UNIVERSITY OF BASRAH
COLLEGE OF AGRICULTURE

DEPARTMENT OF FISHERIES & MARINE RESOURCES

ECOPHYSIOLOGY

A Postgraduate Course

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INTRODUCTION

Physiology is the scientific study of how the component parts of body **function** together in the living **organism**. It can be contrasted with **anatomy**, which is the study of the form or **morphology** of **organisms**. In practice, anatomy and physiology complement each other, the former dealing with the structure of an **organism**, its organs or component parts and how they are put together, such as might be observed on the dissecting table or under the microscope, and the later dealing with how those components function together in the living **organism**.

https://en.wikipedia.org/wiki/Fish_physiology

Osmoregulation in Aquatic animals: Definitions

- **Homeostasis** = maintaining steady state equilibrium in the internal environment of an organisms
- **Solute homeostasis** = maintaining equilibrium with respect to solute (ionic and neutral solutes) concentrations
- **Water homeostasis** = maintaining equilibrium with respect to the amount of water retained in the body fluids and tissues

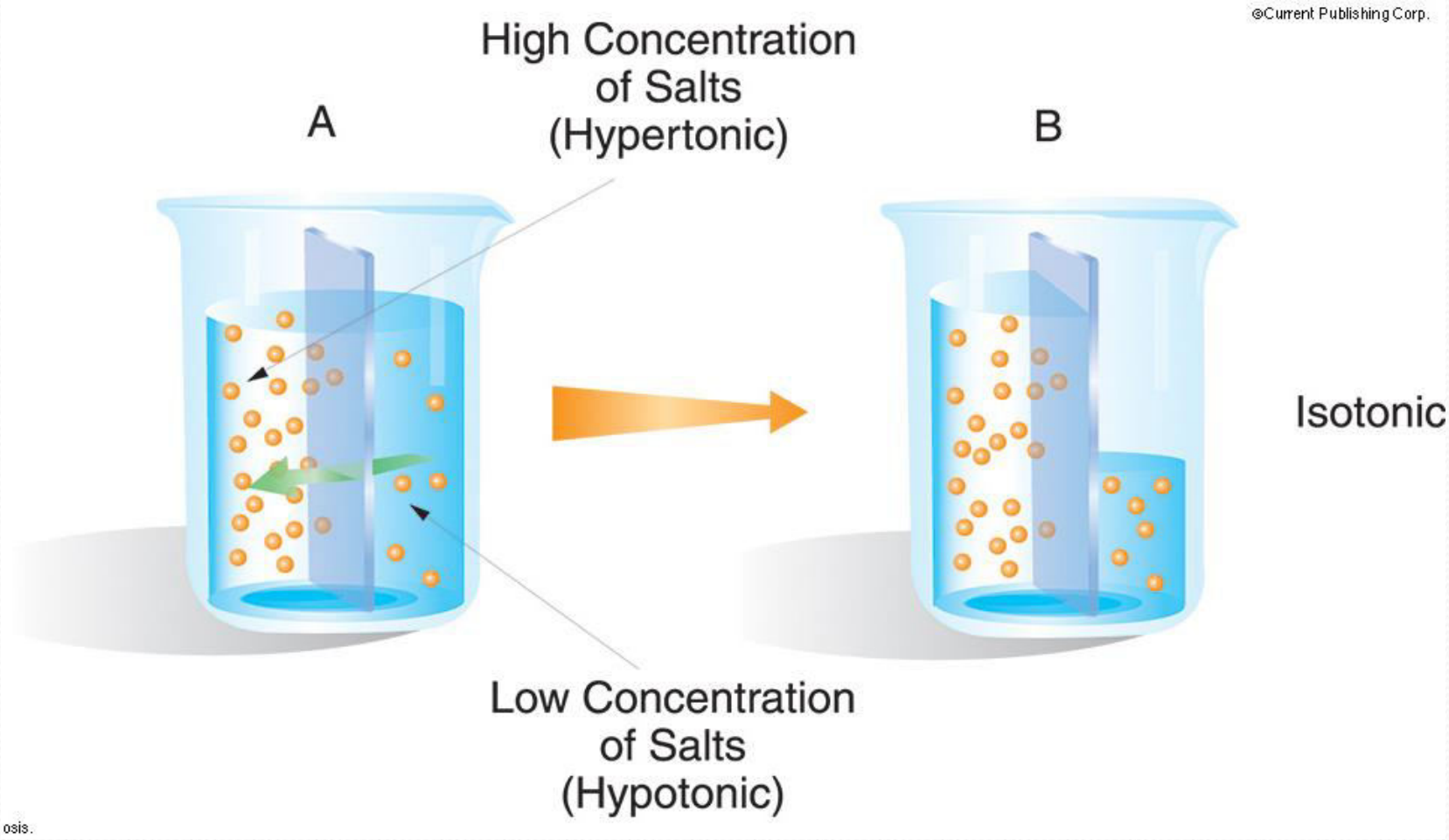
Definitions, continued

- Osmotic concentration
- Total concentration of all solutes in an aqueous solution
- measured in units of osmolal
- osmolals = 1 mole of solute/liter of water
  milliosmolals = 1/1000th of one osmolal

Osmoregulation in different environments

- Challenge to homeostasis depends on
  - steady state concentration of solutes in the body fluids and tissues as well as
  - concentration of solutes in the external environment
    - marine systems: environment concentration = 34 - 36 parts per thousand salinity = 1000 mosm/l
    - freshwater systems: environment concentration < 3 ppt salinity = 1 - 10 mosm/l
    - Estuaries: vary with tides and precipitation

