SUPPORT AND LOCOMOTION EXPECTED RESPONSES

1. (a) Explain the need for support in plants (09 marks)

- Hold leaves in position; to receive sunlight; for photosynthesis;
- Hold flowers in position; to receive pollinating agents; for reproduction;
- Hold fruits in position; for dispersal; to colonise new areas; (1 mark @)

(b) Describe how support in plants is achieved (20 marks)

- Use of parenchyma cells; take up water by osmosis; become turgid; and rigid; in non-woody plants and plant parts;
- Using collenchyma tissues; with cell walls thickened; with cellulose; in plant parts where secondary thickening does not occur;
- Use of sclerenchyma tissues; whose walls are thickened; with lignin;, interlocking end walls;, and occur in bundles; increasing their strength;
- Use of xylem tissues; in which cell walls are strengthened; with deposition of lignin; separate rods run through the stem; and it is central in the root;

(1 mark @)

2. (a) Describe the structure of the following plant tissues

(i) Xylem (06 marks)

- Has vessel elements; which are open ended; cylindrical;
- Tracheids; which are narrower; elongated; perforated; tapering end walls;.
- The cells are connected end to end; to form continuous tubes;
- Other cells include fibres; and parenchyma; (½ mark @)

(ii) Sclerenchyma (06 marks)

- Occurs in two forms fibres; and sclereids;
- Both cell types are polygonal in cross section; have thickened; lignified cell walls; with simple pits; empty lumens; occur singly; or in bundles;
- Fibres are elongated; with tapering; interlocking end walls;
- Sclereids are spherical; (½ mark @)

(iii) Collenchyma (04 marks)

- Living cells; with large vacuole in centre; and prominent nucleus;
- Polygonal cells in cross section; cell walls thickened; with cellulose; at the corners; no intercellular spaces; (½ mark @)

(b) Explain the distribution of the following plant tissues

(i) Xylem (08 marks)

- Arranged in the centre in roots; where they counteract the pull of shoots; as they are blown from side to side;
- Are in bundles; around the periphery of stems; where they resist the compression; and extension; as stems are bent; (1 mark @)

(ii) Sclerenchyma (08 marks)

- Fibres occur in bundles; around the vascular bundles; in stems and leaf stalks; where they add to the rigidity of the xylem;
- Sclereids occur singly; in the epicarp; and mesocarp of fruits; where their rigidity confers firmness; and protection to the organ; (1 mark @)

(iii) Collenchyma (07 marks)

- In stems and petioles; towards the periphery of the organ; just below the epidermis;
- In the midrib of dicotyledonous plant leaves; it's a solid mass around the vascular bundles; where they resist compression; and tension; (1 mark @)

3. (a) Describe how support is achieved in the following groups of organisms

(i) Cartilaginous fish (10 marks)

- Support from swimming; caudal fin plunges downwards at the end of each sweep; This generates an up thrust which supports the posterior part;
- Anterior part is supported; by the up thrust generated when the pectoral fins thrust against the surrounding water;
- Pectoral fins are held with leading edge raised above the trailing edge; water passing over it flows faster than that below it; pressure above the fin is lesser than that below it; this creates a life force;
- Some have bodies containing oils; which reduces on the density of the body; (1 mark @)

(ii) Bony fish (06 marks)

- Use air filled swim bladders; open; or closed; that can be filled with air; to change their density; and stay at a given depth/ have neutral buoyance;. (1 mark @)

(iii) Mammals (09 marks)

- Supported off the ground by limbs; made of rigid bones; with high tensile; and compressional strength;
- Vertebral column; supports the body weight in the abdominal region;
- Tails; provide additional support for tetrapods; when they stand on two legs;

4. (a) Describe the structure of the hydrostatic skeleton. (07 marks)

- Comprises of a fluid-filled cavity; called coelom; divided into compartments; by septum; surrounded by layers of circular; and longitudinal muscles; which are antagonistic; (1 mark @)

(b) Explain the advantages and disadvantages associated with the hydrostatic skeleton (13 marks)

Advantages

- Segmented; which allows swift locomotion;

