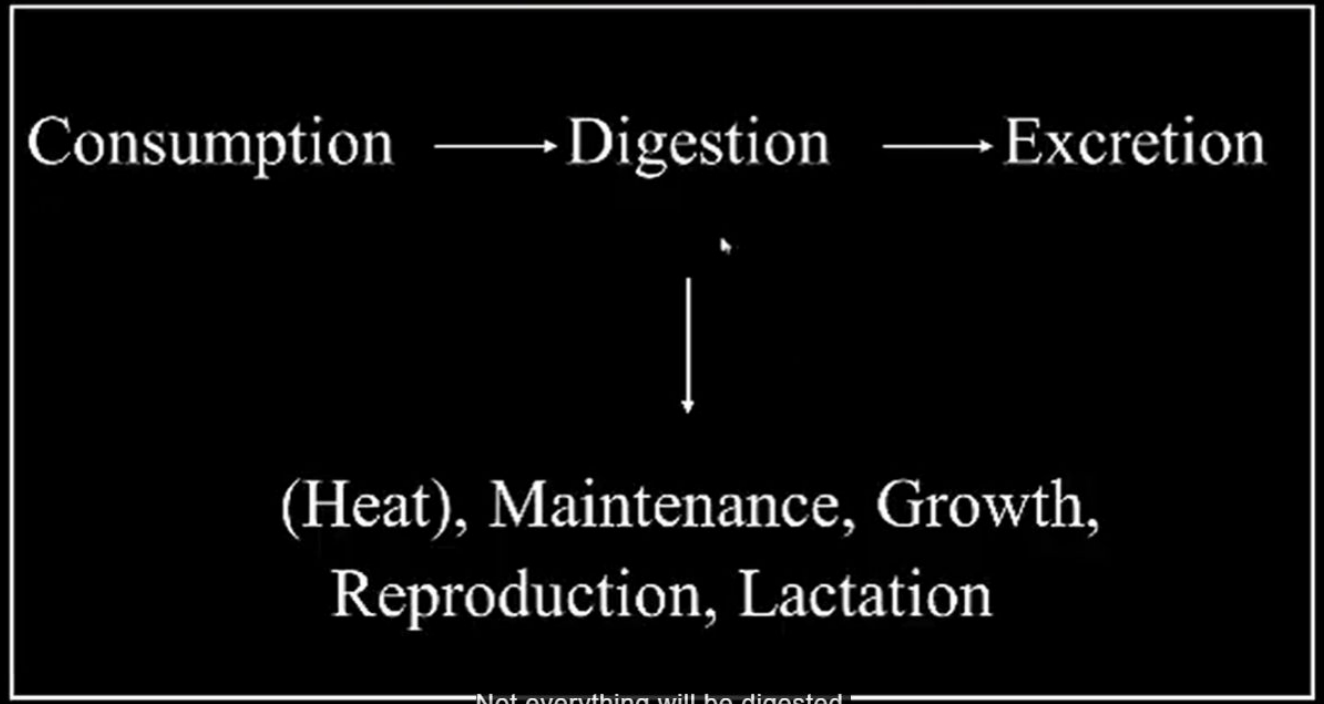
INTRODUCTION TO NUTRITION



Not everything will be digested.

General Nutrition
Six basic nutrients

1. Protein
2. Fats
3. Carbohydrates
4. Vitamins
5. Minerals
6. Water

Source of Nutrients

- In the wild, most animals would eat a varied diet and get all of these nutrients.
- Pets depend on us to supply them.

PROTEINS

- Protein - thousands of kinds and functions
- Made up of **amino acids**
  - 20 - 30 important amino acids
  - 10 - 12 essential amino acids
  - **Essential amino acids** are those that must be supplied in the diet (are not produced by the animal)
- Animals actually need specific amino acids (not protein, *per se*)
- Requirement is usually listed as "% crude protein"

