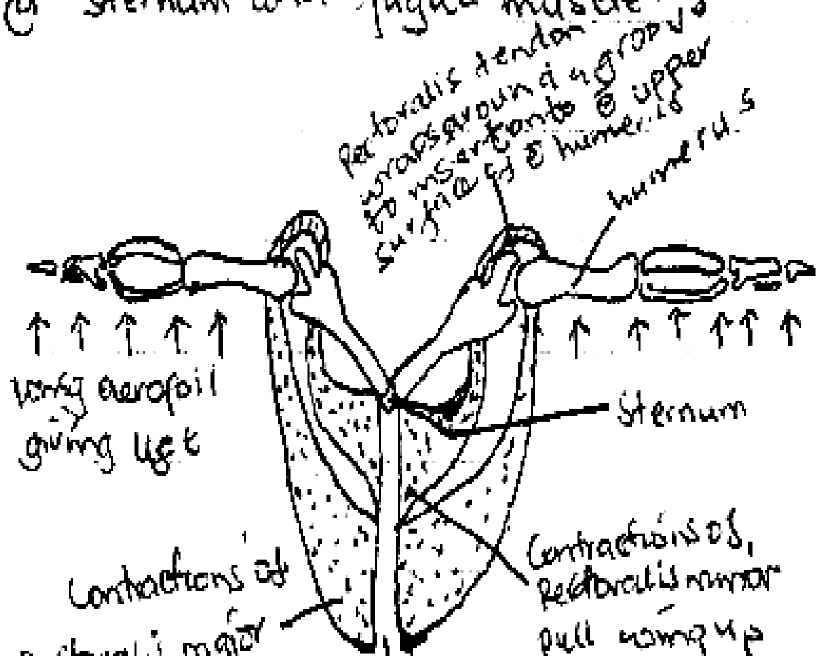
(a) Aerofoil shape

wing of bird acts as an aerofoil



Air moves slowly along under surface, increasing the relative pressure & generating lift

