Homeostasis

Maintaining Balance

- Feedback model
  - Chg can reduce stress that from optimal zone
  - Always return conditions to set point/optimal
  - Mostly +ve for homeo; rares
  - Response continually modifies stimulus by feedback loop
  - Feedback mech. are self-regulating
  - Steady-State controls stress flow of life; through a cycle
  - Chg. uses feedback mech. to detect changes in point; homeo
  - Chg. uses feedback mech. to detect changes in point; homeo
- Feedback Loop
  - S. Stimulus + Initiates response
  - R. Receptor + Recieve cell alarms change in internal/external environment of orgs
  - M. Modulator + Organ that receives signal from receptor
  - E. Effector + Organ that causes response & neurons signal from modulator
  - R. Response + What happens as result of effector
  - 1. Feedback + Where response alters/modifies stimulus
    - +ve
      - Response increases the opposite to original stimulus
    - -ve
      - Response sustained, reversed, decreases or is opposite to original stimulus
- Behavioural response
  - Conscious response to external change to maintain homeostatic balance
  - Stimulus response model
    - S. Stimulus
    - R. Receptor
    - C. Control Centre
    - E. Effector
    - R. response

Tolerance Limits

- Range of conditions which the body can function
- Conditions outside these limits are detrimental
- Law of tolerance
  - For each environmental factor an organism has a range of tolerance within which it can survive
  - Found upper & lower extremes of this tolerance range are uncomfortable factors tend to limit organisms ability to survive
- Optimum Range
  - Area of best funtion
  - Usually abundance of species in areas where environmental factors are in this range
  - Every species has own OR
  - Why very big organisms develops & seasonally
- Abiotic Interfactors
  - Predators
  - Competition
  - Prey
  - Parasites
- Abiotic Interfactors
  - Aquatic
    - Viscosity
    - Buoyancy
    - Dissolved gases
    - Pressure
    - Salinity
    - Mineral nutrient
    - pH
    - Temperature
  - Terrestrial
    - Temperature
    - Soil water
    - Light
    - Soil pH
    - Soil mineral content
    - Concentration of gases
    - Wind
- Dispersal
  - Process of organisms spreading out geographically
  - Greatly influenced by tolerance range
  - Wider tolerance range, more widely dispersed species is
- Variation
  - Wider tolerance range for a given environmental factor; the more widely dispersed the species is across variations in that factor
  - MC have larger tolerance range than SC

Nervous System

- Fast communication network & control centre of body
- Detect stimulus (internal & external) & cause a response
- Responsible for
  - Muscle movement
  - Senses
  - Heartbeat
  - Breathing
  - Digestion
  - Memory
  - Speech
- Made up of
  - PNS
    - Nerves
    - Transmit signals
    - Spinal cord
  - CNS
    - Brain
    - Processing storing & coordinating info
- Nerves
  - Motor neuron
    - Carries messages from CNS to effectors
  - Sensory neuron
    - Carries signals from receptors to CNS
  - Connector neuron
    - Connect motor neurons to sensory neurons
- Effectors
  - Cells that will cause an effect
- Receptors
  - Cells that receive signal
- Synapse
  - Gap between 2 neurons that releases chemicals from one neuron to another
- Neurotransmitter
  - Chemical released from end of synapse to pass on signal

Endocrine System

- Regulate
  - Metabolic rate
  - Metabolism
  - Growth
  - Urine production
  - Sexual development
  - Blood sugar concentrations
  - Fertility
  - Fight or flight response
- Glands
  - Produce hormones
  - Located in different parts of the body
  - Interdependent
  - Not controlled by any one centre
    - Pituitary gland
      - Master gland
      - Controls activities of other glands
      - Located at base of brain
      - Controlled by hypothalamus
    - Thyroid Gland
      - Located in front of throat
      - Relatively lookaway
      - Takes calcium from blood and returns to bone
      - Release
      - Takes calcium from blood and returns to bone
      - Thyroxine
      - Speeds up cellular reactions & assists in temperature regulation
      - Hypothyroidism
        - Overactive thyroid
        - Too much thyroxine
        - High metabolic rate, nervousness, irritability, sweating, weight loss, obesity
- System of ductless glands that secrete hormones into blood stream
- Long lasting; Slow acting
- Hormones
  - Chemical messengers to body
  - Travel to all cells via bloodstream
  - Produced in small amounts
  - Only target cells or specific organs can respond to these hormones
    - Once they reach target they bind with receptor protein and cause a change
- Glands
  - Anabolic steroids
    - Synthetic form of testosterone
    - Boost muscle growth
    - Prevent muscle wasting
  - Adrenalin
    - From adrenal glands
    - Increased heart rate
    - Increases breathing rate
    - Increases blood pressure levels
    - Diverts blood flow from digestive system to brain and muscles
    - Prime for rapid response

