FISHERY SCIENCE I

Excretion and osmoregulation

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Excretion and osmoregulation

- Excretion- elimination of nitrogenous waste from the body
- Osmoregulation – Rudolf Hober- conrol osmotic pressure and ionic concentration inside the body

- Osmosis = movement of solvent through a semipermeable membrane
- Osmoregulation – occurs between intra and extra cellular compartments and also between extracellular compartment and external environment
- Osmoregulation – occurs between intra and extra cellular compartments and also between extracellular compartment and external environment

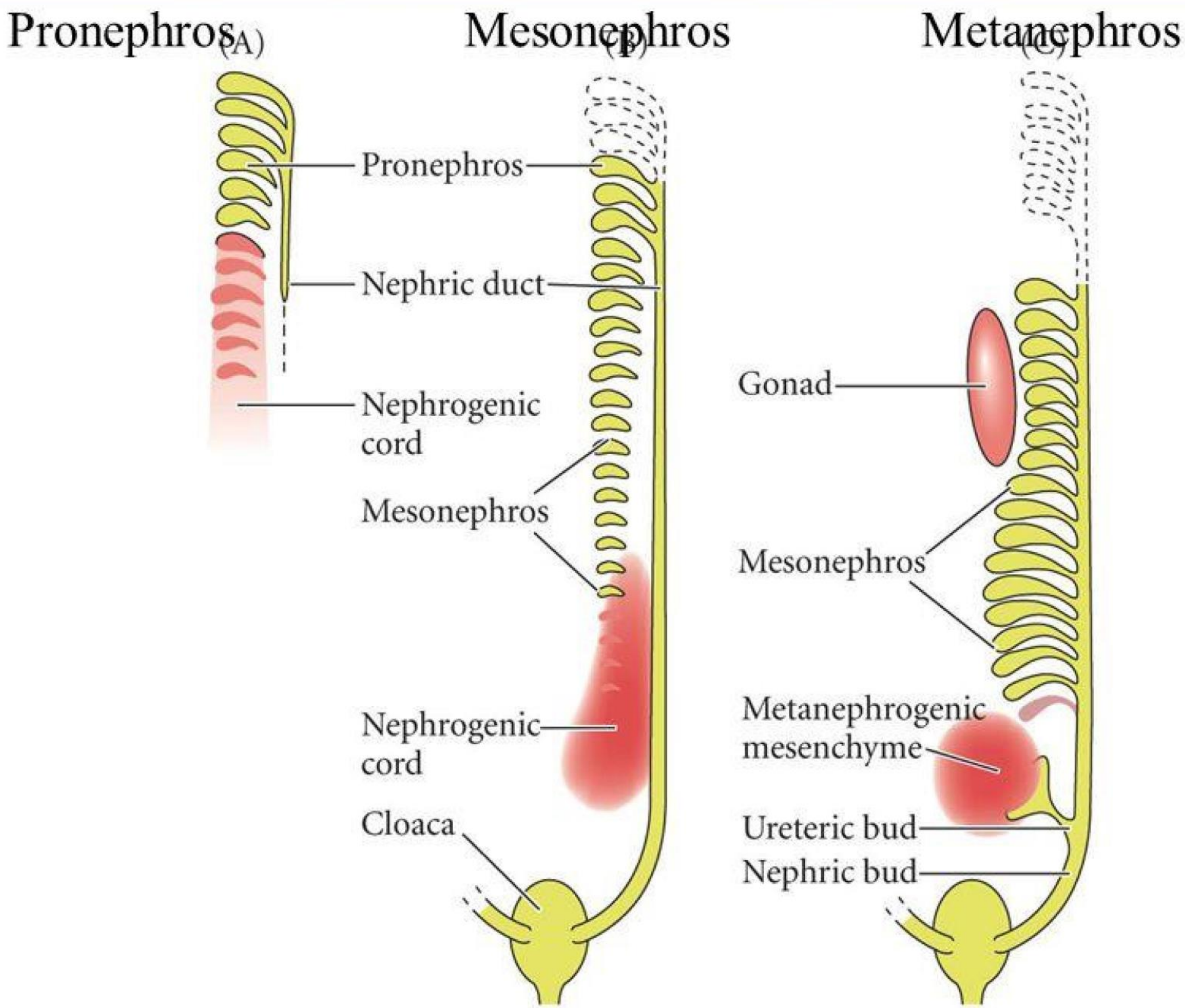
- Osmoregulation carried out by gut,skin,gils,oralmembrane and kidney

Kidney

- Excretory organ consist of fish is kidneys, ureters And urinary bladder
- Kidney is opisthonephron- anterior nephrons or kidney tubules have been lost , more tubule in the posterior end
- Holonephros– primitive