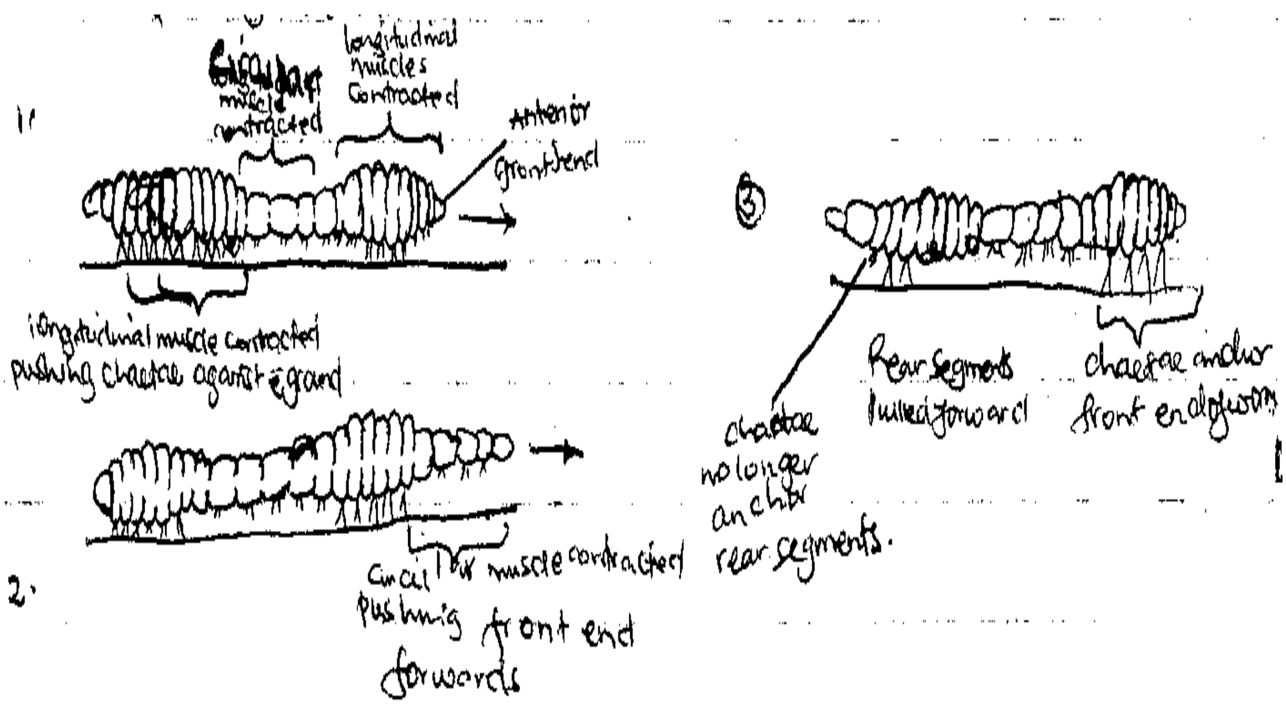
(b) Sternum and flight muscles



The smaller group of breast muscles (pectoralis minor) produce the upstroke of the wings; the larger muscles (pectrorisma (or) produce the down stroke, generating lift and forward movement. During upward recovery stroke, the wing is flexed at the elbow and wrist to reduce air resistance.

USING A HYDROSTATIC SKELETON (EARTH WORM)

During locomotion, the circular muscles and longitudinal muscles contract in turn to produce paristatic waves along the body, beginning at the front end and working backing chaetae (small, stiff bristles sticking cut of the side of the body) anchor parts of the body to the ground so that other parts can be pushed away from or pulled towards these point. Hydrostatics skeleton are also used to extend soft structures, e.g the siphon of amollus of and the penis of a mammal.



Exoskeleton called a cuticle secreted by cells in the epidermis.

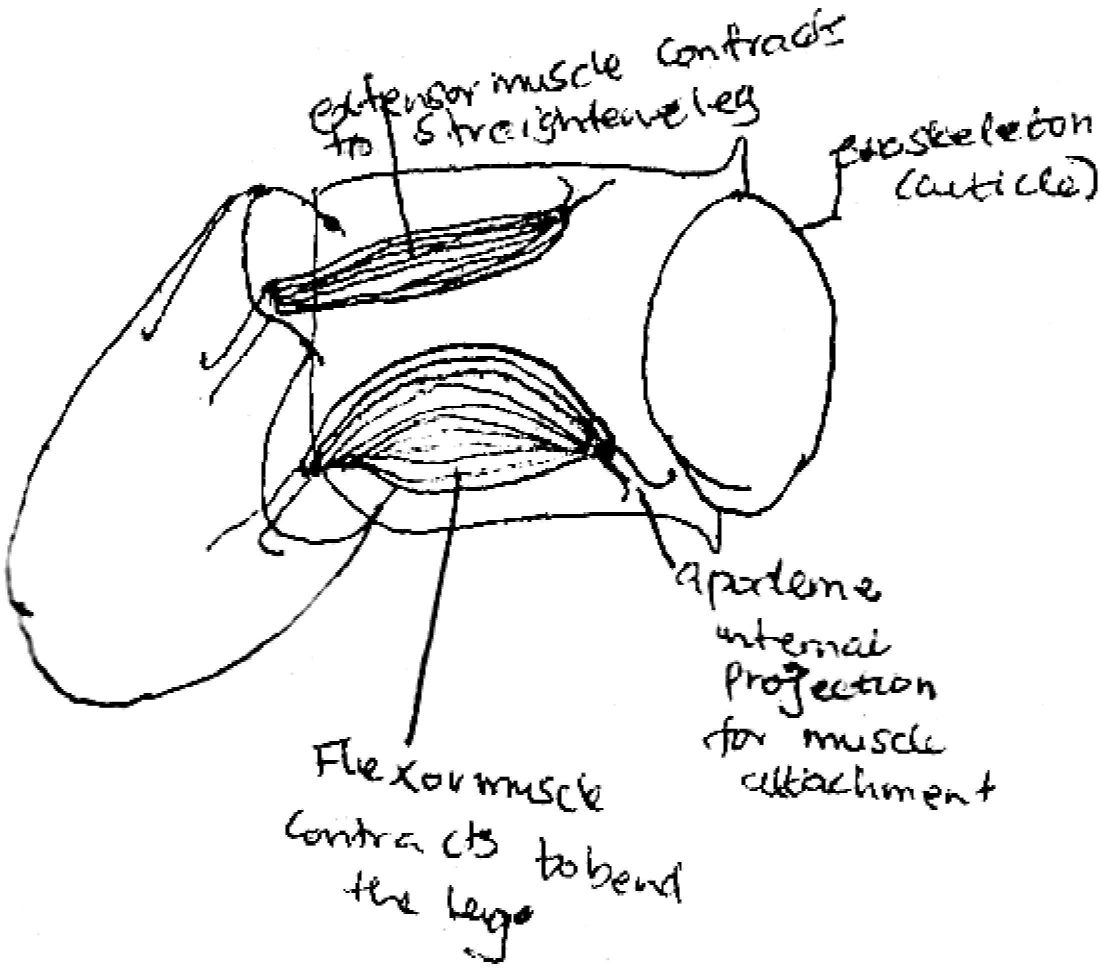
Epicuticle (very thin covered with wax) – to prevent water loss