Temperature & Metabolism

- Metabolism
  - Sum total of all of reactions taking place within an organism
  - Requires input; produces output
  - Rate of energy production and use
  - Measure of chemical activity of a cell
  - Level at which an organism's metabolism is operating
  - Measured by
    - Respiration
      - CO consumption
      - CO2 + heat production
      - Provides most energy to drive metabolism
      - Respiration rate & BR are closely connected
    - Energy
      - Amount of metabolism (energy produced) increases as size of organism increases
  - Metabolic rate
    - Affected by temperature
      - High temp = higher BR
      - Low temp = lower BR
      - Too high = denatured enzymes
    - Higher BR allows process to occur quicker
      - Growth
      - Movement
      - Reproduction
      - Repair
  - Body size
    - BR increases as size of organism decreases in order to replace lost heat
      - SA:Vol ratio
        - Larger animals have smaller SA:Vol ratio; smaller BR
        - Smaller animals have higher SA:Vol ratio; larger BR
        - Don't need as fast BR to increase heat
        - Larger animals have mechanisms to lose heat
        - Small animals have higher SA:Vol, more heat lost = faster BR
  - Homeotherm
    - Causes increased muscle movement = heat
    - Increases BR to provide energy needed for activity
    - Regulated by thyroxine hormone released from thyroid gland
- Ectotherm
  - More from within = homeotherm
  - Heat = by-product of metabolism; this is used to maintain constant body temperature
  - Can maintain constant rate of activity in a wide range of environmental temperatures = high heat requirements
  - If external temp is high; BR is low as less heat produced
  - If external temp is low; BR is high as more heat produced
  - Controlling temp
    - Shivering
    - Panting
    - Counter current exchange
    - Hibernation
    - Sweating
    - Body structure
    - Flee-or-fight
    - Vasodilation/constriction
- Ectotherm
  - Warmed from outside
  - Poikilotherms = Fluctuate with external temperature
  - Uses outside means (muscular activity/behaviour to overcome)
  - Not able to control body temp while close limits which it can't survive
  - Can usually survive large changes in body temp
  - Have much lower BR than endotherms at same temperature
  - Have lower food requirements
  - Able to survive in habitats with low or unreliable food availability
  - Controlling temp
    - Basking/moonbathe
    - Counter current exchange
    - Movement
    - Fasulthermicur
    - Burrowing
    - Colour change
    - Body raising (lifting feet)

Thermoregulation in Heat

- Cutaneous
  - If temps rise above set point enzymes denature & metabolism fails
  - Hyperthermia (heat stroke / exhaustion)
- Ectotherm
  - Poikilotherms Ectotherms
    - Obtain heat from external source & fluctuate with surroundings
    - Reptiles
    - Most fish
    - Amphibians
    - Invertebrates
    - Snails
    - Starfish
  - Homeotherms Ectotherms
    - Obtain heat from external sources & maintain relatively constant internal temp
    - Move to places it is warm for heat
    - Some tropical reptiles
    - Desert reptiles
    - Deep oceanfish organisms
    - Tropical marine
    - Invertebrates
- Endotherm
  - Homeotherm Endotherms
    - Maintain relatively constant internal temp
    - Mammals
    - Birds
    - Some fish
    - Insects
  - Poikilotherm Endotherms
    - Retain heat from metabolic activity & fluctuate with surroundings
    - Mammals that engage in long periods of torpor
      - Hibernation
      - Aestivation
    - Fast swimming fish
      - Tuna
    - Most sharks
    - Bees
- Adaptations
  - Structural
    - Less furfoulation
    - Lighter furrier/skin colour
    - Drape & size
      - Large extremities = hot climates
    - Shelter from high temperatures
    - Lizard adapts to heat by evaporation
      - Arctic foxes have high amounts of some close to surface
    - Gangrenes
      - Dig holes to lie in cooler sand
    - Shelter in cool vegetation
    - Subterranean
    - Open mouth to increase evaporation
    - Cocoaffer
    - Aest to sur in cold months to get warm enough to digest meals
    - Burrowing
    - Nocturnal
  - Behavioural
    - Hibernation
    - Aestivation
    - Sleeping
    - Nocturnal
    - Migration
    - Hibernation
    - Aestivation
    - Dormancy
    - Dormancy
    - Resting
    - Nocturnal
    - Resting
    - Nocturnal
    - Recumbent to generate heat
  - Physiological
    - Sweating
    - Panting
    - Mouthing
    - Concentrated urine
    - Decrease BR
  - Aestivation
    - Occurs when water is too low to assist in maintaining stable internal environment
    - Metabolic activity lowered to a level that only just sustains life
    - Conserves energy
    - Rests
    - Eyelessness cut into half
    - Lungfish burrows in mud until rainy season
  - Structural, behavioural or physiological that aid an organism's survival & to maintain in its given environment
- Need to be able to maintain heat balance
  - Heat loss = heat gain = heat balance; equilibrium
  - Heat transfer methods
    - Radiation
    - Conduction
    - Evaporation
    - Convection