- Anterior tubules become functional in early life- pronephros

14.21 General scheme of development in the vertebrate kidney (Part 1)



DEVELOPMENTAL BIOLOGY, Eighth Edition, Figure 14.21 (Part 1)

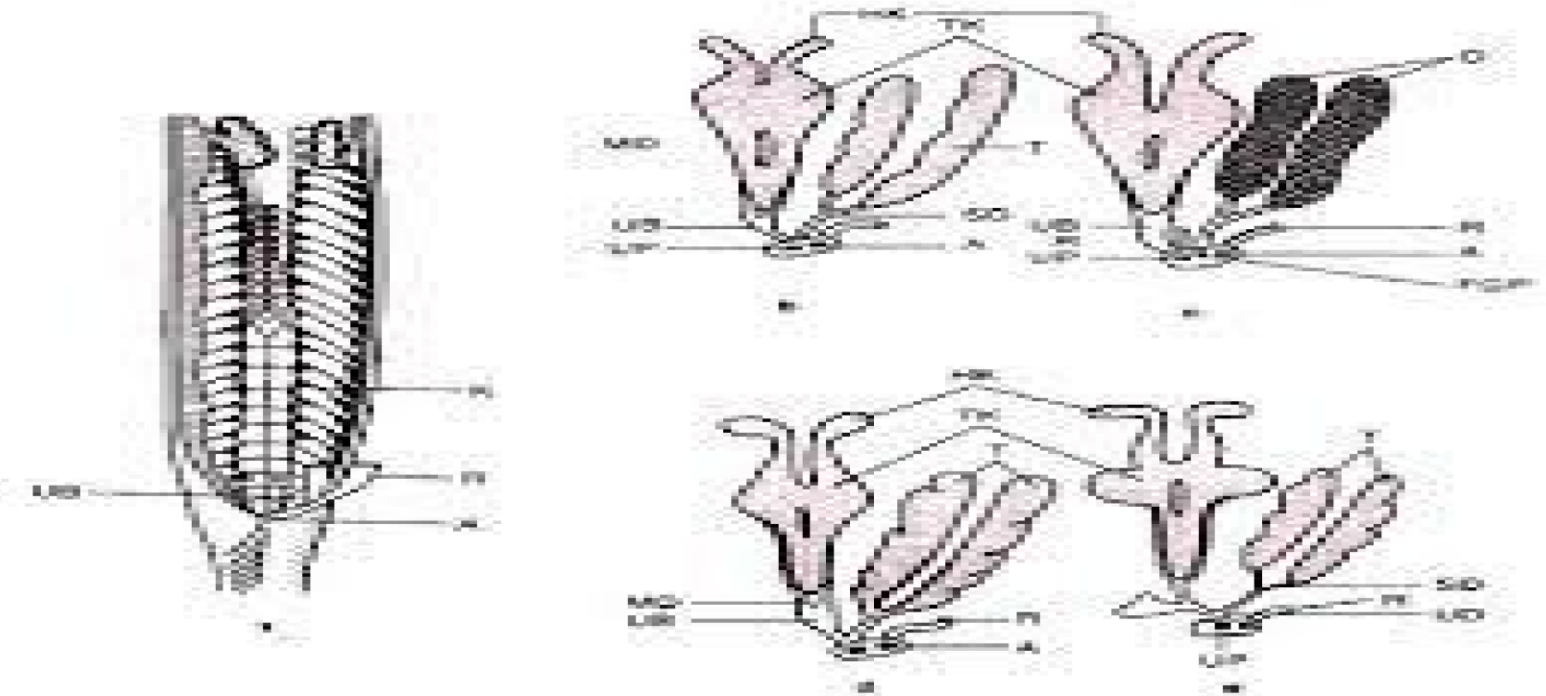


Fig. [illegible] : Excretory system of (a) [illegible] (b) Cirrhina (male) (c) Cirrhina (female) (d) Labeo (male) (e) [illegible] (male). A, anus; FGP, female genital pore; HK, head kidney; MD, mesonephric duct; O, ovary; R, rectum; SD, sperm duct; T, testis; TK, trunk kidney; UB, urinary bladder; UD, urinary duct; UP urinogenital pore.