Cuticle outer rigid eocuticle

Inner procuticle

Inner more flexible encuticle

One joint of an insect's limb showing the attachment of its antagonistic muscles



Although each joint can move in one place only, successive joints in an insects limb bend in different planes, giving a wide range of movements. This joint mobility is particularly important for insects that fly.

Arthropods have to moult periodically cecdysis in order to increase in size. During moulting arthropods are particularly vulner able to predation.

Question

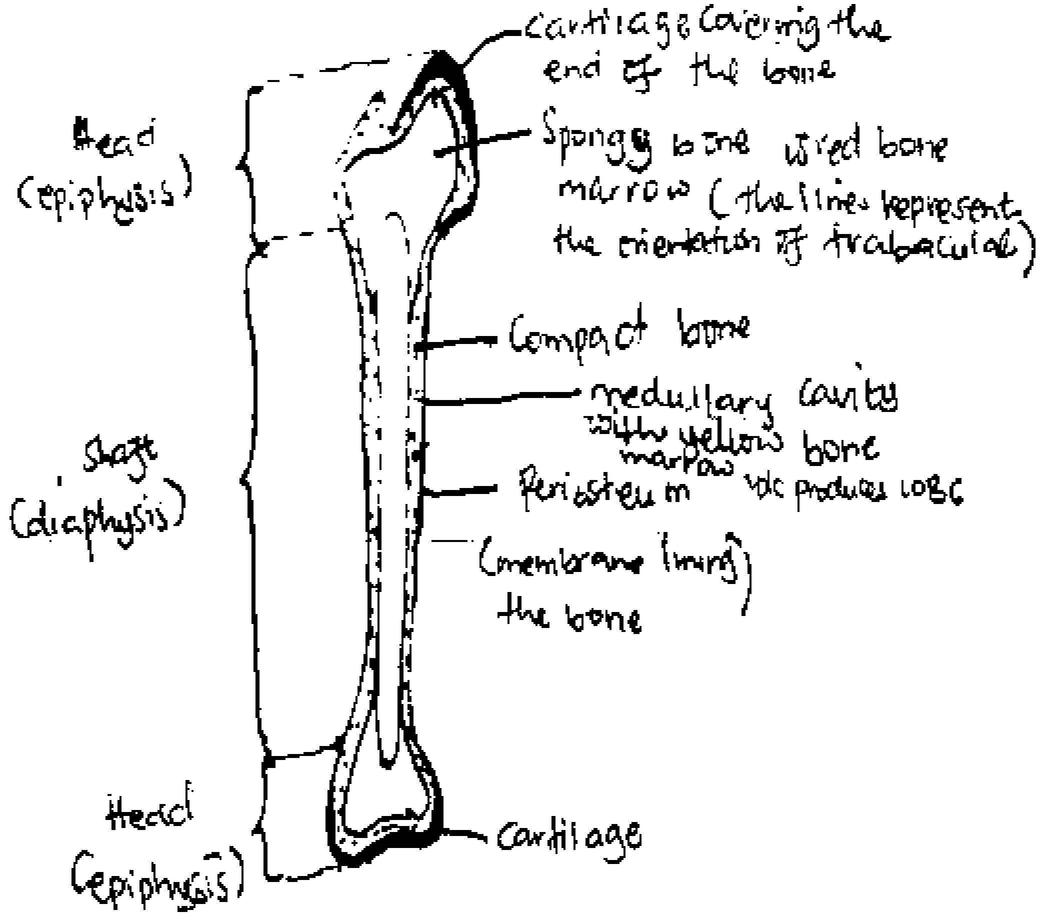
1. The cytoskeletotonics a dynamic structure, continually changing its shape. Which one of the 3 main types of animal skeleton shares this property? Hydro skeleton.
2. List 3 functions of the exoskeleton of an arthropod.