- Thin flexible cuticle**;** does not limit growth of an organism**;**
- Offers some protection to the organisms**;**

Disadvantages

- Offers less protection to the organism**;**
- Has limited area for muscle attachment**;**
- Cannot support large body weight**;**
- Thin cuticle limits the organisms to damp areas**;** to prevent desiccation**;** Thick cuticle would prevent efficient gaseous exchange flexible**;**
- Little support causes the organism to crawl on ground**;** which slows down locomotion**;**
- Does not contribute to the formation of locomotory structures**;** (1 mark @)

5. (a) Describe how locomotion occurs in earthworms (11 marks)

- Extension of the anterior end occurs when chaetae retract in the body**;** circular muscles contract**;** exerting a pressure on the coelomic fluid**;** longitudinal muscles relax**;** body part narrows and extends forward**;**
- In this extended part, chaetae extend**;** the longitudinal muscles contract**;** circular muscles relax**;** body shortens and bulges here**;**
- The rear end is brought forward by contraction of the longitudinal muscles**;** and relaxation of circular muscles**;** (1 mark @)

(b) Explain how the hydrostatic skeleton in earthworms is suited for its functions (10 marks)

- Longitudinal and circular muscles**;** operate antagonistically to move different body segments**;**
- Segmentation**;** increases flexibility during locomotion**;**
- Coelomic fluid is incompressible**;** transmits the pressure exerted to it by the muscles effectively**;**
- Septa separate segments of the body**;** prevent loss off the fluid**;**
- Chaetae**;** for anchorage**;** (1 mark @)

6. (a) How is a bony fish able to propel itself forward (10 marks)

- Fish swims by undulatory/ wavelike movements**;** caused by the alternating contraction**;** and relaxation**;** of antagonistic muscles/myotomes on either side of the vertebral column**;**
- Tail thrusts against water**;** and the reaction of water**;** on the body provides the forward thrust**;** which moves the fish forward**;** and lateral drag**;** which is cancelled out**;** by the general massiveness of the head**;**
- Speed of movement increases with speed of action**;** surface area**;** angle with which the body/tail is held with respect to direction of motion**;**. (1 mark @)

(b) Explain why terrestrial organisms need more supportive structures than aquatic organisms. (05 marks)

- Water is more denser than air**;** provides more support to the organisms than air**;** hence less supportive tissues are developed**;** Terrestrial organisms need

more supportive tissues to keep their bodies off the ground in a medium that provides little support;. (1 mark @)

(c) What instabilities does a fish experience during swimming and how are they counteracted? (06 marks)

Instability	Counteraction
• Pitching; tendency of the nose to plunge vertically downwards;	• Horizontally; held pectoral and pelvic (paired) fins;
• Yawing; lateral deflection of the anterior part of the body due to propulsive action of the tail;	• General massiveness of the head; and vertical/ median/ dorsal and ventral fins;
• Rolling; rotation of the body about its longitudinal axis;	• Paired and unpaired fins; acting as stabilisers; (½ mark @)

7. (a) Explain how the swim bladder has contributed to the efficient swimming in bony fish compare to cartilaginous fish. (10 marks)

- Bladder provides neutral buoyance in bony fish; while fins do so in cartilaginous fish;
- Without the need to provide support, pectoral and pelvic fins are reduced in size; pressed against the body during locomotion; which reduces drag;
- Pectoral fins can also be operated independently to act as pivots for the fish to swim; or brakes for it to stop;
- Tail is symmetrical; and energy is used in only in providing forwards force; while in cartilaginous fish some of it goes to support; (1 mark @)

(b) How is a fish suited for efficient swimming (10 marks)

- Streamlined body; through tapering body; scales overlap facing backwards; to reduce drag;
- Layer of mucus; smoothens body surface;
- Tail/caudal fin; moves side to side to produce forward thrust;
- Paired and unpaired fins; counteract instabilities; such as yawing;
- Lateral line; for sensitivity during locomotion;
- Swim bladder in bony fish; provides neutral buoyance;
- Antagonistic muscles on each side of the vertebral column; to move tail;
- Heterocercal tail in cartilaginous fish; provides more support;
- Vertebral column is jointed; for flexibility; (½ mark @)