Hypertonic vs Hypotonic

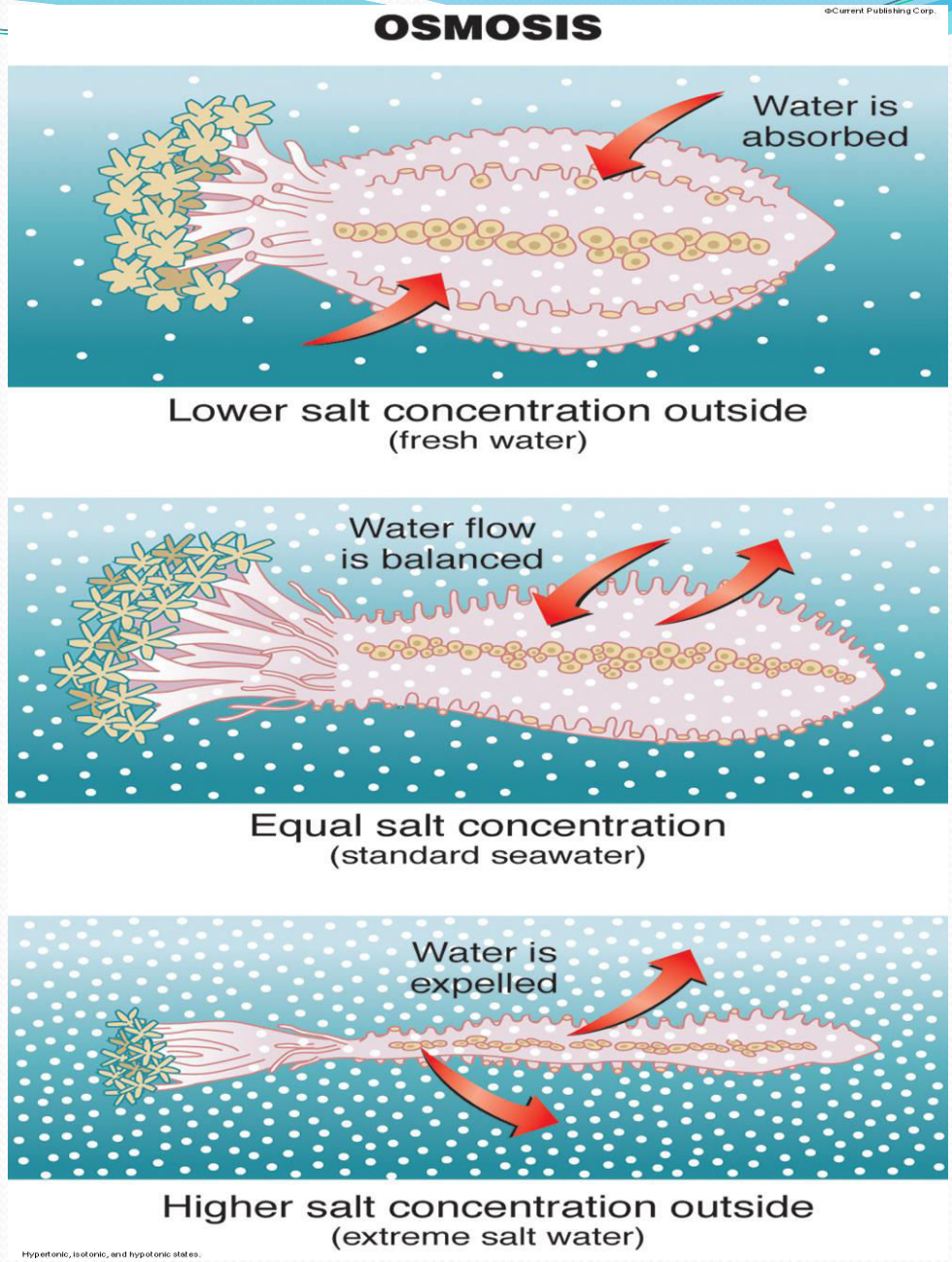


osis.

