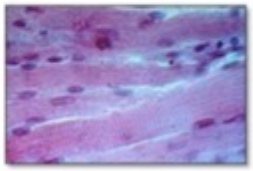
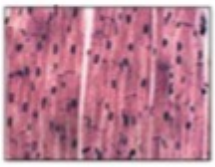
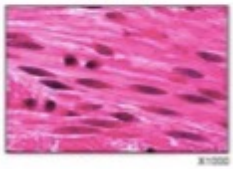
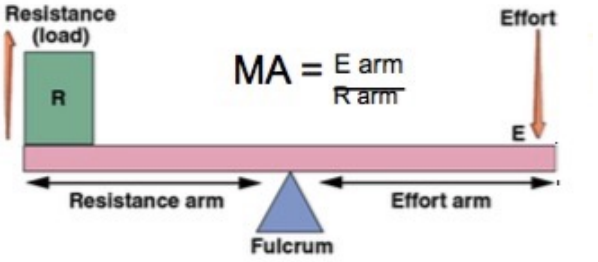
Comparison of vertebrate muscle types

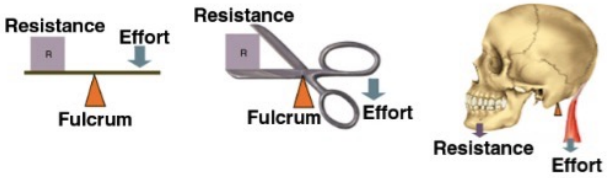
	Skeletal	Cardiac	Smooth
Location	skeleton	walls of heart	walls of hollow viscera
Function	movement, posture	pumping of heart	movement, peristalsis
Histology	striated many nuclei transverse tubules	striated uninuclear transverse tubules intercalated discs	not striated uninuclear no transverse tubules
Control	voluntary	involuntary	involuntary
Contraction	contracts, relaxes & tires quickly	contracts as unit self-exciting, rhythmic	contracts & relaxes slowly, self-exciting, rhythmic
			

mechanical action of skeletal muscles
- power effected by
  - type of fibre (fast or slow)
  - muscle cross section (thinner less force)
  - leverage (how muscle attaches to bone thats doing movement
- power = force x speed

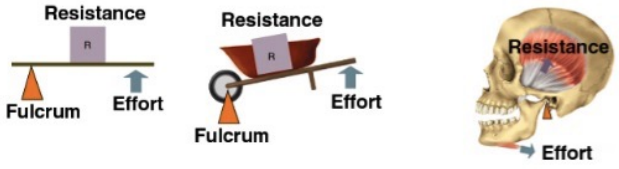
components of a lever
- rigid objects that rotates around fulcrum - seesaw
- rotation occurs when effort overcomes resistance
- mechanical advantage (MA) determined by relative position of fulcrum
- low MA = low force but high speed eg. bicep
- high MA = high force but low speed eg. jaw
- same lever can have different MAs eg. leg



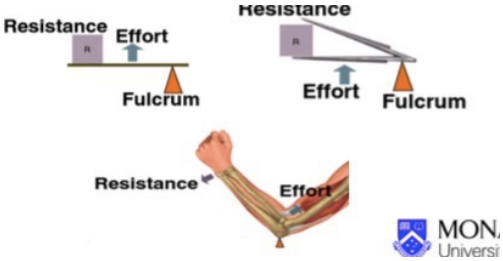
1st class lever
- fulcrum in middle
- e.g. alantooccuptal joint maintains head posture



2ns class
- wheelbarrow
- resistance between fulcrum and effort
- eg. temporalis msucle between jaw joint and pull of diagnostic muscle on chin



3rd class lever
- effort in middle between resistance and fulcrum
  - most joints of body
- eg. effort applied by biceps applied to forearm between elbow and wright of forearm



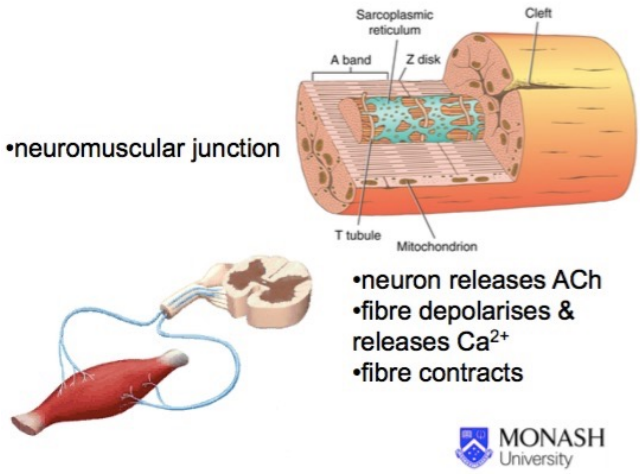
skeletal muscle
- attached to bone by tendon
- composed of fibres (long multinuclear cells)
- myofibril subunits composed of sarcomeres
- sarcomere functional unit in geometric pattern of actin and myosin filaments
- muscle contracts when filaments slide towards each other

sliding filament theory
- sarcomere uses energy to slide filaments
- energy dependent contraction
- passive relaxation

muscle fatigue
- ATP required for actin myosin cross linking
- cellular respiration provides energy
- anaerobic conditions with sustained use
- lactic acid by-product
- toxicity of lactic acid reduces muscle force

control of muscle contraction
- nerve stimulation
- skeletal muscles innervate by motor neurons from spinal cord
- motor unit is neuron and all fibres it innervates (few to 2000)
- force correlated with number of motor units activated and muscle tension increases
- precision or speed: all at once or one by one (recruitment)

how neuromuscular junction works
- nerve impulse t muscle fibre
- axon terminals and motor end plate
- 1. impulse comes down
- 2. calcium channels
- 3. synaptic vesicles release acetylcholine
- 4. acetyl goes to receptors - depolarisation of membrane
- sodium and potassium goes through
- acetylcholinesterase takes away acetylcholine