8. (a) Describe the structure of the exoskeleton in insects (08 marks)

- It is a hollow skeleton covering organs; composed of mainly chitin; which is tough; light; and flexible; it is strengthened by tanned proteins; unmodified at the joints; and covered with a layer of wax; (1 mark @)

(b) Explain the advantages and disadvantages of an exoskeleton (12 marks)
Advantages

- Forms limbs and wings for locomotion;
- Offers more protection; due to its hardness;
- Camouflage; due to dull colour;

- Forms other body structures like mouth parts**;**
- Prevents desiccation**;** due to presence of waxy cuticle**;**
- Offers sufficient support in small organisms**;**

Disadvantages

- Its hardness/rigidity**;** does not allow continuous growth**;** moulting leaves organisms vulnerable to predators**;** and water loss**;**
- Limits the size and insect can attain**;** because the skeleton is only efficient in small organisms**;** In large organism, the skeleton would be too heavy to allow locomotion**;** (½ mark @)

9. (a) Distinguish between synchronous and asynchronous flight muscles in insects (04 marks)

- Synchronous muscle contracts once for every nerve impulse reaching it**;** while asynchronous muscles contract more than once for every nerve impulse reaching it**;**
- Synchronous muscles operate wings beating at lower frequency**;** while Asynchronous muscles operate wings beating at a higher frequency**;**

(1 mark @)

(b) How is flight in insects brought about by

(i) Direct flight muscles (08 marks)

- Muscles attached to the base of the wing**;** elevator and depressor muscles**;**

Upstroke;

- Elevator muscle contracts**;** depressor muscle relaxes**;** wings pulled upwards**;**

Down stroke;

- Depressor muscle contracts**;** elevator muscle relaxes**;** wings pulled downwards**;** thrust against air**;** air reaction on the wings**;** provides lift force**;** and forward force**;** (½ mark @)

(ii) Indirect flight muscles (09 marks)

- Muscles not attached directly to the wing**;** dorso-ventral and longitudinal muscles**;** wings attached to the pleuron**;** and tergum**;**

Upstroke;

- Dorso-ventral muscles contract**;** longitudinal muscles relax**;** the tergal wing attachment is pulled downwards relative to the pleural attachment**;** wing is raised/moves upwards**;**

Down stroke;

- Longitudinal muscles contract**;** dorso-ventral muscles relax**;** thorax tergum becomes dome-shaped**;** pulling the tergal wing attachment upwards relative to the pleural attachment**;** wing is lowered**;** reaction of air on the wing**;** provides the lift force**;** and forward force**;** (½ mark @)

10. (a) How is the exoskeleton suited for its function in arthropods (08 marks)

- Hollow**;** to reduce weight of the animal**;** which allows swift locomotion**;** by walking**;** and flying**;**
- Waxy cuticle**;** prevents excessive water loss**;**
- Unmodified at joints**;** flexibility at joints allows movement**;**

- Hardened; by tanned proteins and calcium carbonate; to provide protection; and rigidity; for support;
- Dull coloured; for camouflage e.g. in cockroaches; (½ mark @)

(b) Compare flight in insects and birds (12 marks)

Similarities

Both

- Use wing;
- Wings attached to the skeleton;
- Wings are attached to the thoracic region;
- Have muscles that move wings;
- Streamlined bodies for swift flight;
- Can fly actively and passively; (any 4; 1 mark @)

Differences

Flight in insects	Flight in birds
• Use membranous wings	• Use feathery wings
• Thin wings	• Thick wings
• Faster wing beat rate	• Slower wing beat rate
• Wings made of chitin	• Wings made of bones, cartilage collagen and feathers
• Use both direct and indirect flight muscles	• Uses only direct flight muscles attached to the wings
• No bastard wing to prevent turbulence/some use haltares for balance	• Has bastard wing which prevent turbulence
• Muscles lack myoglobin	• Muscles have myoglobin
• Oxygen is delivered by tracheal system	• Oxygen is delivered by RBCs in blood circulatory system
• Wings attached to exoskeleton	• Wings attached to endoskeleton