And the first one I'll
talk about are proteins

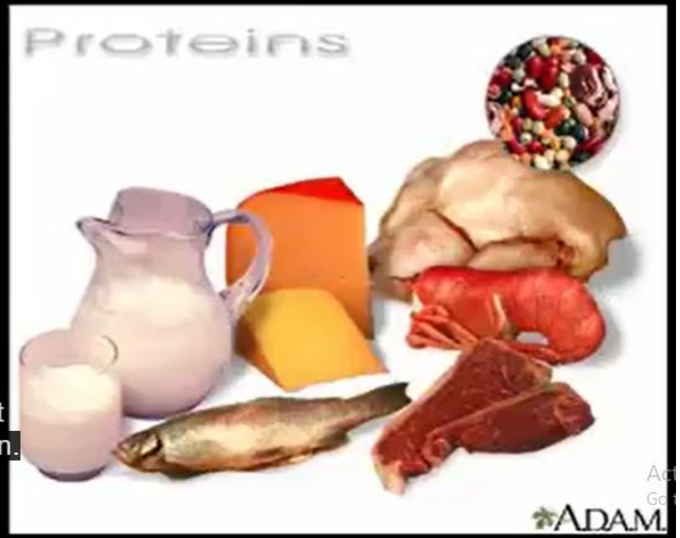
Essential Amino Acids

- arginine
- histidine
- isoleucine
- leucine
- lysine
- (cystine)
- phenylalanine
- threonine
- tryptophane
- valine
- methionine

you probably will, but we

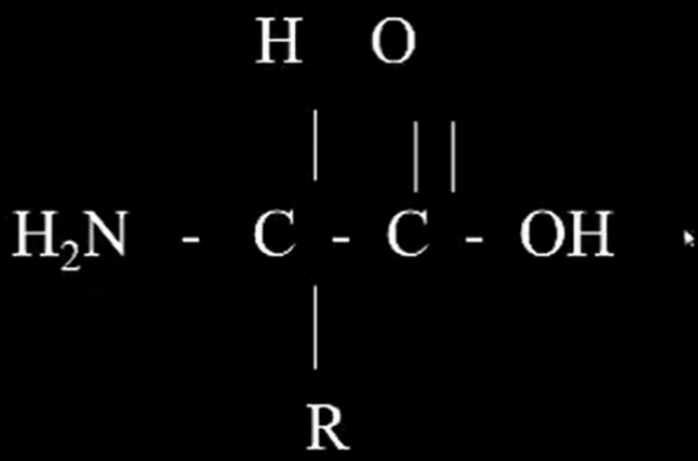
PROTEINS

- Very important in young growing animals
- Examples of protein sources
  - Eggs
  - Meat
  - Soybean meal
  - Alfalfa
  - Corn gluten meal
  - Insects
  - Blood meal
  - Fish meal
  - Feather meal
  - Nuts
- Quality of protein is variable



Just a little bit more on protein.

Characteristics of Amino Acids



Important keys to remember: "R" group different in each amino acid, in simplest form it is H

AND, nitrogen is present in H_2N group

And so I won't ask a lot about chemistry in this class.

Fats (fatty acids)

- A few are essential depending on species
  - linoleic acid
  - linolenic acid
  - arachidonic acid
- Fats are also important as a delivery vehicle for fat-soluble vitamins

I will point out,

Point to keep in mind for later!

- Fat will produce 2.25 times more energy than carbohydrates, per unit.

And we'll talk about
calories in a few minutes.

Fatty acids (continued)

- Deficiency can lead to poor skin, hair loss, uncontrolled nervous responses, and mortality.
- Sources:
  - Oils
  - Fats
  - Lard
  - Tallow

like poor skin and hair loss.

Carbohydrates (starches, sugars, cellulose, etc)

- None are technically essential.
- Digestibility varies among species.
- Very common, inexpensive source of energy used in most feeds.
  - corn, rice, wheat

starches, sugars, cellulose is one.

MORE ON ENERGY

- Energy can be supplied by
  - fats
  - carbohydrates
  - proteins
- Energy is produced by breaking C - H bonds

Those can be used.

