Based on Mader, Sylvia S. 1996. Biology - 5th Ed.. WCB
and
Cox, G.W. 1997. *Conservation Biology* - 2nd ed. WCB [Chapter 8]
and
Levine, J.S. and K.R. Miller. 1994. *Biology: Discovering Life*. D.C. Heath [pp. 392-394, 682-687] and Chapter 38

I. Deserts

less than 25 cm rainfall/year
some less than 2cm rain/year
hot and cold deserts
1/3 of all land area
hot days cold nights because no water vapor to block radiation
wide variety of plants

A. adaptations to dry conditions - plants

a) short life cycles (annuals, rainy season)
b) annuals spend much of year as seeds

2. small leaves - thick cuticles
3. photosynthetic stems (reduced leaf surface area)
4. water storage
5. spines or chemicals for defense
a) spines - cactus
b) creosote - creosote bush
6. roots
a) deep to water source - mesquite tree
b) shallow to absorb infrequent rains - cactus
c) spacing of plants (chemical warfare underground) allelopathy

B. adaptations to dry conditions - animals

1. burrowing
2. nocturnal
3. short life cycles
4. living on water from respiration
5. efficient kidneys

II. Homeostasis

A. definition: the maintenance of internal conditions in cells or organisms

B. examples:
1. temperature
2. salinity
3. sugar levels
4. pH

III. Photosynthesis in Deserts

A. Three types of photosynthesis (pages 392-394)

1. Normal - C_3

a) RuBP carboxylase grabs CO_2
b) inhibited at high oxygen concentrations because photorespiration occurs
   (1) high oxygen under high light conditions
c) light reactions and carbon fixation proceed simultaneously in same cell

2. C_4 photosynthesis

a) PEP carboxylase grabs CO_2
b) carbon taken up in mesophyll cell and moved into bundle sheath cell as oxaloacetate
c) no photorespiration
d) carbon fixation in mesophyll, Calvin cycle in bundle sheath cells
e) less efficient because of energy lost in pumping materials, but even though less efficient, still better than C_3 under hot, dry conditions

3. CAM photosynthesis Crassulacean-Acid metabolism

a) CO_2 taken up only at night
b) stored in vacuoles - build up of oxaloacetate (acidic)
c) partitioning of carbon fixation and Calvin Cycle over time
d) stomata only open at night
e) low production, but works in extreme environment

4. overview: C_3 best under moist conditions, C_4 under warm, sunny, dry conditions, CAM under desert conditions

a) crabgrass is C_4 plant that thrives in late summer

IV. Water Balance [Chapter 38]

A. problem I: organism must maintain inside of body (cells) at constant salinity - balance of water and salt

definitions:

a) diffusion - the tendency of a substance to move from areas of high concentration to areas of low concentration
b) osmosis - diffusion across a semi-permeable membrane
c) osmotic concentration - the amount of material (solutes) dissolved in water
d) semi-permeable membrane: a membrane which allows certain materials (usually water) to pass, while retaining others (solutes)
e) note: water will move from areas of low osmotic concentration to areas of high osmotic concentration

B. problem revisited: an organism's body fluids (and cells) usually has a different osmotic concentration than the surrounding fluids

1. **on land, organisms lose water by evaporation**
2. **in freshwater, organisms gain water and lose salts**
3. **in saltwater, many organisms lose water and gain salts**
4. **some saltwater organisms have the same osmotic concentration as seawater**

C. solution 1: make body impermeable to water loss

1. **waxy coatings**

D. new problem: an organism must exchange some things with the environment to live:

1. **food - and to use food the organism (animal) must:**
   a) obtain oxygen
   b) release CO_2

E. problem revisited: An organism must maintain some surfaces open for gas exchange, and water will be lost or gained over that surface. To maintain homeostasis, this water loss must be balanced.

F. one last problem - excretion

1. **proteins composed of amino acids**
2. **amino acid composed of nitrogen + sugar (carbohydrate)**
3. **when broken down, amino acids yield:**
   a) CO_2
   b) water
   c) nitrogen (ammonia)
4. **ammonia is toxic and must be excreted**
   a) excretion - elimination of waste products from metabolism
   b) defecation - elimination of undigested wastes
5. **excretion of ammonia requires water - will affect homeostasis**

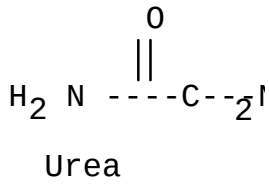
G. excretion: ammonia can be excreted in three forms:

1. ammonia - has one N

a) is highly toxic, requires much water to excrete
b) requires little energy to produce, easily moves into water
c) used by most aquatic organisms, moves across skin or gills

2. urea - has 2 N

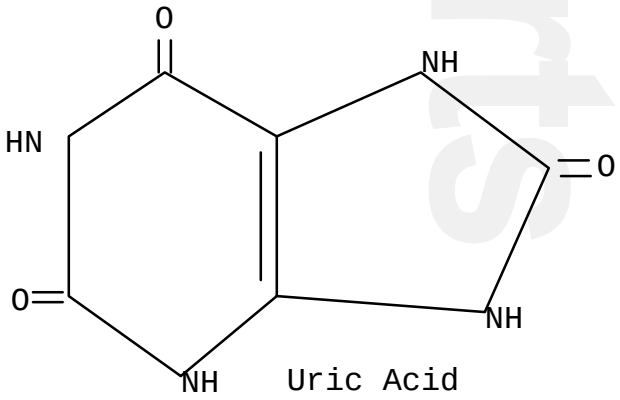
a) less toxic, requires less water to excrete
b) requires some energy to produce
d) used by terrestrial amphibians, sharks, mammals