Thermoregulation in Cold

- If temp fall below set point enzymes slow too much
  - Hypothermia
- Adaptations
  - Structural
    - Smaller extremities
    - Small ears/no ears
    - Short stocky body
    - Thick fur/feathers/blubber
  - Behavioural
    - Low BR fat
    - Sleeping
    - Huddling
    - Shivering
    - Nesting
    - Diurnal
    - Recumbent to generate heat
  - Physiological
    - Counter current circulation
      - Fine or webbed feet
      - Traps heat in body core, reducing heat loss from extremities of body
    - Homeoinsulation
      - Heat in arterial blood coming from body's core is transferred to venous blood instead of being lost to external environment
    - Piloerection/Goosepimples
      - Erection of hair follicle due to contraction of little structures pilgrim muscles
      - Backed by stimulation of cold to sympathetic nervous system
    - Shivering
      - Trap heat between skin surface and hair follicles
    - Mouthing
    - Increase BR
  - Hibernation
    - When resources are too low to assist in maintaining stable internal environment
    - BR lowered to only just sustain life
    - Lowers set point significantly
    - Conserves energy
    - Rests
    - Nocturnal
- Polyiso
  - Waxy coat for water proofing
  - Thick coat to restore heat under water
  - Blubber; has conductance equal to that of air
  - Human hairless for sweating
  - Tail stores fat + energy

Osmoregulation & Osmoconformation

- Osmotic Pressure
  - Pressure produced by a difference in concentration between solutions on the two sides of a surface such as a semi-permeable membrane
    - Greater the concentration difference = greater osmotic pressure
    - More concentrated side will good water by osmosis & for solver higher osmotic pressure
  - Measure of tendency of a solution to take in water + osmosis
  - Minimum pressure which needs to be applied to a solution to prevent the inward flow of water across a semipermeable membrane
  - Water balance (changing osmotic pressure)
    - Kidneys keep an equilibrium of water and ions in blood
      - Plasma filtered
      - Fluid reabsorbed into blood stream
      - Urine secreted into another region of kidney
      - Excretion
    - Osmotic Solut with Homeoregulators
      - Dogs need to pant for evaporation to reduce heat but means water is lost to environment
      - Found in both marine & freshwater environment
    - Aquatic osmoregulators
      - Possess various adaptations to assist
      - Require energy to regulate
      - Greater the difference in osmolarity between internal fluids and external surroundings more energy must be expended to maintain it
    - Freshwater fish
      - Gains fluid via habitual large intaugen to constantly replenish lost fluids (with little issue)
      - Concentration inside fish + their osmo
      - Hypotonic to environment (hypotonic)
      - Have not reflux of water across gills and lose fluid of urea
      - Continually lose water by producing lot of dilute urine
      - Salts actively reabsorbed from GI explorer - not lost to environment
    - Marine fish
      - Concentration of solutes inside fish < than ocean
      - Tetrodotoxin/tetrodotoxin Gives fish poisonous to environment
      - Not loss of water through gills - drink sea water
      - Gain ions diffusion
      - Blue Whales use
      - Specialised cells in gut increase salts from blood
      - Chloride secretory cells in gills remove chloride ions
      - Produce concentrated urine become almost pure salt
    - Insects
      - Exoskeleton prevent water loss
      - Respiratory surface is within body so not direct contact with external environment
      - Drink water about needed
    - Birds
      - Produce bit pellets containing very little water
      - Tough keratinous scale skin preventing desiccation
      - Excrete SA semi-solid form (insoluble)
      - Tough rubbery shelled eggs that are buried preventing desiccation
      - Lungs inside body
    - Reptiles
      - Turtles
      - Iguanas
      - Some marine reptiles have salt-excreting glands in head (near eyes & nose)
      - Big reabsorb water from chyme
      - Skin relatively impermeable
    - Frogs
      - Low evaporation due to feathers & or mucus glands
      - Lose skin to breathing
      - Nitrogenous waste = UA
      - Marine birds also have salt-excretion glands to rose that drinks from to drink salt water
      - Stay redrench water from cloaca
    - Amphibians
      - Can slow down urine production by reducing rate of filtration in nephron
      - Relative water to blanker
      - Swells up the tail into water in dry season
      - Aestivation
      - Can burrow for several months
      - Create a cocoon created from layers of skin
    - Mammals
      - Kidney allows some water & salt loss
      - Reabsorbs most water & salts
      - ADH acts on PCT & CT to cause reabsorption
      - Cells become more permeable
      - Some water moves back into blood by osmosis & some by active transport
    - Adaptations for water retention in arid environments
      - Structural
        - Nephrons longer & hairpin to balance more water
        - Nocturnal
        - Place tail in front of prizzel
        - Dig burrows that has humidity
        - Aestivation
      - Behavioural
      - Physiological
        - Able to produce concentrated urin through action of hormones
        - Able to reabsorb water from food rather than drink it
        - Metabolise fat to produce water
        - Tolerant to concentrated body fluids
  - Mostly marine invertebrates
    - Crustacea
    - Molluscs
    - Highly permeable skin surfaces
    - No energy expenditure maintaining water balance
    - Very narrow tolerance range of outside concentration at which they can function normally
- Osmoconformers
  - Thermo
  - Rays
  - Increase osmotic pressure of body fluids by retaining urea
  - Excrete water & nitrogenous waste controlled by kidney
  - Only in marine environments
  - Isotonic to environment
- Osmoregulation