Measures of energy

- Calorie = energy required to increase the temperature of 1ml of water 1° C

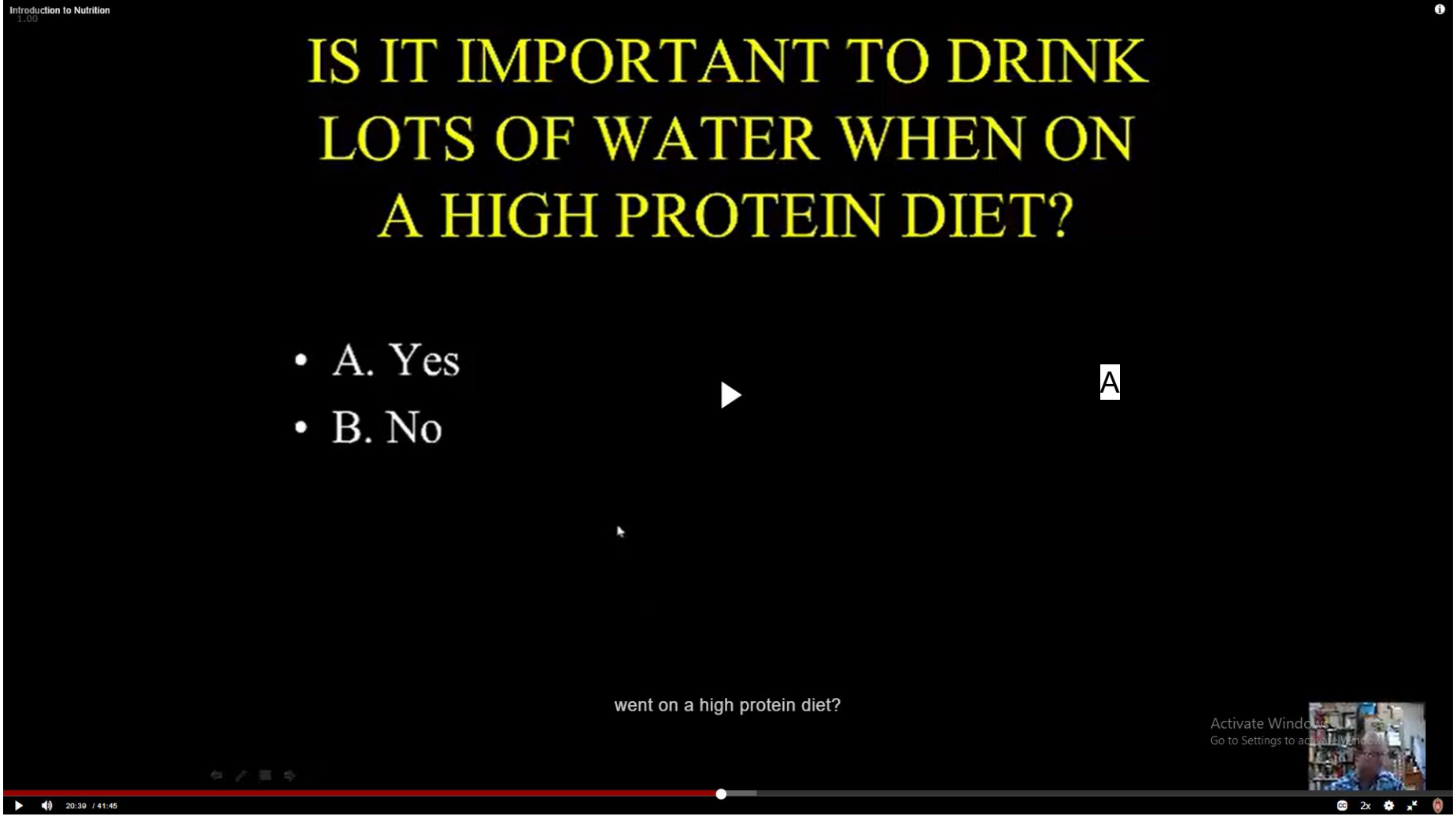
A calorie is really a measure of heat or heat energy.

What happens when protein is used for energy, rather than as protein (building muscle, etc.)?

D

- **A.** All of it is used for energy.
- **B.** Some parts are used and some are excreted.
- **C.** Some parts are excreted and some are stored for later.
- D. Both B and C are possible

Okay, so couple questions
I want you to think about.



Problems with energy

- Problem with the use of **protein** as an energy source
  - kidneys
  - cost
- "Problem" of use of **fat** for energy

suggest not using protein as an energy source.