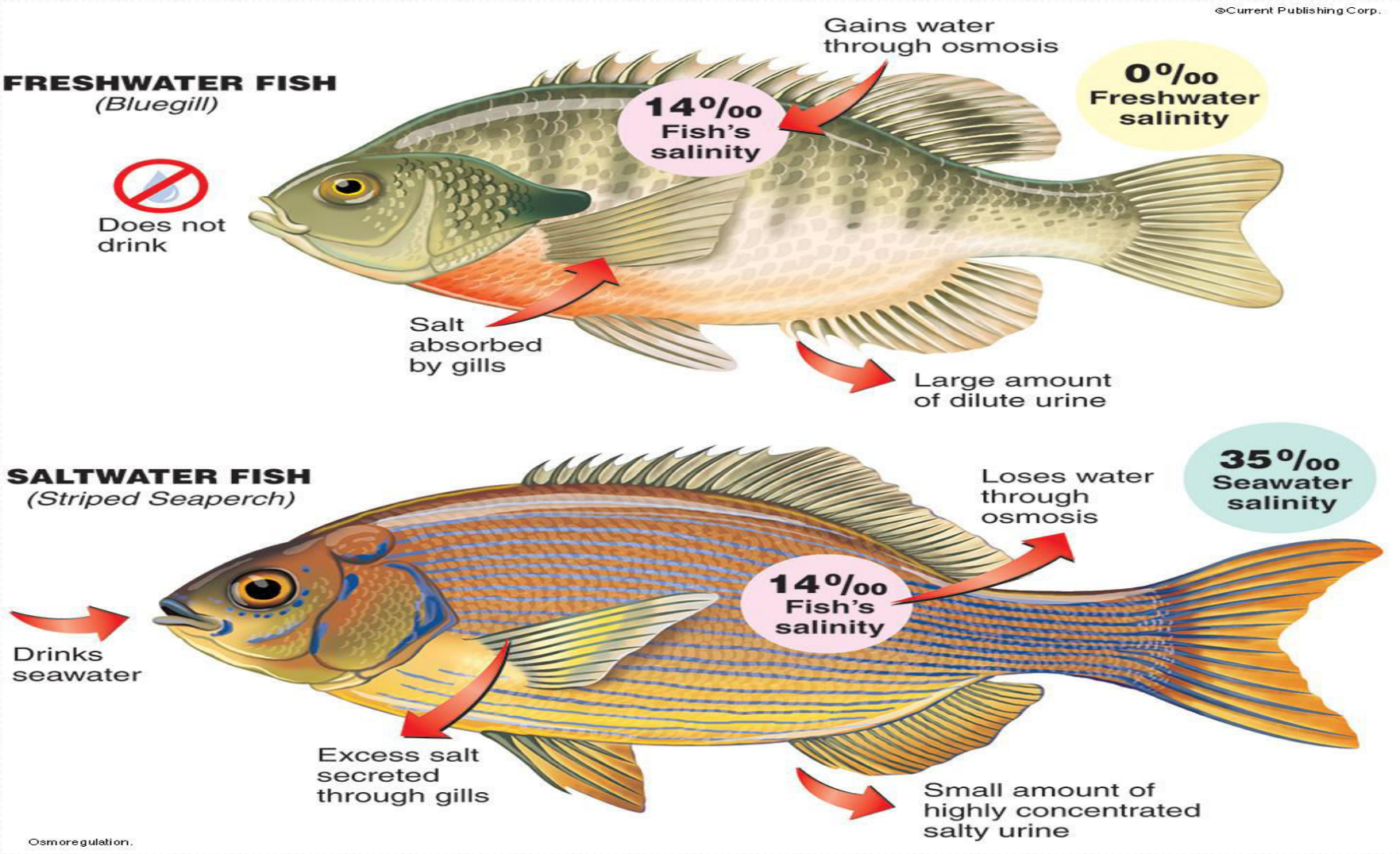
Osmoregulatory Strategies

- Hypoosmotic – saltwater animals
- Hyperosmotic – freshwater animals
- Isosmotic: regulation of specific ions
- Isosmotic: nearly isoionic, osmoconformers

Cells swell or shrink

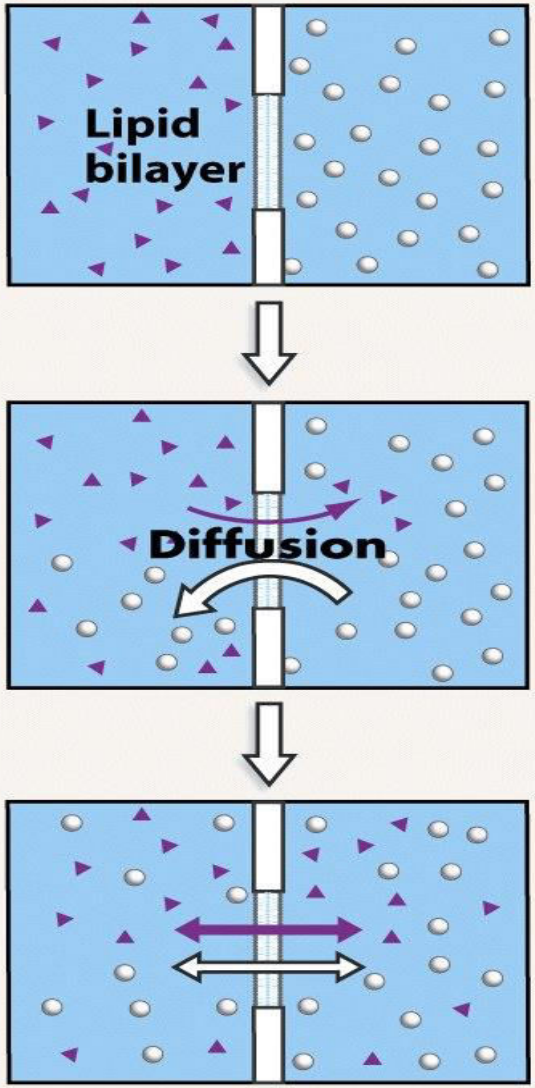