- Prevention of water loss
- Provides mechanical support
- Protects soft tissues against mechanical damage
- Acts as an attachment point for muscles and a system of levers for locomotion.

3. Exoskeletons are an efficient means of supporting small animals. Explain briefly why an animal, the size of a dog would require a disproportionally large and unwidely exoskeleton to support its body mass.

Ans: Compared with a small animal, a dog has a low surface area to mass ratio, exoskeleton are surface features, therefore the dog would require every thick exoskeleton to support its relatively high body mass.

Structure of long bone: (Vertical section through the femur)



Spongy bone

Called so beoit consists of hardened bars called trab cube between which are large spaces filled with red bone marrow, a soft + tissue made by cells that also form blood cells and lymph cells.

Structure of compact bone

Compact bone is made of structural units called Harversion systems. Each system forms an irregular cylinder with layers of matrix called lamellae. Dotted throughout the matrix are bone cells in their lacunae. Non dividing and inactive bones cells called osteocytes; dividing bone cells that can lay down a new matrix are called osteoblasts. And bone cells that can reduce the size of bones by reabsorbing the matric are called osteoclasts.

Osteocytes are connected to each other and to a central canal (the Harvesion canal by radicating canaliculi (microscopic channels) filled with tissue fluid.

The canaliculu transport material to the from blood vessels in the Harvesian canal, which also contains nerves, blood vessels, and hymph vessels. The nerves and vessels are carried down the bone surface to the Harversian systems by Volkmann canals.

Questions

1. List the main fraction of a vertebrate skeleton
- Maintains body shape – support soft tissue
- Act as a system of levers for locomotion
- Produce blood cells – store minerals
2. Name 2 features which distinguish cartilage from bone
3. List 3 structures contained within attaversian canal

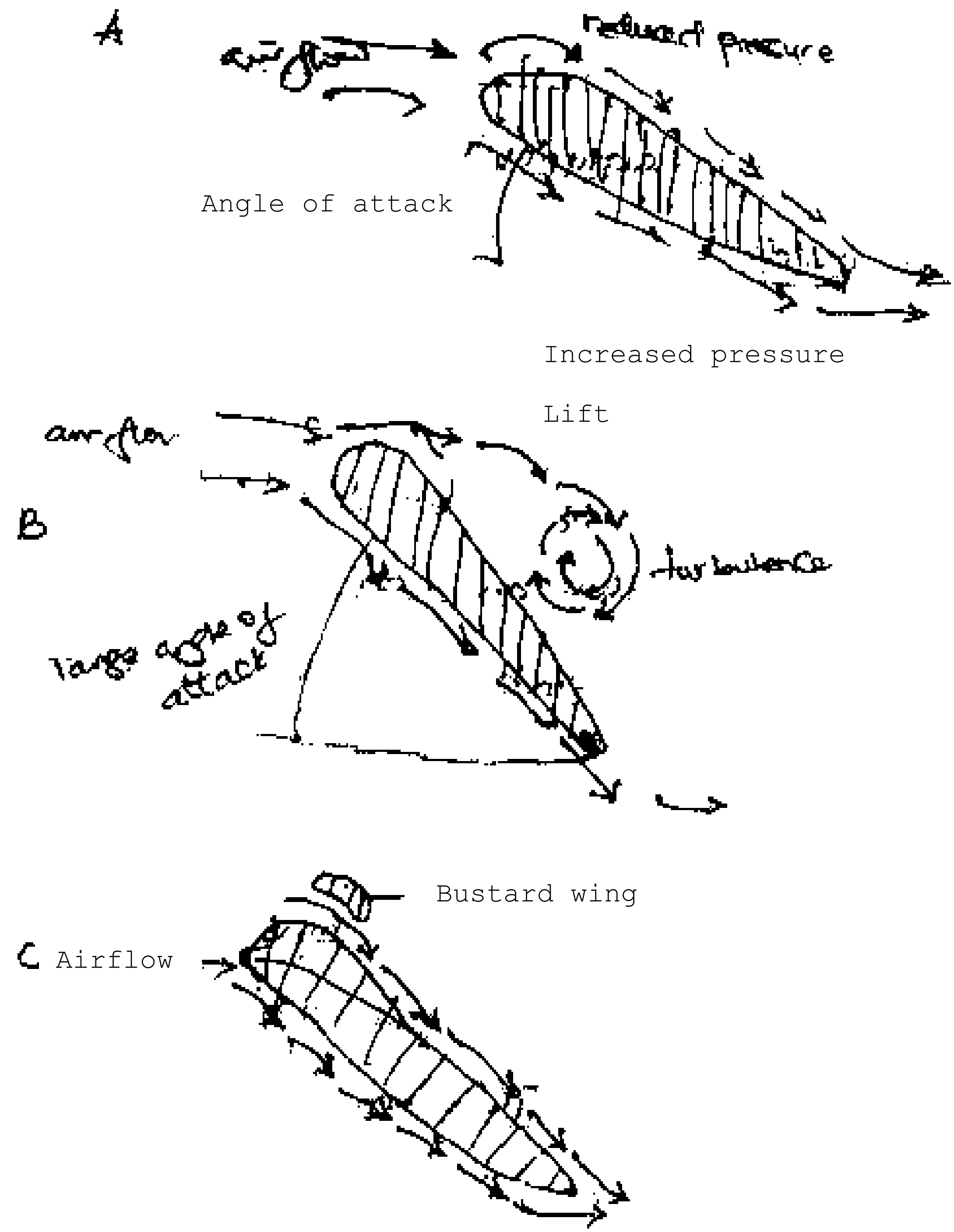
   Nerves, blood vessels, lymph vessels
4. What is the total number of bones in a typical human vertebral column?