Vitamins

- Involved with many functions in the body
  - Coenzymes
  - Antioxidants
  - Hormones
  - Catalysts
- Fat soluble:
  - A epithelial tissue, eye sight
  - D bones and teeth
  - E antioxidant, normal reproduction
  - K blood clotting
- Water soluble:
  - Thiamin, riboflavin, niacin, B_6, B_{12}, folic acid, pantothenic acid, biotin and vitamin C

Water soluble vitamins (continued)

- Vitamin C is an essential vitamin in some fish, guinea pigs, and primates

Minerals

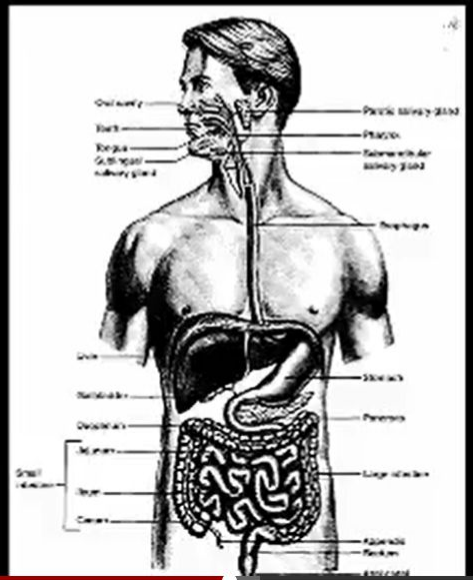
- Minerals are inorganic
- Functions
  - Cofactors for enzymes
  - Components of bones and teeth
  - Electrolyte balance
  - Cell structure and function
- Macro minerals - Ca, P, K, S, Na, Cl
- Trace minerals - Fe, I, F, Zn, Se, Cu, Mn, Mg, etc.
- In fish, some minerals will be absorbed from the water.

Water

- Arguably the most important
- Functions
  - Shape and structure
  - Transport - nutrients and wastes
  - Solvent for chemical reactions
  - Heat regulation
- Deficiency symptoms
  - headaches, lethargy, mood changes and slow responses, dry nasal passages, dry or cracked lips, dark-colored urine, weakness, tiredness, confusion and hallucinations

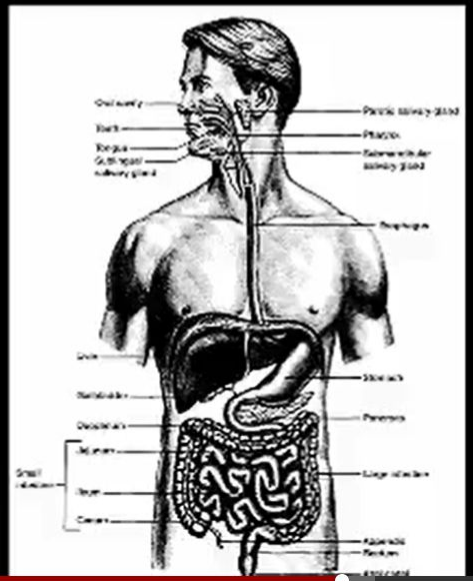
DIGESTIVE TRACT

- Monogastric animal
- Human – example (~20 feet long)
  - Mouth
    - Mastication
    - Saliva – with enzymes
  - Esophagus
  - Stomach
    - Acid
    - Enzymes
    - Storage
    - Some mixing



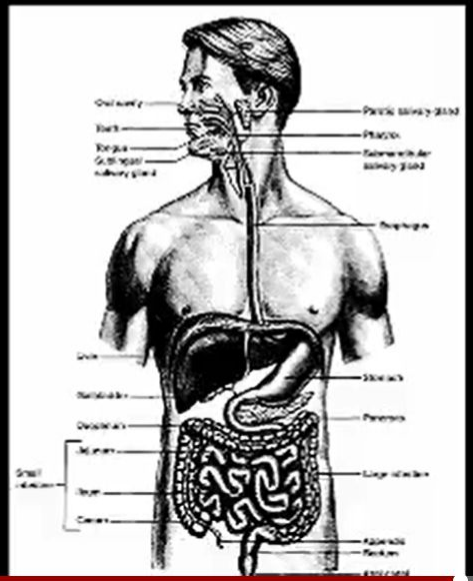
DIGESTIVE TRACT

- Small intestine
  - Duodenum, jejunum, ileum
  - Digestive enzymes
  - **Absorption**
- (Pancreas)
- (Liver)
  - (Gall bladder)
  - Bile