Freshwater vs Saltwater Fish



DIFFUSION

Solutes move from areas of higher concentration to areas of lower concentration.



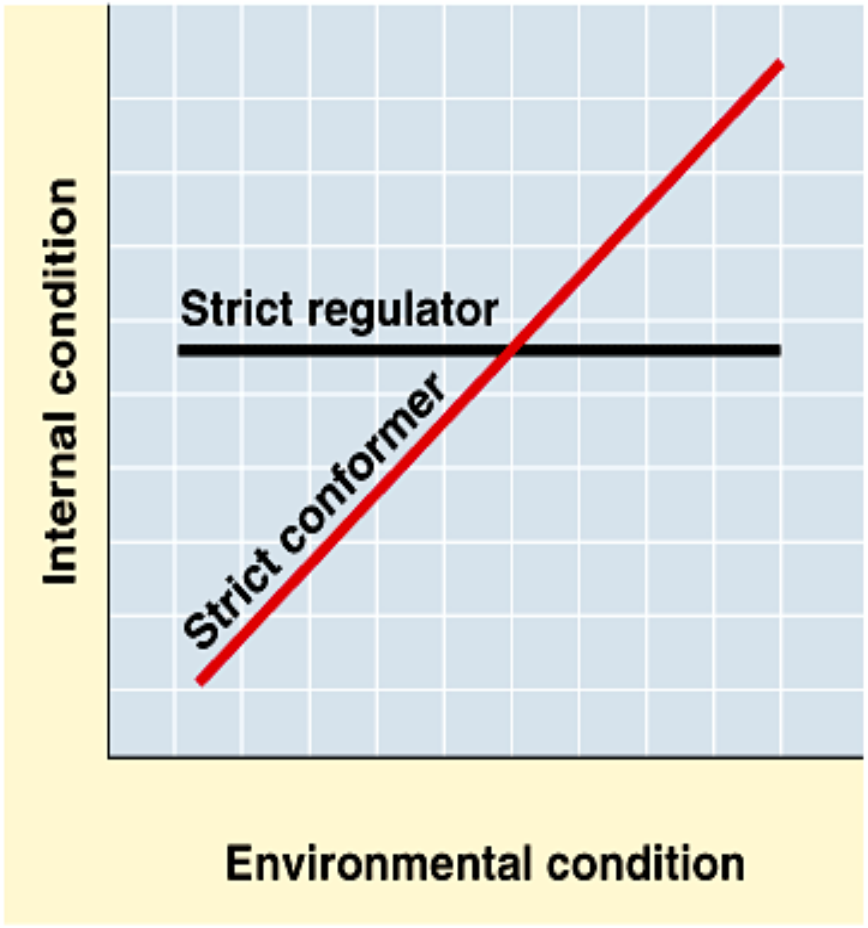
1. Start with two different molecules on opposite sides of a selectively permeable membrane (a phospholipid bilayer).