(any 8; 1 mark @)

11. (a) Describe how active flight occurs in birds (10 marks)

- Occurs by direct flight muscles; pectoralis minor; and pectoralis mojor; acting of the wings to cause flapping;
- **Upstroke;**
- Pectoralis minor contracts; pectoralis major relaxes; humerus bones pulled upwards; wings are raised; while bent;
- **Down stroke;**
- Pectoralis major contracts; pectoralis minor relaxes; humerus bones pulled downwards; wings moved downwards; and backwards; thrusting against air; whose reaction; provides lift; and forwards force; (½ mark @)

(b) Explain how the bird's wing acts an aerofoil. (10 marks)

- Bird's wing is made of quill feathers; arranged such that the upper surface is convex; while the lower surface is concave;
- The wing is moved through air such that the leading edge is raised above its trailing edge;

- Air flowing over the upper surface meets less resistance**;** than air flowing over the lower surface**;.** Hence air flowing over the wing moves with greater velocity than that flowing below it**;**
- Air pressure above the wing decreases below that under the wing**;**
- The pressure difference generates the lift force**;**

12. (a) What is gliding in birds (01 marks)

- Gradual loss of height in birds without flapping/ thrust**;**

(b) Explain the factors that determine the speed of glide (06 marks)

- Fast gliders**;** have small body size**;** long**;** and narrow wings**;**
- Slow gliders**;** are heavy birds**;** with short**;** and broad wings**;**

(c) How is a bird adapted for flight? (12 marks)

- Well-developed pectoral girdles**;** provides firm base for the wings**;**
- Sizeable keeled sternum**;** for attachment of flight muscles**;**
- Fusion of forelimb bones**;** forming a large wingspan**;**
- Rigid skeleton in some places of vertebral and pelvic girdle fused**;** transmits the force of the wings more efficiently and provide better lift**;**
- Hind limbs are lengthened**;** easy take off**;**
- Streamlined body**;** through compact skull**;** pointed bill**;** feathers placed over facing backwards**;** short tail**;** legs retracted/ tucked up**;** lack of external ears**;** to reduce air resistance**;**
- Hollow spongy bones**;** toothless jaws**;** and small sex organs**;** reduce weight**;**
- High constant body temperature for high metabolic rate**;** to produce enough energy flight**;** feathers provides good insulation**;** ensures efficient muscle contraction**;**
- Good visual acuity**;** to judge distances accurately
- Nictating membrane**;** protects the eye during flight**;**
- Bustard wing**;** prevents turbulence**;**
- Powerful flight muscles**;** to move the wings**;** (any 24; ½ mark @)

13. (a) Explain advantages and disadvantages of an endoskeleton. (09 marks)

Advantages

- Does not restrict growth**;**
- Allows faster locomotion since body is supported off the ground**;**
- Can support larger organisms**;**
- Provides more area for muscle attachment**;**
- Offers maximum protection to delicate body parts because of its rigidity**;**
- Offers other physiological roles like storage of calcium and phosphate ions and production of red blood cells**;**

Disadvantages

- Rigidity offers limited flexibility**;**
- Does not protect organisms from water loss**;**
- Some parts of the body are protected**;** (1 mark @)

(b) Explain how the structure of the mammalian skeleton is suited for locomotion (12 marks)

- Rigid**;** to resist tension and compression forces developed during locomotion**;**
- Bones are hollow**;** to reduce weight without reducing mechanical efficiency**;**
- Spongy bones at the head of the long bones**;** maintains bone rigidity with minimum weight**;**
- Cartilage**;** cushions the articulating surfaces of bones and reduces friction**;**
- Elastic ligaments connect bone to bone**;** which allow movement**;**
- Tough, inelastic tendons connect bones to muscles**;** which transfer the pull of muscles directly the bones**;**
- Jointed**;** for flexibility**;**
- Has muscles**;** which move the bones**;** (any 12; 1 mark @)

