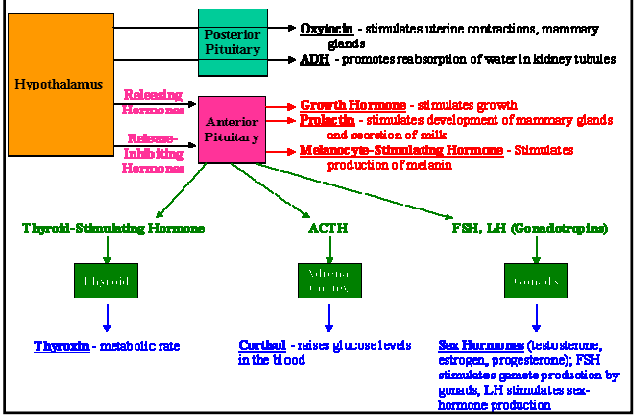
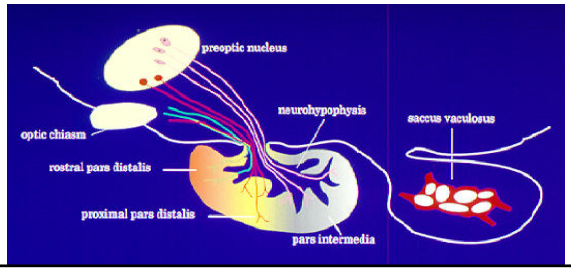
Homeostasis – Chapter 7 - Endocrine



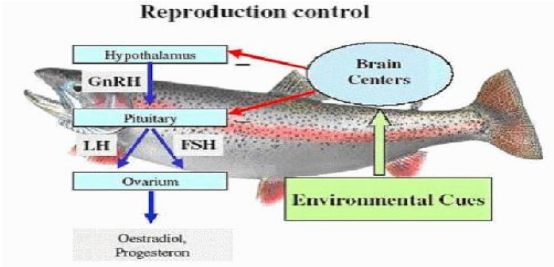
Endocrine System - Pituitary – 3 parts;

- Neurohypophysis – release chemicals – water loss (vasotocin & isotocin), regulatory (releasing factors effect other parts
- Pars intermedia
- Adenohypophysis (pars distalis) – prolactin (osmoregulation), Growth, ACTH (release cortisteroids), MSH (color)



Endocrine System

- Hypothalamus – controls pituitary
- Caudal Neuroendocrine System – Urophysis (caudal end spinal cord) – 2 Urotensins (osmoregulation & steroid)



Endocrine System

- Thyroid – small cells makes Thyroxin
- Interrenal cells = adrenal like cells; Two cell types – chromaffin (epinephrine & norepinephrine) and steroid producing cells (controls metabolism w/ costeroids).
- Autonomic Nervous System – poor in agnathans but well developed in teleosts (along either side of spine) – controls involuntary functions

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- Thermal regulation
- Cold blooded vs warm blooded
- Poikilotherm vs Homeotherm – fish change temp but water more stable
- Ectotherms vs Endotherms - Most = same temperature as water = ectotherms (most fish) v Endotherms (some fish) – temperature vs metabolic rate; eg high metabolic costs

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- Endothermic Fish = Scombrids and Lamnidae (mackeral) & Alopiidae (thresher) Sharks
- Heat lost at gills; bring body to external temperature; in tunas etc cooled blood to outside; counter-current; Rete mirabile; blood warmed by muscle activity and heat transferred to cool blood moving to muscles; oxygenated blood is warmed; heat not lost but returned to muscle.
- In thunniform swimming fish – more red cells medial, less heat loss
- Also rete mirabile on liver associated w/ gut
- Also warm parts of the CNS especially brains and eyes – "regional endothermy"
- Eye muscles have lost the ability to contract now produce heat;
- Also rete system near eyes;

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- Thermal regulation
- Acclimation (coping with temperature fluctuations)
- Metabolic rate can be dependent or independent on temperature; effects seasonality
- Heat Shock Proteins; Alternate enzymes systems (isozymes) vs alternate forms of enzymes from alternate gene forms (allozymes);
- Cellular or Tissue level changes - Muscles/heart/liver villi can all change

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- Thermal regulation
- High and low temperature (coping with temperature extremes)
- Water freezes at 0, seawater at –1.87 but densest at 4 degrees; fish freeze at -.7 so freshwater fish are protected but salt water fish have problem
- Supercooled and do not encounter ice crystals
- Some = biological antifreeze (glycoproteins)
- INCREASE CONCENTRATIONS OF OSMOLYTES;

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- Thermal Preferences and habitat selection – select best habitat for growth and reproduction – good link of physiology and behavior/ecology;