- Posterior tubules function throughout lifemesonephros
- Kidney located near alimentary canal, close to vertebral column
- Shape of kidney varies according to species

2 parts

HEAD – pronephros- anterior- become functional in early stage of life

- Head kidneyis non excretory and endocrine in function

- Interenal glands (homologous to adrenal cortex of mammals)and chromaffin cells (similar to adrenal medulla)also present
- Trunk- mesonephros – posterior – become functional late trunk kidney (posterior kidney)excretory in function

Types of kidney in marine teleosts

1. Fused – no distinction between head and trunk – Salmon
2. Semi fused – distinct head and trunk , mid and posterior part fused- eels
3. Partialy fused – head and trunk separate, only posterior fused – Mugil

4. Posteriorly fused – fusion in the posterior end of trunk – Syngantha
5. Separate- completely separated throughout their length – lophius

Fresh water teleosts

Type 1- salmon type

Type 2 – cyprinids, type3- cottids

Some species specific variation also

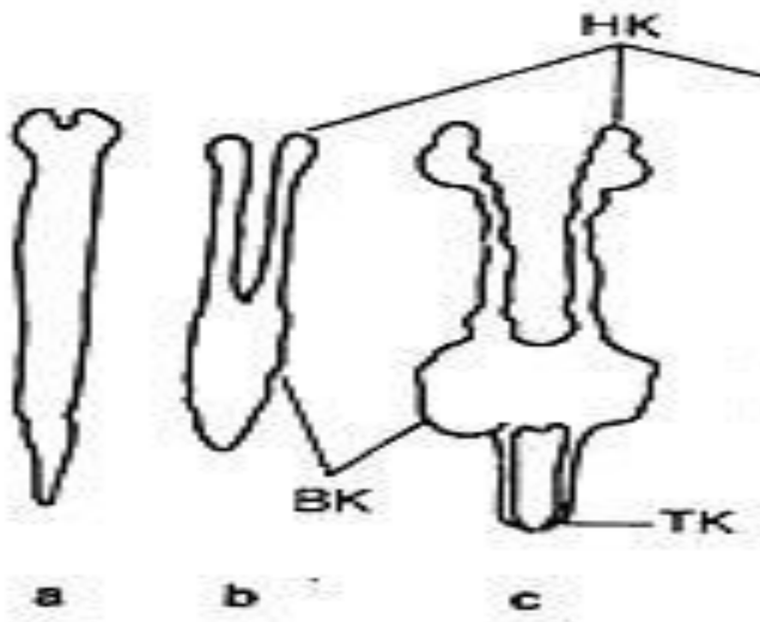


Fig. 11.3a-e : External view of teleostean kidney. (a) rainbow trout. (b) *Ayu*. (c) carp. (d) Eel. (e) yellow tail; BK, body kidney, HK, head kidney; TK, tail kidney.

Structure of kidney

- Yellowish bodies are embedded with kidneys called Corpuscles Stannius – Endocrine in functio
- Head kidney function as a haemopoesis organ
- Mesonephric ducts or ureters lie closed together in the median line
- Anteriorly they are separate ; posteriorly 2 mesonephric ducts open separately into thr urinary baldder

- Urinary bladder usually opens to the exterior by common urinogenital aperturer in male , and separate in female