14. (a) Describe the structure of the different vertebrae in mammals (10 marks)

Cervical (atlas)	Thoracic	Lumbar
• Small centrum	• Long, backwardly pointing neural spine	• Short, wide centrum
• Short neural spine	• Short transverse processes	• Wide neural arch
• Vertebrarterial canal	• Transverse processes have small tubercular facets	• Long, wide transverse processes projecting downwards
• Wide, flat transverse processes	• Small centrum	• Extra processes like the mate-, ana- and hypapophyses
• Large neural canal	• Demi-facets on each side of the centrum	• Short, broad neural spine
• Small neural arch	• Small neural canal	• Wide neural canal

(b) Relate the structure of the vertebral column to its function (10 marks)

- Vertebral bones connected by ligaments which prevent dislocation**;** but permit movement so that the vertebral column is flexible**;**
- Flexibility allows locomotion by arching the back in many organisms
- Bones have longs processes**;** for muscle attachment**;**
- Bones are rigid**;** to withstand stress**;**
- Neural canal for passage and protection of spinal card**;**
- Intervertebral discs hold adjacent vertebral bones together**;**
- Articulating facets of the vertebral bones are smooth**;** to prevent wearing away**;** (any 10; 1 mark @)

15. (a) Describe how the structure of the skeletal muscle relates to its function. (12 marks)

- Muscle fibres are elongated**;** to which can contract and relax**;**
- Well supplied with blood vessels**;** to bring it metabolites and carry away waste products**;**
- Myoglobin**;** to store oxygen**;**
- Mitochondria**;** to provide energy**;**

- Well supplied with nerves**;** for proper coordination of muscles**;**
- Sarcoplasmic reticulum**;** stored calcium which activates muscle contraction**;**
- Fibres are parallel**;** to transmit the contraction in the same direction
- Motor end plate**;** for innervation and excitation of the muscles**;**

(any 24; ½ marks @)

(b) Describe the different energy sources for an active muscle (08 marks)

- Aerobic respiration glucose, and fats**;** using oxygen from haemoglobin and myoglobin to produce ATP during the first few minutes of the exercise**;**
- Generation of ATP from the phosphocreatine system when ATP generated from aerobic respiration is used up.
- Anaerobic respiration of glucose during intense activity**;** occurs fast enough to generate required energy; lactate builds up in muscles to contribute muscle cramp

16. (a) Describe the fine structure of a striated muscle (15 marks)

- Contains numerous parallel muscle fibres**;** enclosed in a connective tissue**;**
- Each muscle fibre is long**;**, cylindrical**;** with many nuclei**;** enclosed by a membrane called the sarcolemma**;**.
- Within the fibre are protein myofibrils, thick myosin**;** and thin actin filaments**;**
- Fibre has light and dark bands**;** only actin filaments occur in the light band**;**, myosin and actin filaments occur in the dark band**;**
- In the middle of the light band is the Z-line**;** while in the middle of the dark band is the M-line**;**
- The distance between two successive Z-lines is the sarcomere**;**.
- In the middle of the dark band is a region occupied only by the myosin filaments called the H-zone**;**.

(b) What changes occur in the sarcomere when the muscle contracts (04 marks)

- Sarcomere length decreases
- H-zone reduces/ disappears
- Light band decreases
- Dark band remains the same

17. (a) Describe the events that occur during muscle contraction (12 marks)

Activation/excitation

- Arrival of an impulse at the neuromuscular junction via the motor neuron**;** acetyl choline is released into the cleft**;**
- Acetyl choline diffuses across the cleft and attaches to the post synaptic membrane/sarcolemma**;** depolarising the of the motor endplate**;**
- The depolarisation is propagated through the transverse tubules as an action potential**;**
- This causes the sarcoplasmic reticulum to release calcium ions**;**

Contraction

- Calcium ions bind to troponin**;** displacing tropomyosin from the myosin binding site on actin**;**
- The myosin heads now become attached to the actin filament (actin binds to myosin)**;** and changes position so that the actin filament slides past the myosin filaments in a ratchet mechanism**;**
- ATP attaches to myosin head**;** causing it to detach from the actin filament**;**
- The myosin head has ATPase activity which catalyses the hydrolysis of ATP to provide energy for activation of the myosin head**;** and the process is repeated