Plant adaptations

- Xerophyte
  - Drought & salinity stress are major causes of agricultural productivity losses
  - Inhibition of growth
  - Salinity causes additional ion toxicity effects mainly through alterations in protein & membrane structure
  - Plant able to survive in environment with little water
  - Adaptations
    - Thick waxy cuticle on surface
    - Reduced no. of stomata on top of leaf, increased at bottom
    - Sunken stomata
    - Epidermal cuticle
    - Reduced leaf no. / no leaves / spines
    - Hairs on leaves
    - Rolled leaves
    - Wide stomtae roots - expanding stomatacure water
    - Leaves hang downward
    - Dense leaves
    - Lighter colour leaves
    - Water storage in trunk or leaves
    - Close stomata during hottest part of day
    - Flower only when rain comes
    - Germinate when rain comes
    - Die when drought arrives
    - Roots capture lots of water at once to use with rain
    - Drop leaves in dry periods (deciduous)
    - Annual
    - Secrete resins & waxes
    - Modify leaves produced - smaller in drought
    - Succulent
    - Stop growing
  - Cuticle
    - Change elevation of production of photosyntheses to Cuticle
    - Coat cuticle containing chlorophyll - reduces need for leaves, stores water
    - Specialised
    - Spines protect from predators
    - Spines reduce transpiration
    - Thick waxy cuticle reduce evaporation
    - Cuticl spines trap water
    - Roots spines have hairs to reduce transpiration
    - Stems have tendrils to allow gas exchange
    - Stomata closed during day to reduce water loss
    - Lost CO2 in
    - CO2 combines with organic substance to produce malic acid
    - Malic acid stored in vacuole
    - During day malic acid converted back to release CO2 which used for photosynthesis
    - Crassulacean acid metabolism
  - Stomata open at night
  - Cuticle
  - Root
  - Plant able to survive in waters with high salinity
  - Either salt tolerant or salt resistant
  - Halophytes
    - Facultative halophytes
    - Can grow in both saline and non saline environments
    - Obligate halophytes
    - Cannot survive non saline environments
    - Obligated to be in Saline environments
  - Cakeile
    - Stands outside salt
    - Tolerate large salt storage; discarded when salt load is too high
    - Resistant opening of stomata to prevent salt entry
  - Mangrove
    - Pneumatophores
    - Roots
    - Have stomata at end of leaf
    - For reaching exposed roots for structural support in soft soils
    - Allow oxygen to be transferred to roots under ground in anaerobic soil
    - Reproduction
    - Viviparous
    - Dispersal method to avoid overcrowding
    - Produce seeds that float
    - Seed permeates attached to tree, drops into water and drifts until land found
    - Germinate
  - Other adaptation
    - Excreting salt from transpiration back to roots
    - Excreting salt from glands on leaf tips, show up as crystals on leaves
    - Shedding leaves that contain high salt concentrations
    - Retaining salt from transpiration back to roots
    - Storing excess salt in vacuole to reduce toxicity
    - Excreting salt from glands on leaf tips, show up as crystals on leaves