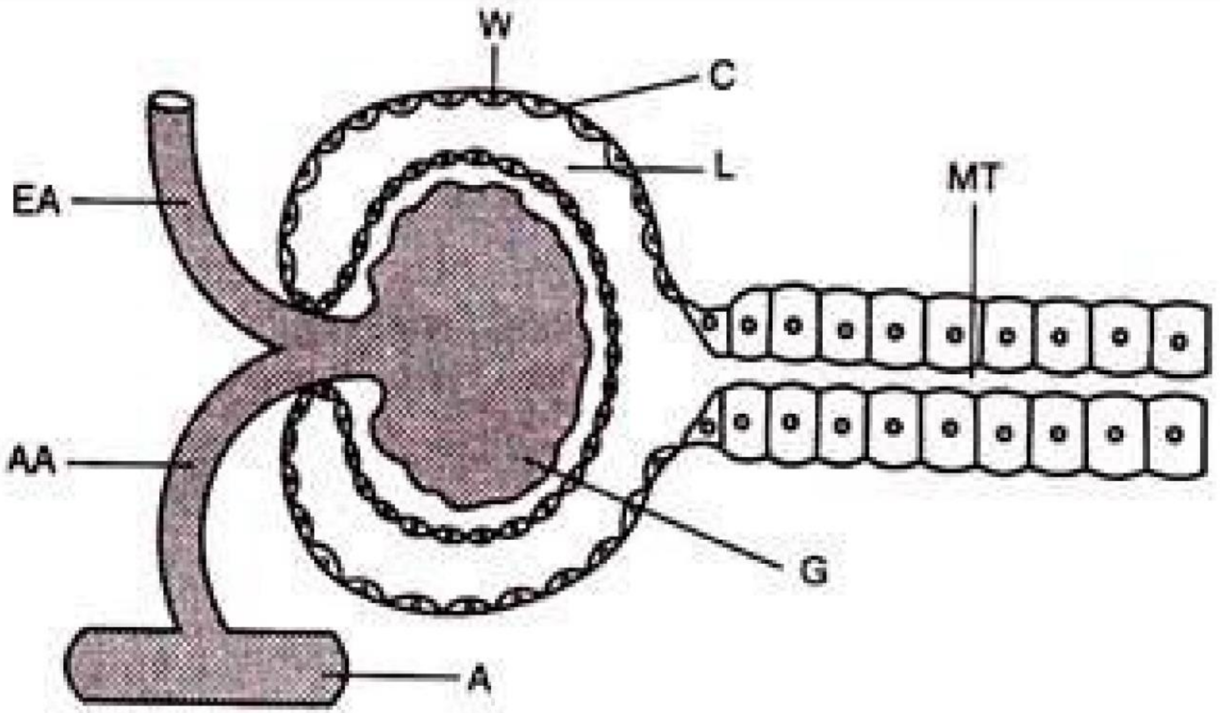


Fig. 11.8 : Diagram of renal corpuscles of fish. A, aorta; AA, afferent arteriole; C, capsule; EA, efferent arteriole; G, glomerulus; L, lumen; MT, mesonephric tubule; W, wall.

- Trunk kidney or body kidney contains renal tubules (nephrons) and interstitial lymphoid tissue
- Number of renal tubules varies in different species
- Each nepron consist of 2 parts – renal corpuscles(Malpighian body or Bowman’s Capsule) and renal tubules(urinary tubule)

- Bowman’s capsule is a double layer cup- like structure of uriniferous tubule which contain tuft of capillaries known as glomerulus
- The remaining segment of urinary tubule is divided into proximal convoluted segment , intermediate and distal segments
- Distal segments is absent in marine fishes

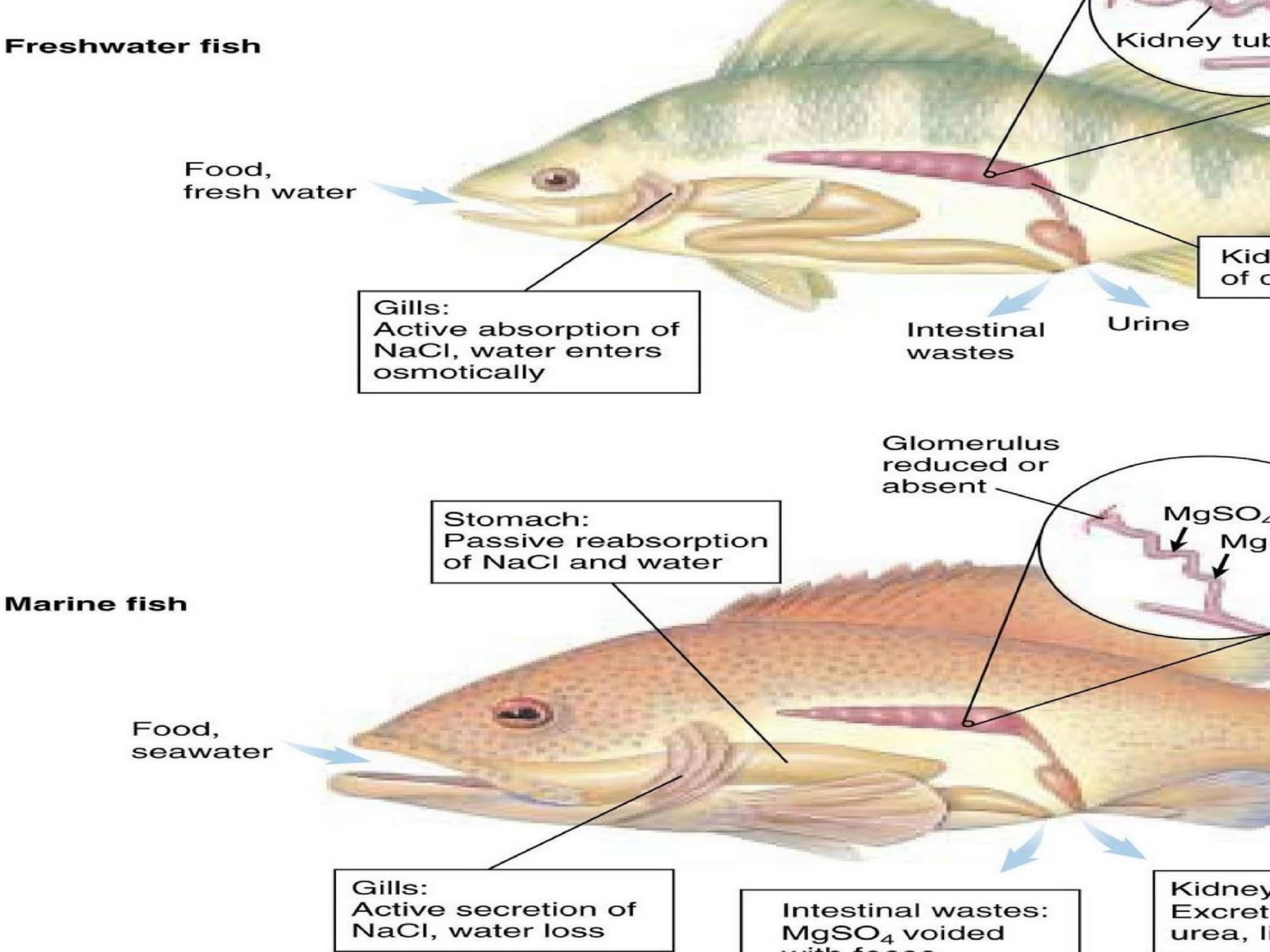
- Glomerulus and B capsule together constitute the renal or Malpighiancapsule – filtration apparatus of kidney
- Glomerular capillaries – vascular part of R Copuscle- is the afferent arteriole which divides and forms capillary loops
- The loops reunite and leave the capsule as efferent arteriole