Relaxation

- When excitation of the muscle by nerve impulses stops, calcium ions are actively pumped back into the sarcoplasmic reticulum**;**
- Troponin returns to its original site allowing troponin to block actin filament**;**
- The muscle relaxes

(b) Distinguish between tonic and twitch muscles (08 marks)

Tonic/slow muscles	Twitch/fast muscles
• Many mitochondria	• Fewer mitochondria
• Poorly developed sarcoplasmic reticulum	• Well-developed sarcoplasmic reticulum
• Much myoglobin and cytochrome pigments	• Little myoglobin and cytochrome pigments
• Low in glycogen content	• High glycogen content
• Deep lying muscles	• Close to the surface of limbs
• Associated with small nerves	• Associated with large nerves
• Many motor end-plates per fibre	• One or two end-plates per fibre
• Membrane is electrically inexcitable	• Membrane is electrically excitable
• Slow graded muscular contraction	• Faster contraction
• Fatigue occurs very slowly	• Fatigue occurs quickly
• ATP from aerobic respiration	• ATP from anaerobic respiration
• Oxygen debt slowly builds up	• Oxygen debt quickly builds up
• Heat is transported away from the muscle as soon as it is produced	• Heat is not immediately removed by the circulatory system
• Used in maintenance of posture	• Used during locomotion

(any8; 1 mark @)

18. (a) Describe the properties of a skeletal muscle (12 marks)

- Excitability**;** when stimulated, a skeletal muscle becomes depolarised**;**
- Contractibility**;** muscles when stimulated respond by shortening**;**
- Extensibility**;** under tension, skeletal muscles can stretch**;**
- Elasticity**;** the muscle can return to its original/ normal resting length once it has been stretched
- Summation of stimuli**;** reaching it quick succession to give a larger and longer contraction**;**
- Tetanus**;** can remain in s state of contraction if stimulated at high frequencies**;**

- Obeys the all-or-nothing law**;** only stimulations of a high enough. Above the threshold intensity can cause a contraction**;**
- Refractory period**;** a skeletal muscle undergoes a brief inexcitability after a contraction**;**
- Fatigue**;** muscle response declines and soon disappears when the stimulation is maintained for a long time (1½ @ point; 12 marks)

(b) Explain the role of the following in muscle contraction

(i) ATP (06 marks)

- Attachment of the ATP molecule on the myosin head**;** allows the myosin filament to detach from the actin filament**;**
- Hydrolysis of ATP**;** provides energy for activation the myosin head**;**
- Used in the active pumping of calcium ions**;** back into the sarcoplasmic reticulum for the muscle to relax**;** (1 mark @)

(ii) Ca^{2+} **(04 marks)**

- Released from the sarcoplasmic reticulum**;** upon the arrival of an impulse**;** and attach to troponin**;** which displaces tropomyosin from the myosin binding site on actin**;** (1 mark @)

19. (a) What are the effects of exercise on the muscles and muscle performance? (12 marks)

- Number and size of mitochondria in the muscle increases**;**
- Processes occurring the mitochondria occur more rapidly**;**
- More myoglobin**;** which stores more oxygen**;**
- More glycogen, fat and phosphocreatine are stored**;**
- Lower rate of lactic acid accumulation**;** due to presence of more stored oxygen**;**
- Muscle strength increases**;** as it adapts to the load/resistance it's working against**;**
- Increased number of blood vessels supplying blood to the muscles**;** providing more oxygen and glucose to the muscles**;** while removing waste products rapidly**;**
- Coordination between antagonistic muscles improves**;** (1 mark @)

(b) Explain why splinters generally run on their toes (04 marks)

- It increases the effective length of the limb**;** longer strides are taken**;** propelling the body over a greater distance**;** sprinter moves forwards at a faster pace**;** (1 mark @)

(c) Give problems faced by organisms during locomotion on land (04 marks)