2. Molecules diffuse across the membrane — each along its own concentration gradient.

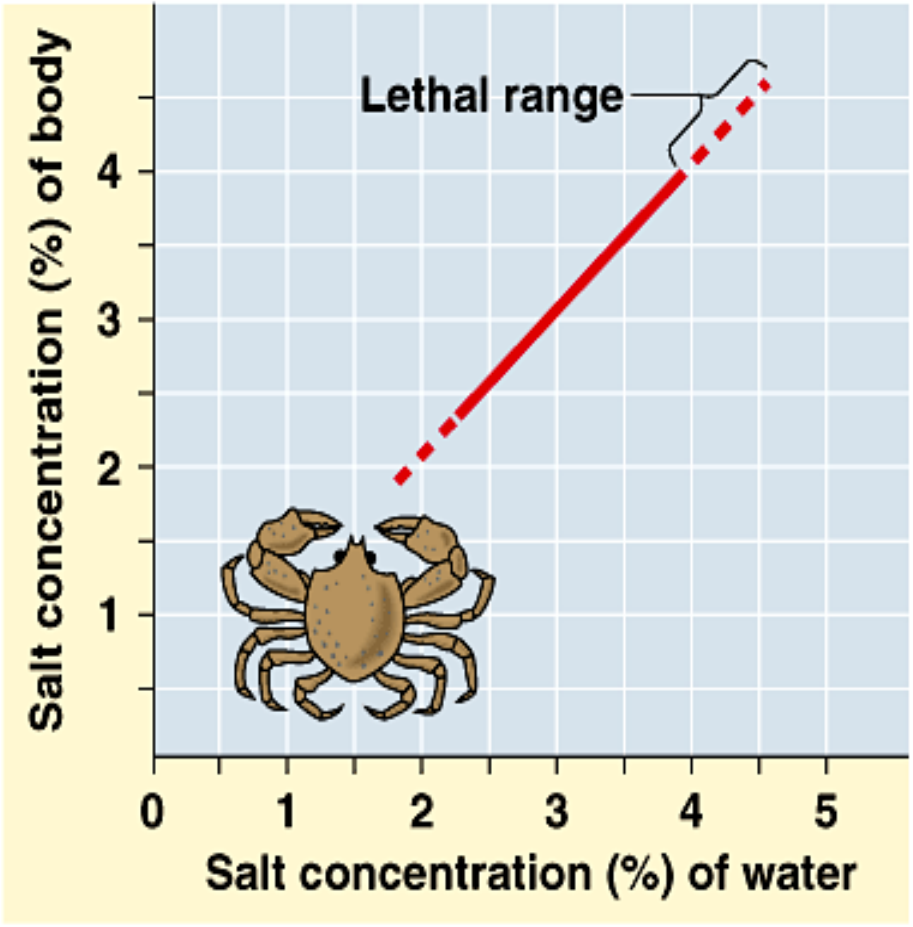
3. Equilibrium is established. Molecules continue to move back and forth across the membrane but at equal rates.