   33 (7 cervical, 12 thoracic, 5 lumbar, 5 sacral, 4 coccygeal)

THE WING OF AN ACTOFOIL

Reduced aetofoil

Reduced pressure



Mozilla Firefox.lnk Slow twitch and fast twitch muscle fibres.

There are two types of muscles

(1) **Fast twitch muscles:-** these are usually while in coulour. They contrast rapidly and are switched for quick burst of activity. They produce ATp quickly and an aerobically from energy reserves known as creatinine phosphate and from lactate fermentation. Canaerobic breakdown of glucose. They have relatively low myoglobin content and a small number of mitochondria. However, they are rich in enzymes for anaerobic respiration. The lactate from this makes them fatigue quickly.

(2) Slow twitch muscles (red muscles) or ionic muscles.

They contract slowly and are adapted for steady action over long periods of time i.e sustained contraction. They can use the stored glycogen, as well as fat stores of the body. They have minerous intochondria, a rich blood supply and abundant myoglobin (O_2 store).

They cannot generate ATP at a very high rate and are not very powerful.

They are important in maintaining posture (remain in a state of sustained contraction) titanic response)

Properties of tonic muscle and twitch muscle

Tonic muscle fibres (slow)	**Twitch muscle fibres (fast twitch)**
1. Sustained contraction for maintaining posture	1. Fast contraction e.g for locomotion
2. Many mictochondria	2. Fewer mitochondria
3. Red due to myoglobin	3. White (with little or no myoglobin)
4. Many motor end plates along fibres	4. One or few motor end plates
5. Obtain ATP from aerobic respiration	5. Obtain ATP from anaerobic respiration once O_2

6. Require frequent stimulation to contract 7. Slow muscular contraction of long duration	is used up => O_2 debt can build up 6. Membrane elastically excitable 7. Fast muscular contraction but fatigues quickly

QUESTION

(a) How is flight achieved in birds?

By action of antagonistic muscles. Pectoralis major and minor attached to the keel of the sternum. In downstrol P. major contract while P. minor relaxes.

The long pulled down. The wings have an aerofoil shaped so continuous pulling of wings. Cresterregion increasing pressure below and decrease pressure above.

This force provides uplift.

During upstroke P. major relaxes collide.

Wing is raised upward. Here, the quick feathers of the wing tend to open up in order to provide minimum resistance. And the wing is folded with the leading edge upwards and the trailing edge downwards to reduce resistance.

During fight 3 forces over counter lifting force due to increased air pressure above drag force and gravity due to increased pressure below the wings. The resultant of the 2 forces provide uplift.

Wings have been backward and downwards.

(b) Describe other types of movement without the use of muscles

i.e Amoeboid

ciliary

flagelia, englenoid