- Renal corpuscle contain Mesangial cells – located between the loops of glomerulus and also in the inner wall of capsule
- M cellsc can remove large proteins from the glomerular basal lamina
- Juxtaglomerular cells present in the wall of afferent arterioloes

- Jg cells contain secretory granules – produce renin hormone – increase blood pressure – controlo glomerular filtration
- Renal tubules are thin and short in the neck segments and consist of single layer of low epithelial cells with long cilia

- Proximal convoluted segment provided with cuboidal epithelial cells- cytoplasm contains secretory granules

- Distal convoluted segment is absent in marine fishes


Freshwater fish
Kidney tub
Food, fresh water
Kid of c
Gills: Active absorption of NaCl, water enters osmotically
Intestinal wastes
Urine
Glomerulus reduced or absent
$MgSO_4$
Mg
Stomach: Passive reabsorption of NaCl and water
Marine fish
Food, seawater
Gills: Active secretion of NaCl, water loss
Intestinal wastes: $MgSO_4$ voided
Kidney Excret urea, li

- Ureter is made up of external tunica adventitia, middle lamina propria and innermost columnar epithelial cells
- Ureter conduct urine upto urinary bladder
- Urinary bladder is a thin walled sac like structure
- Made up of 3 layers similar to ureters
- Corpuscles of Stannius is a small ductless gland produce hypercalcemic effect

- Thyroid is not a discrete organ but fused in the kidney as follicles – heterotopic thyroid

Histology of kidney of Fresh water Teleosts

- Trunk kidney consist of nephrons or urinary tubules
- Head kidney is made up of lymphoid , interrenal and chromaffin tissues – devoid of

renal corpuscles and tubules – so not excretory in function

- Typical nephron is called glomerular nephron7 parts

1. Renal corpuscle or Malpighian body= Bowman's capsule + glomerular contains a well vascularized glomerulus
2. Neck segment with ciliated columnar epithelium

3. First proximal segment with brush border epithelium & lysosomes
4. second proximal segment with brush border epithelium and mitochondria
5. Narrow intermediate segment
6. Distal segment
7. Collecting tubule lined with cuboidal cells

Kidney of marine Teleosts

- Less developed glomerulus – aglomerular nephron
- Less no. of renal corpuscles- poorly vascularized
- In Hippocampus, kidney completely devoid of renal corpuscles
- No distal segment
- Short neck

- Proximal segment directly leads to collecting duct

Physiology of Excretion

- Blood supply by renal artery (to glomeruli) and renal portal vein (capillary network around the kidney)
- Ultrafiltration by glomerulus and Bowman's capsule
- High pressure filtration

- Excretory fluid flows through renal tubule by the movement of cilia and net filtration pressure
- Na &Cl ions completely reabsorbed from the ultra filtrate
- Uric acid and creatine excrete through kidney in fresh water teleosts
- Urea and ammonia through gills in FWT
- Gills are the main excretory organs of nitrogenous waste