Figure 42-1a Biological Science, 2/e

Body fluid osmotic concentrations



(a)



(b)

Osmoregulation in different environments

- Each species has a range of environmental osmotic conditions in which it can function:
  - stenohaline - tolerate a narrow range of salinities in external environment - either marine or freshwater ranges
  - euryhaline - tolerate a wide range of salinities in external environment - fresh to saline
    - short term changes: estuarine - 10 - 32 ppt
      intertidal - 25 - 40
    - long term changes: diadromous fishes

Anadromous vs catadromous fish

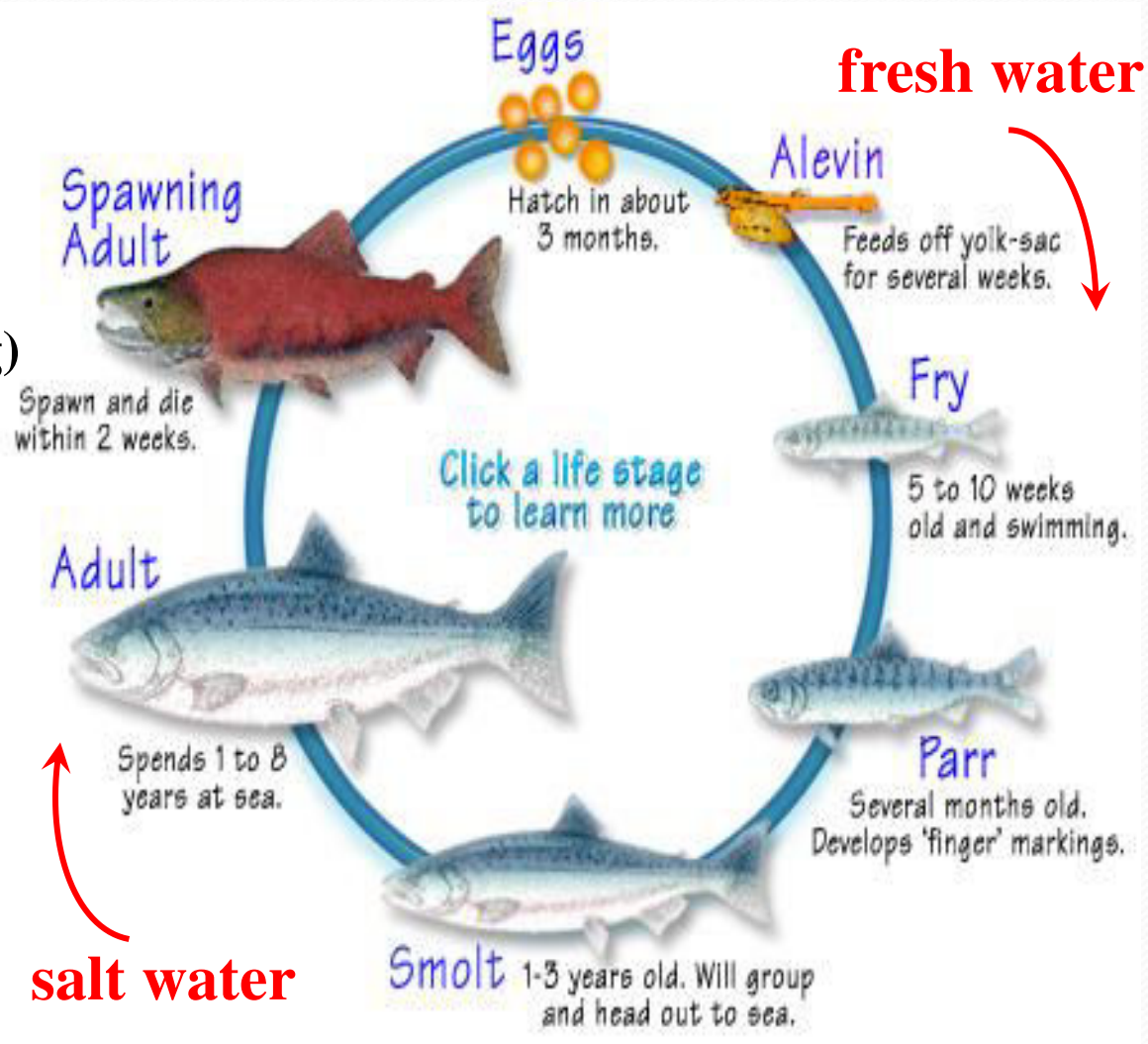
- **Diadromous** fishes - spend part of life in salt water, part in freshwater
- An **anadromous** fish, born in fresh water, spends most of its life in the sea and returns to fresh water to spawn (Greek: ἀνά *ana*, "up" and δρόμος *dromos*, "course") . Salmon, smelt, shad, striped bass, and sturgeon are common examples.
- A **catadromous** fish does the opposite - lives in fresh water and enters salt water to spawn (Greek: κατά *kata*, "down" and δρόμος *dromos*, "course") . Most of the *eels* are catadromous.