- Less support provided by air due to its low density**;**
- The pull of gravity**;**
- Supporting the weight of the body off the ground**;**
- Air resistance**;** (1 mark @)

20. (a) Give the three classes of muscular tissue (03 marks)

- Cardiac muscle**;**
- Involuntary/ smooth/ unstriated/ muscle**;**
- Voluntary/ striated/ striped/ skeletal muscle**;** (1 mark @)

(b) Outline the distinguishing features of each type of muscular tissue. (17 marks)

Distinguishing features of the cardiac muscle

- Composed of muscle fibres with one or two nuclei
- Each muscle fibre contains numerous myofibrils
- It is striped
- Intercalated discs between individual muscle cells
- Has branching fibres that connect different muscle fibres
- Contracts more slowly
- Does not fatigue easily
- It is myogenic
- Occurs only in the heart (any five; 1 mark @)

Distinguishing features of smooth muscles

- Has short, spindle shaped cells
- Not striped
- Found in internal body organs,
- Concerned with movement of materials through the organs
- Controlled by autonomic nervous system
- Each muscle cell has one nucleus
- Not under conscious control of the brain
- Contracts slowly
- Does not fatigue
- Have low energy requirement (any six; 1 mark @)

Distinguishing features of skeletal muscles

- Has long, cylindrical muscle fibres
- Striated/ striped
- Attached to skeleton/ bones
- Used in locomotion / movement of bones
- Regulated by somatic nervous system
- Under conscious control of the brain
- Faster contractions
- Fatigues easily
- Each muscle fibre has many nuclei
- Has a high energy requirement (any six; 1 mark @)

21. (a) In mammals, there is a flexible connection between pectoral girdle and the vertebral column. Explain the significance of this arrangement. (07 marks)

- Allows free movement of the rib cage**;** which is important during breathing**;**
- Animal can withstand shock sustained by forelimbs**;** when the organism lands at the end of a jump**;**
- Forelimbs remain relatively free**;** and can have wide range of movement**;** to carry out other activities such as climbing**;** (1 mark @)

(b) What is muscle fatigue?

- This is the inability of a skeletal muscle to contract**;** when given sufficient stimulation**;** (02 marks)

(c) Explain why muscle fatigue occurs in skeletal muscles and not in cardiac muscles. (12 marks)

- The skeletal muscles have shorter absolute refractory periods than cardiac muscles**;**
- Longer refractory period in cardiac muscles allows it recover fully before it can respond to another stimulus**;** During this time, the neurotransmitter can be resynthesized**;** to allow passage of other impulses**;** complete oxidation of metabolites occurs**;** which prevents accumulation of lactic acid**;** that contribute to muscle fatigue**;**.
- In skeletal muscles there are shorter refectory periods, rapid stimulation causes faster exhaustion of the neurotransmitter**;** at the neuromuscular junction**;** so that subsequent impulses cannot be transmitted**;**. In addition, rapid stimulation causes tetanus**;** anaerobic respiration occurs to supply the required energy**;** lactic acid accumulates in the muscles which contributes to fatigue**;**. (1 mark @)

22. Describe the structural adaptations of vascular tissues for support. (14 marks)

- Xylem parenchyma**;** has polygonal cells**;** that form medullary rays for support**;**
- Parenchyma tissue has flexible membrane**;** that allow the cells to expand and become turgid**;** with cells closely packed**;** offering hydrostatic support**;**
- Collenchyma tissue**;** has polygonal cells**;** with thick cellulose cell walls**;** to offer tensile strength**;** and compressional support**;** for extra support
- Sclereids are form of sclerenchyma**;** which are lignified**;** spherical**;** arranged in groups**;** to offer firmness**;**
- Xylem comprises of tracheids**;** and vessel elements**;** that are lignified to offer strength**;**
- Tracheids have tapering ends**;** that interlock with neighbouring tracheids to increase support**;**
- Mature xylem has annular**;** spiral**;** or reticulate lignification for support**;**
- Xylem fibres are long**;** lignified**;** and occur in bundles to increase their tensile strength**;** (any 28 ½ mark @)