Lecture 4: Feeding I

food sources and feeding

which food gives the most energy
- nectar -> meat -> grass -> soil -> sticks

which is easiest to get
- soil -> grass -> sticks -> meat -> nectar

limited number of food sources
- only a few fundamental ways to obtain food
  - e.g. herbivory carnivore detritivore symbiosis
- diversity of specific ways which animals feed
  - constrained by environment
    - e.g. food in sediment, or catch-fast moving food
  - constrained by body form
    - e.g. exoskeleton in arthropod, echinoderm and mollusk shell

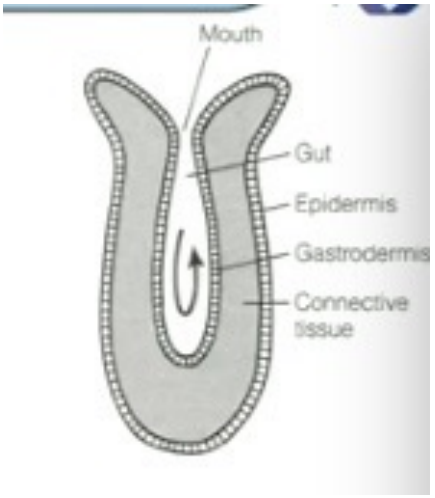
obtaining energy
- autotrophs
  - organisms that synthesis complex molecules from simple inorganic substances
  - energy - light, chemicals (H20, CO2)
  - plants, some protists, some bacteria
- heterotrophs
  - obtain energy by consuming other organisms
  - ingest and digest
  - all animals, fungi most bacteria
- food materials
  - plant, animal, symbiosis
- digestive systems
  - no gut cavity
  - gut cavity
- feeding mode
  - deposit feeding
  - suspension feeding

plants as food
- plants have cell wall - hard to eat
- plants are abundant
- low quality - not accessible energy and lower in proteins,
- low assimilation efficient - hard to get energy out due to cell wall - need to break, break chemical bonds
- requires
  - bite and chew
  - space in stomach and time - lots of food
  - special enzymes - no vertebrae have these

animal food
- high quality - sugars and proteins
- high assimilation efficiency - more 90% energy out
- most animals defend themselves
- requires
  - sophisticated feeding strategies

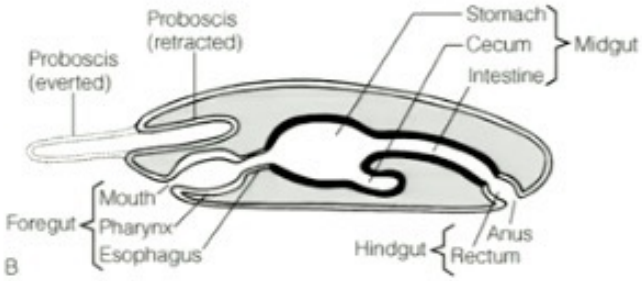
symbiosis
- produce food used by host
- mostly bacteria or protozoa - use chemical reactions host cant do
- host must accomodate the symbiont - coevolution
- e.g. sponges and photosynthetic photosymbionts
  - termites with cellulose digesting microorganisms
  - herbivores mammals and gut flora

food size
- very small food
  - endocytosis followed by intracellular digestion
- larger food
  - digestive system - gut
  - extracellular digestion
  - often partially break down food before swallowing - jaws teeth etc



digestive system
- no gut
  - gut not required if very thin
  - food engulfed by endocytosis
  - e.g. protozoans, sponges
- gut
  - some digestion by enzymes in gut (extracellular)
  - ingest larger food masses

- greatly increase surface area for absorption
- types of gut
  - single opening - 2 way flow - bag
    - no anys
    - e.g. flatworms
  - two openings - one way flow
    - have anus
    - specialisation of gut regions
    - if eat big food need large gut as have to digest - one way



deposited food
- abundant yet dilute in terms of energy and nutrients you can get out of it
- mixed with large volumes of organic matter
- must eat a lot of it - 2-300 x body weight
  - nonselective - eat a lot and everything
  - selective - pick bits of dirt that are useful

food in suspension
- dilute
- small quantities of food
- large volumes of media - inorganic water
- process a lot of water to get enough nutrients
- requires
  - net
  - current or mobility - food to animal or animal to food

evolution of food
- what did first organism eat
  - anaerobic heterotroph - get food, no O_2 used
  - then anaerobic autotrophs - can make their own food - H_2S, no O_2
  - then oxygenic autotrophs - make food using H_2O, produce O_2
  - then aerobic heterotrophs - get food, use O_2

unicellular organisms - heterotrophs
- deposit feeders
- filter feeders
- parasites
- carnivores
- herbivores

form and function

sponges
- filter feeders
- perforated tubes - draw water through holes and water expelled out top osculum
- generated current by choanocytes
- engulf food particles - intracellular digestion
- sort particles by size between 1 and 50 microns
- can also be photosynthetic - symbionts - algae living inside tissue of sponge - provide 40-80% of energy
- carnivorous sponges - spicules act like velcro and eat decomposed animals

jellyfish
- can be carnivores
  - 2 way sac gut - one opening
  - intracellular and extracellular digestion can release enzymes int gut
  - capture prey using nematocysts - harpoons into prey so prey is stuck to them = poisonous
- also algae symbionts
  - zooxanthellae - 90% nutrition - almost all energy from these
  - more algae than cnidarian