Diadromous fishes

Anadromous - Pacific salmon, lamprey, shad

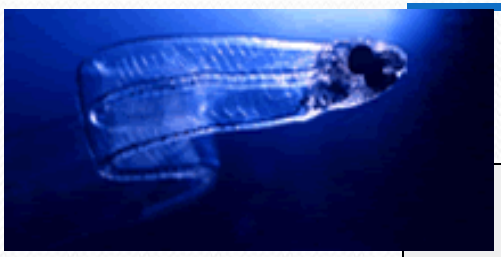
behavioral change (drinking)
changes in kidney function
landlocked species (Potamodromous) – reversion of salt-water tolerance

Metamorphosis – cued to photoperiod,
lunar cycle

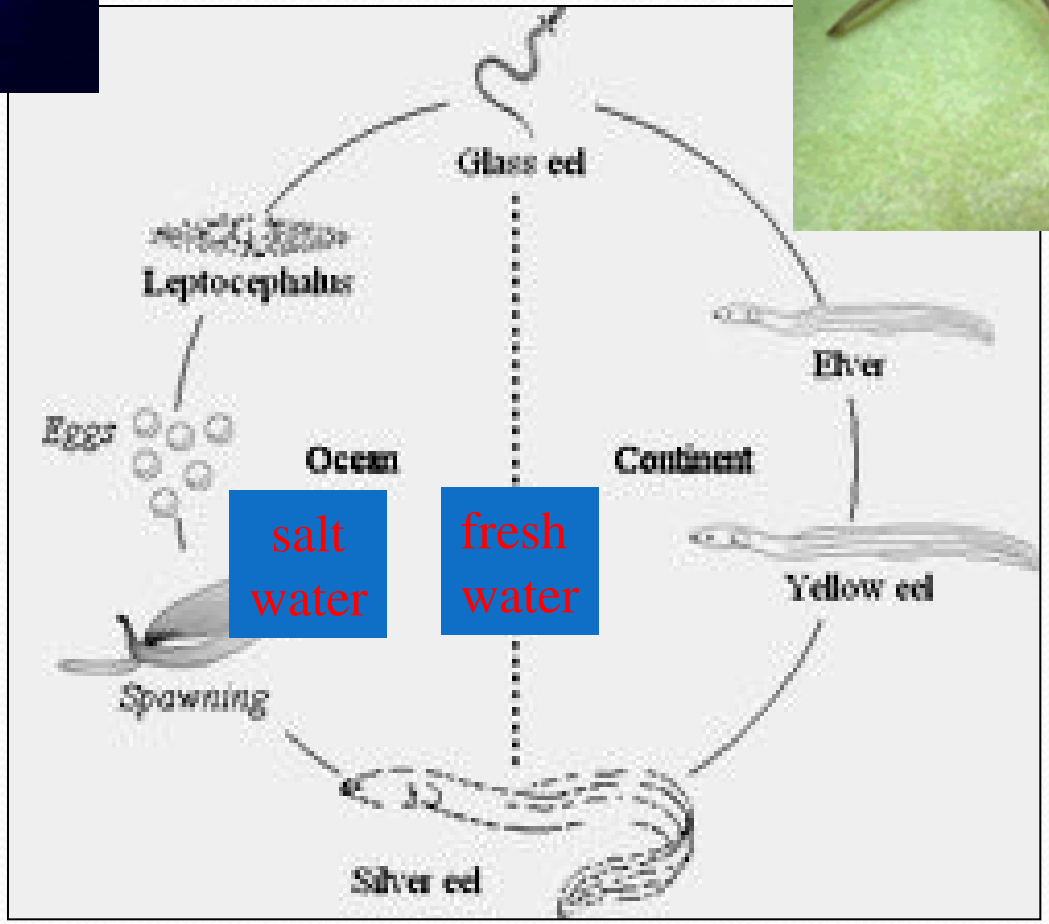