Urea

3. uric acid - has 4 N

a) least toxic, requires very little water to excrete
b) requires more energy to produce
c) used by reptiles, birds - related to life in egg



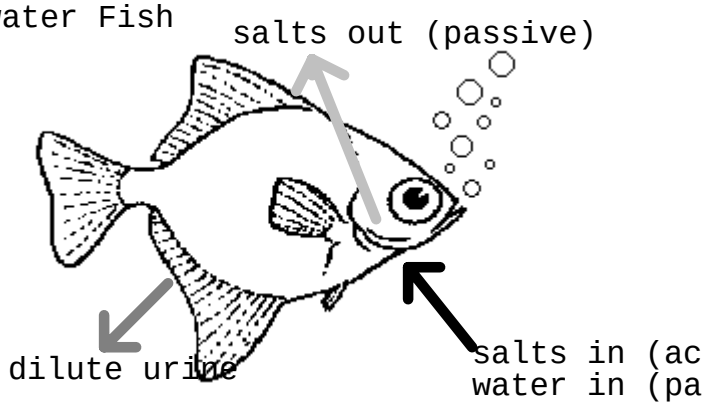
c) Uric Acid

H. Excretion: four case studies:

1. freshwater fish

a) body fluids have greater osmotic concentration than freshwater
b) absorb water, lose ions (salts), chiefly across gills
c) fish must take up ions, remove water
d) produces copious dilute urine - undeveloped kidneys
e) pumps salt in across gills
f) does not drink

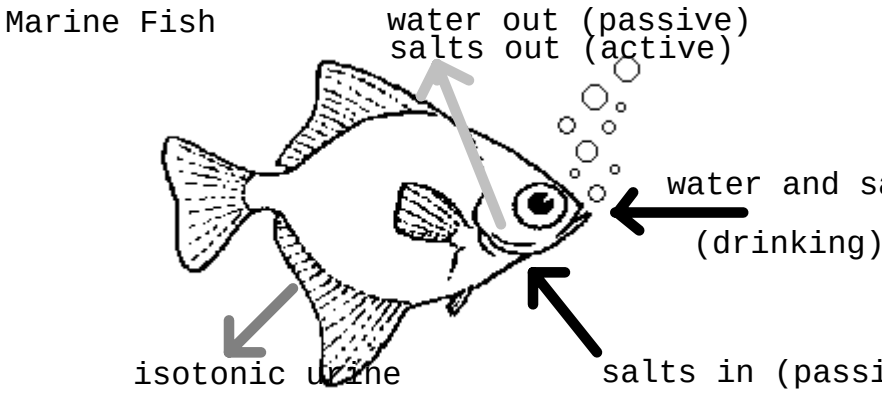
Freshwater Fish



g)

2. marine fish

a) body fluids have lesser osmotic concentration than saltwater
b) lose water, absorb ions (salts), chiefly across gills
c) fish must remove ions, drink water
d) produces isotonic urine - developed kidneys
e) pumps salt out across gills



3. human

a) loses water through evaporation, largely through lungs
b) water obtained from food, metabolism, drinking
c) concentrated urine produced by kidneys
   (1) urine not as concentrated as seawater

4. kangaroo rat

a) loses water through evaporation, largely through lungs
b) stays in burrow during day
   (1) burrow cooler, moister
c) water obtained from food, metabolism, - does not drink
d) concentrated urine produced by kidneys
   (1) urine more concentrated than seawater
   (2) porpoises, whales similar, can drink seawater

I. other forms of excretion:

1. nephridia - earthworms dilute urine, nutrients reclaimed
2. malpighian tubules - insects

a) branch of gut, trap uric acid, water
b) absorb water from uric acid

J. the mammalian kidney

1. urinary system

a) kidney forms urine
b) urine moves through ureter
c) urinary bladder hold urine
d) leaves body through urethra

2. kidney structure & function

a) made up of nephrons
(1) Bowman's capsule
(2) proximal tubule
(3) loop of Henle
(4) distal tubule
b) capillaries run through Bowman's capsule
(1) blood pressure forces salts, water, wastes from capillary into capsule
(2) blood cells and proteins stay in capillary
c) proximal tubule, loop of Henle
(1) water, salts, glucose reabsorbed
d) distal tubule, loop of Henle
(1) toxins pumped into urine
(2) penicillin too!

3. process controlled by hormones

a) ADH - antidiuretic hormone
(1) causes more water to be reabsorbed
(2) alcohol reduces ADH formation, increases urine
(3) caffeine also

4. kidney dialysis

a) blood is pumped through tubing in a salt solution
b) wastes leave blood

K. roles of organs in maintaining homeostasis:

1. gut

a) responsible for maintaining nutrient levels in blood
b)

2. lungs

a) responsible for maintaining O_2 and CO_2 levels in blood (also pH)
b)

3. gills

a) responsible for maintaining O_2 and CO_2 levels in blood (also pH)
b) salt uptake or excretion
c) nitrogen excretion

4. kidney

a) responsible for water and salt balance, excretion

5. skin

a) also important in water and salt balance
b) may play role in gas exchange, excretion, temperature regulation

6. liver

a) maintains starches to regulate glucose levels
   (1) low glucose level - starches broken down
   (2) high glucose level - starch formed

7. blood

a) maintains constant environment for cells
b) moves nutrients, wastes, heat, gasses

8. brain

a) controls other functions

V. Desertification

A. soil becomes too dry to support plant life

B. causes

1. grazing
   a) reduces plant life, which helps to hold down erosion, hold in moisture

2. physical disturbance
   a) cultivation
   b) mining
   c) vehicles
   d) all remove native plants

3. deforestation of tropical dry forests
   a) building material
   b) fuel

4. irrigation
   a) cannot be sustained - salts build up in soils

5. changing rain patterns

6. **global warming?**

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