Osmoregulation – 4 Strategies

- Osmoregulation; Most fish stenohaline (very narrow salt tolerance) but Diadromous (part freshwater part salt) fish (lampreys, salmon, eels) – Euryhaline (wide tolerance for salt)
- Anadromy – adults spawn in fresh – juvs to salt
- Catadromy – adults spawn at sea, move to fresh and return to sea to spawn
- Amphidromy – Spawning either freshwater or saltwater

Examples of Diadromous Fish

- Anadromous – Lampreys, sturgeons, herring, salmon, smelts, icefice, gobies, sea catfish, soles, sticklebacks, cods, sculpin
- Catadromous – Eels, scorpionfish, galaxiids, temperate basses, snooks, mullets, righteye flounders
- Amphidromous – grayling, whitebaits, galaxiids, herrings, sculpins, sandperches, sleepers, pipefish

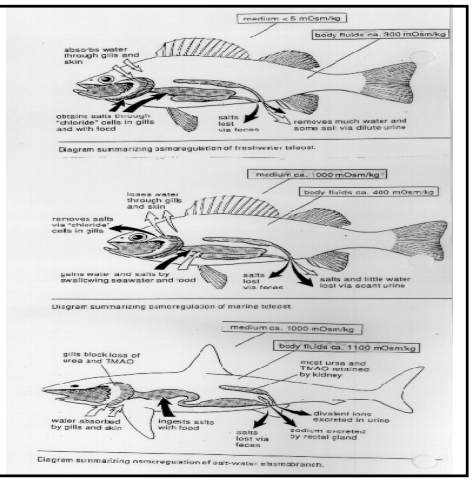
Osmoregulation – 4 Strategies

- – Four major strategies
- (1) Nothing – Hagfish – all marine and stenohaline (tolerate narrow range); Have salt concentration about equal to seawater – only vertebrate to do so.

3 – Marine Teleosts

4 – Freshwwater teleosts

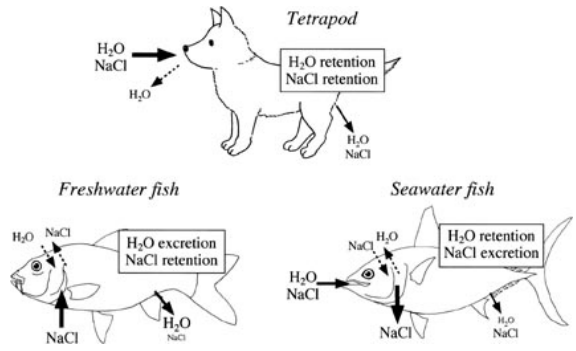
2 – Marine elasmobranches and coelacanths



Osmoregulation – 4 Strategies

- – Four major strategies
- (2) Marine elasmobranches and Coelacanths = Inorganic salt concentrations equal about 1/3 seawater (like most verts) – but organic salts (Urea and trimethylamine Oxide TMAO) brings total salt concentration up to seawater

Freshwater vs. Saltwater



Osmoregulation – 4 Strategies

- (3) Marine Teleosts – Internal salt concentration = 1/3 sea water – operates Hyposmotically – lose water to diffusion
- Replace water by continually drinking then special cells (Chloride cells) in gill filaments & opercular skin epithelia eliminate salt via active transport

Osmoregulation – 4 Strategies

- Marine Teleosts
- 1) Loses water through gills and skin
- 2) gains water and salt by drinking
- 3) Removes salt via **chloride cells**
- 4) Salt lost via feces
- 5) Salt and little water lost via minute urine
- 6) Fewer and smaller glomeruli; reabsorb glucose/proteins in convoluted tubules

Osmoregulation – 4 Strategies

- (4) Freshwater teleosts and some elasmobranches = Hyperosmotically (blood conc greater than H2O) – they gain water by diffusion.
- Well developed kidneys excrete large amounts of dilute urine (.33 body weight per day) – controlled by blood pressure; Salts are taken up primarily through the gills – ions pumped inwards – chloride cells

Osmoregulation – 4 Strategies

- Freshwater teleosts
- 1) absorb water through gills and skin
- 2) obtain salts through “chloride” cells and with food
- 3) removes water via copious, dilute urine (5-12% body weight)
- Numerous large glomeruli and reabsorbs salts along convoluted tubules

Gill filament

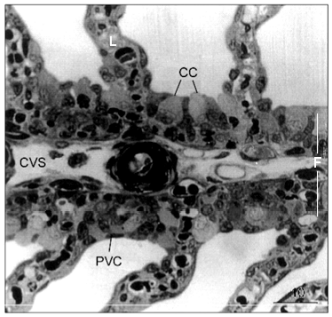


Fig. 1 — Filament (F) and lamellar (L) epithelium of *H.* cf. *plecostomus.* Semi-thin longitudinal section of gill filament stained with Toluidine blue. CC = chloride cell; PVC = pavement cell; CVS = central venous sinus. Scale bar is in µm.

Chloride Cells