Diadromous fishes

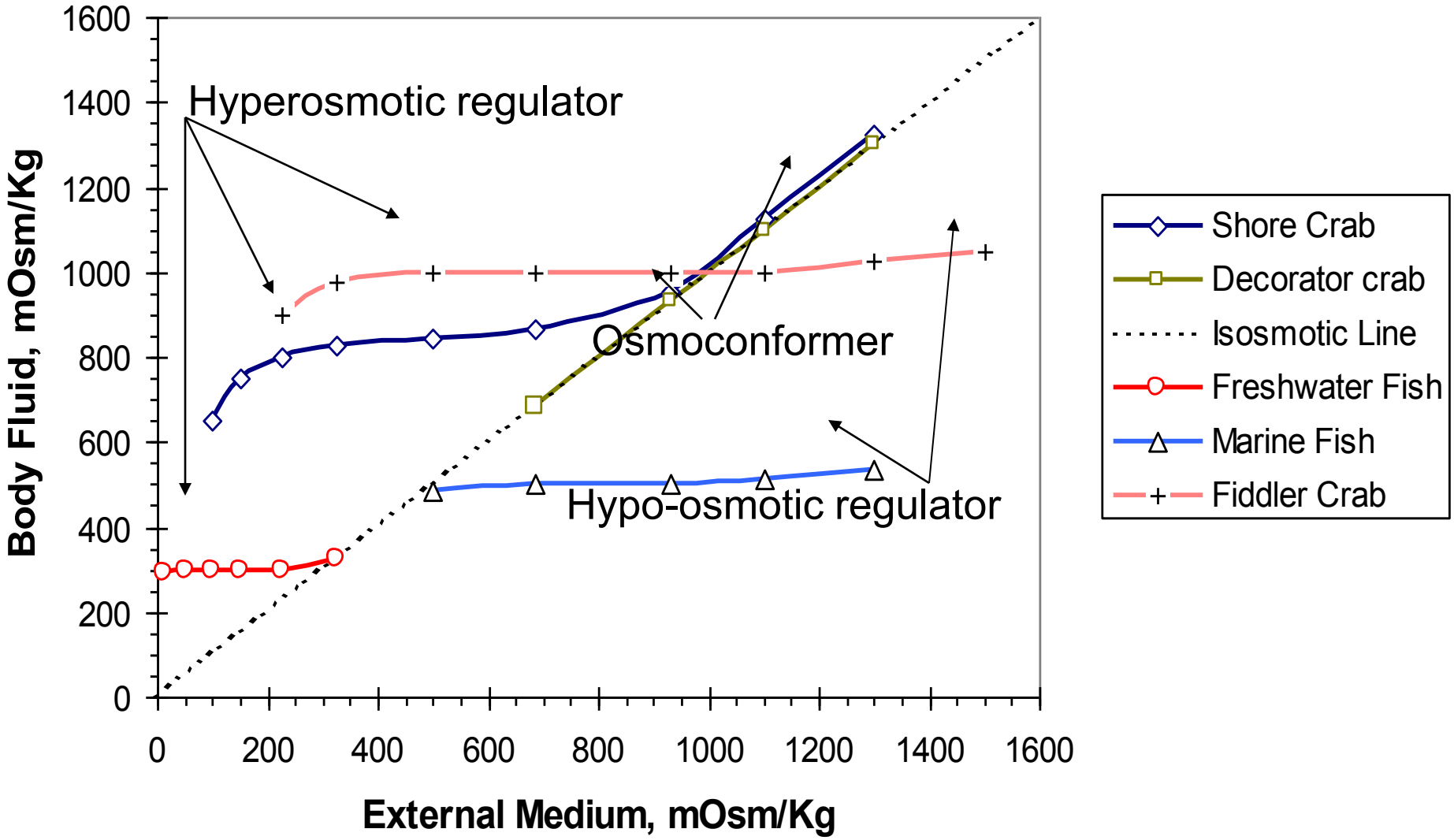
Catadromous - eels



Hormone-mediated changes associated with metamorphosis . Convert from FW adaptations to SW or vice versa, depending on direction of migration



Types of Osmoregulators



Osmoregulators and osmoconformers