- Kidney removes Mg, So4, Na, K,Ca ions in marine teleost
- Marine fishes produce concentrated urine contains Ca, Mg, So4,Po4 ions.

osmoregulation

- Osmoregulation is defined as the ability to maintain a suitable internal environment in the face of osmotic stress

- Maintainance of constant osmotic pressure in the fluid of an organism by the control of water & salt concentration
- Osmotic exchange are 2 types :-

A. Obligatory exchange – occurs usually in response to physical factors, animal has no physiological control
B. Regulatory exchange – physiologically controlled

Factors affecting obligatory exchange

1. Gradient between the extracellular compartment and the environment – hyperosmotic and hyposmotic
2. Surface/ volume ratio- animal with small body size hydrate more rapidly than a larger animal of the same shape
3. Permeability of the gills- active transport of salts
4. Feeding- take water and salts along with the feeding

- Different in fresh water fishes and marine water fishes
- Several adaptations for the maintainance of internal environment – homeostasis
- In fresh water fishes, body fluid is hypertonic – so movement of water into and ions out
- In marine fishes, just opposite, so they tend to drink water
- Osmoregulators- animals who can maintain internal osmolarity different from the medium

in which they live with the help of endocrine mechanism

- Osmoconfirmers :- unable to control osmotic state of their body fluids

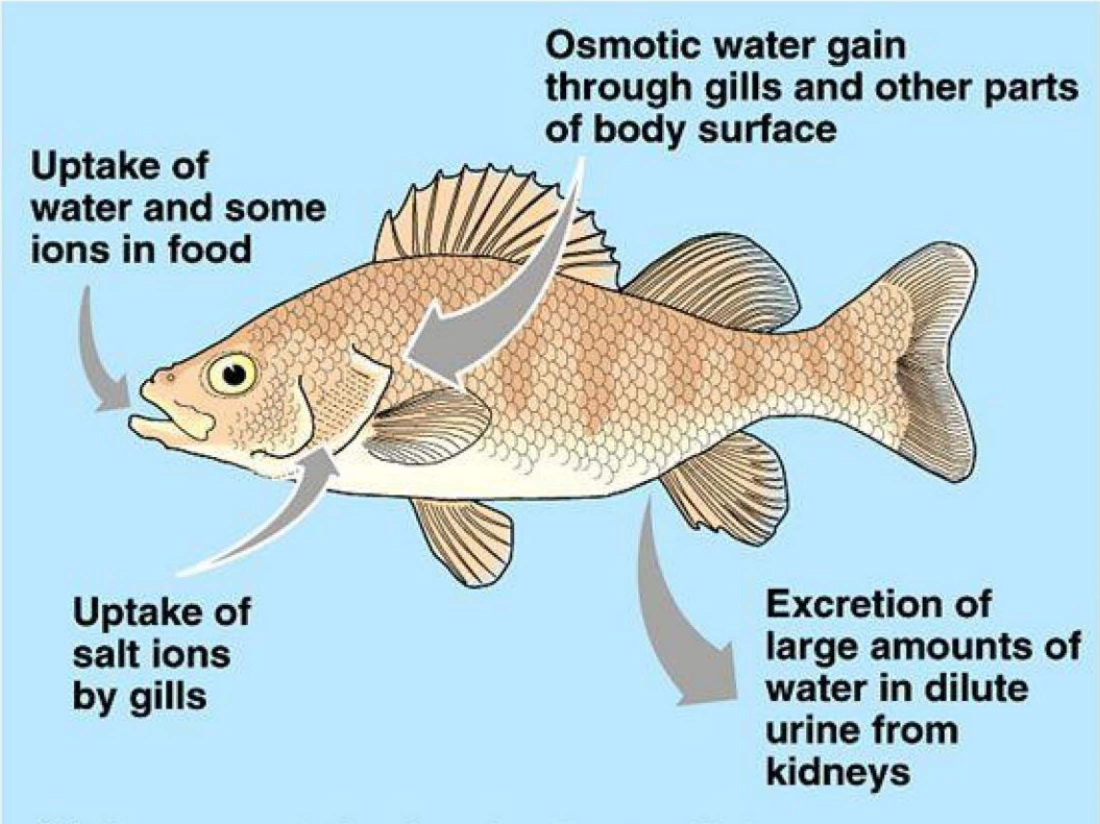
Osmoregulation in fresh water fishes

- Water enters their body through oral membrane, gills, skin and intestinal surface
- Compensation of hydration, produce large quantity of urine

- Reduction of salt loss- dilute urine by reabsorbing salts from urine

Osmoregulation in freshwater fish

Freshwater fish face two problems: they tend to lose ions and gain water.



(b) Osmoregulation in a freshwater fish

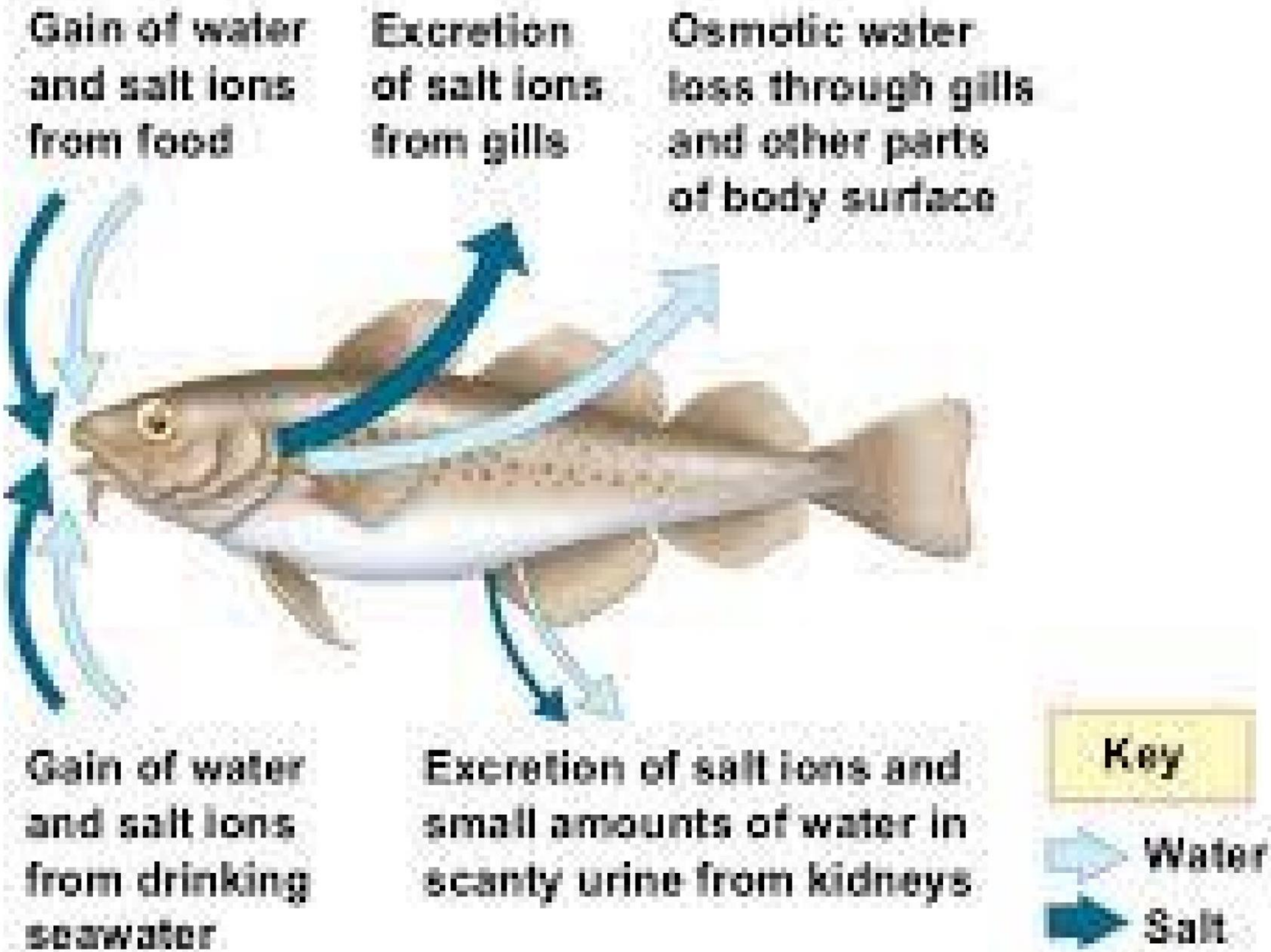
Osmoregulation in marine Teleosts

- Danger of water loss
- To compensate osmotic dehydration drink water
- This enhance their salt content
- Kidney tubules are highly modified for retension of water – so very less urine production
- Skin is impermeable to water and salts
- No. and size of glomeruli very less or absent
- Distal segment is lacking – to conserve water
- Reduced glomerular filtration rate
- Much concentrated urine than fresh water teleosts
- Urine is hyperosmotic to blood

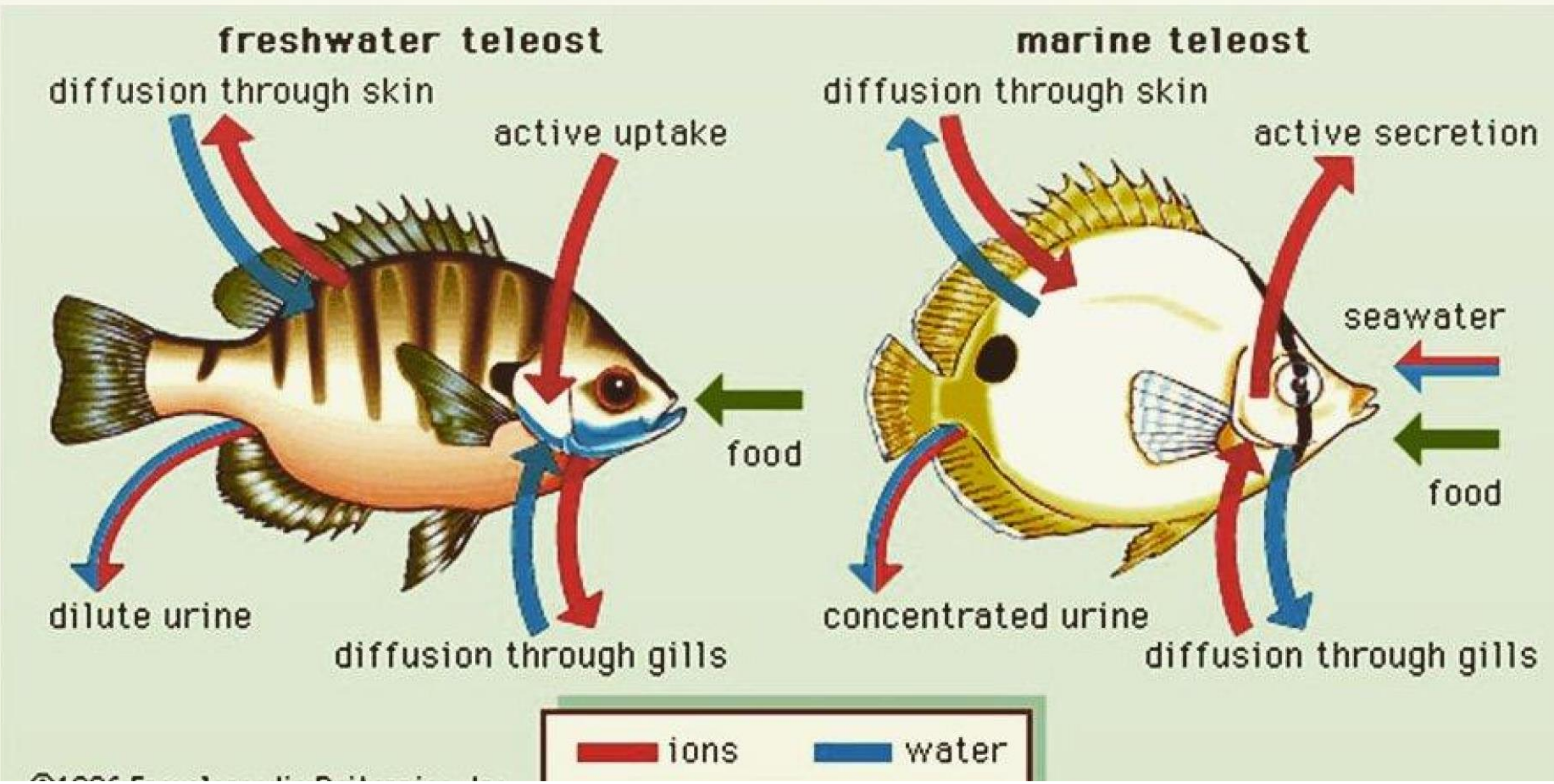
- Water loss through gills compensated by water drinking
- This drinking enhances salt content in blood
- Excess salt pumped out by chloride cells
- In marine teleosts, chloride cells are for the removal of salts
- In some elasmobranchas, rectal gland – functional analog to chloride cells

Figure 44.3a

(a) Osmoregulation in a marine fish



FRESHWATER VS. MARINE FISH



Hormonal control of Osmoregulation

- Hormones control blood pressure – which change ultrafiltration rate
- Some hormones directly affect tubular cells- change permeability and reabsorption rate
- Renin hormone from juxtaglomerular cells- increase blood pressure- control glomerular filtration
- Corticosteroids from adrenal cortex minimize Na elimination through kidneys and increase excretion through gills by changing permeability and rate of uptake

- Hypothalamus , thyroid hormones and gonadal hormones control mineral uptake