DIGESTIVE TRACT

- Large intestine (colon)
  - Water resorption
  - Microbial digestion
  - Vitamin and salt absorption
  - Fatty acid absorption
  - Storage
- Rectum
  - Storage of feces
- Anus
  - Defecation



Specific Aspects of Fish Nutrition

- Aquaculture industry has provided most information on fish nutrition
- High protein (lower energy) - 40% protein is not unusual.
- Young growing animals need higher protein than do mature animals.
- VERY important to have highly digestible diet
- Factors affecting nutrient requirements
  - Age
  - Sex
  - Temperature *
  - Size
  - Breeding status
  - Sickness

Reasons energy requirement is less than land species

- **Thermal control**
- Movement
- Resistance of gravity

Don't overfeed.

- Adult fish only need what they will eat in about 5 minutes, once a day.
- Juveniles, 3 minutes, 3 times a day

Live Feed

- Necessary for some species
- Can transmit diseases
- Can take over a tank
- Some examples:
  - Brine shrimp -- other fish
  - *daphnia* -- flies
  - worms (earthworms, tubifex)
  - ants are not good

Warning Signs of Malnutrition

- Fish don't eat
- Fish don't grow
- Fish stay at surface

FEEDING FRY

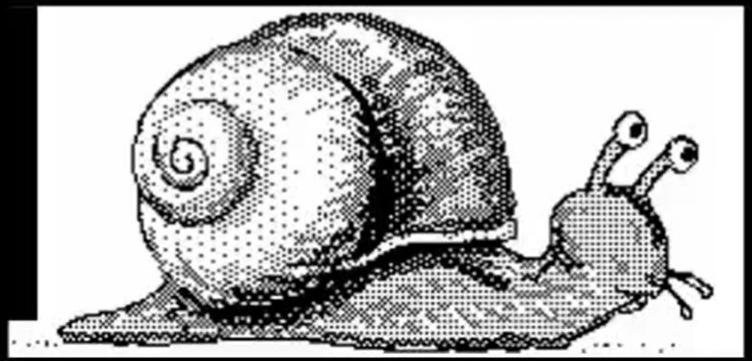
- Will live off egg for first few days
- Then, can only eat microorganisms at first
  - infusoria
  - "green water"
- You can "make" this yourself
  - use water from an established tank
  - add a little lettuce, grass, (boiled egg), etc.
  - wait a few days

FEEDING FRY (cont.)

- Later, can eat naupalii (baby brine shrimp)
- You can also "grow" these
  - add brine shrimp eggs
  - add salt
  - add aeration
  - wait a couple days
- Also, can use daphnia (young, then adult)

FEEDING FRY (cont.)

- Best to raise in a large, established tank
- Good to have some snails to clean up
- Generally, parents should be removed
- Be careful when cleaning (!)



FUNDAMENTAL FACTORS

Liberal water surface
Enough light
Right temperature
Water quality
Correct feeding

FUNDAMENTAL FACTORS

Liberal water surface

Enough light

Right temperature

Water quality

Correct feeding

Light

- Probably more important for our viewing.
- Much more important if you have live plants.

TEMPERATURE

- Tropical:
  - 72-78 F, usually
  - 75 F optimal, for most species
- Goldfish
  - below 60 F, optimally
- Remember, cold water holds more oxygen than does warm water

CORRECT FEEDING

- Feed what the fish will eat in about 5 minutes.
- Feed once a day, and skip a day once in a while
- Juvenile fish will need to be fed more often.

LOCATION

- Away from direct sunlight
  - Why?
- On a sturdy stand or table
  - Estimate 10 pounds per gallon of capacity
- Not on a radiator or in front of a heater
- Most importantly -

Where you can watch it.

3 TYPES OF FILTRATION

- Mechanical
- Chemical
- **Biological**

FILTER MATERIALS

- Mechanical
  - Gravel (~1-2 lbs / gal.)
  - Wool, floss etc.
- Chemical - activated charcoal, usually
- Biological -- **bacteria**

DECORATIONS

Okay

Glass
Plastic
Stainless Steel

Driftwood

Bad

Coral
Limestone
Marble
Metals

What Kind of Water?

- Tap water is best
- Chlorine concerns
- Distilled water (??)

- Water needs vary by species, too.

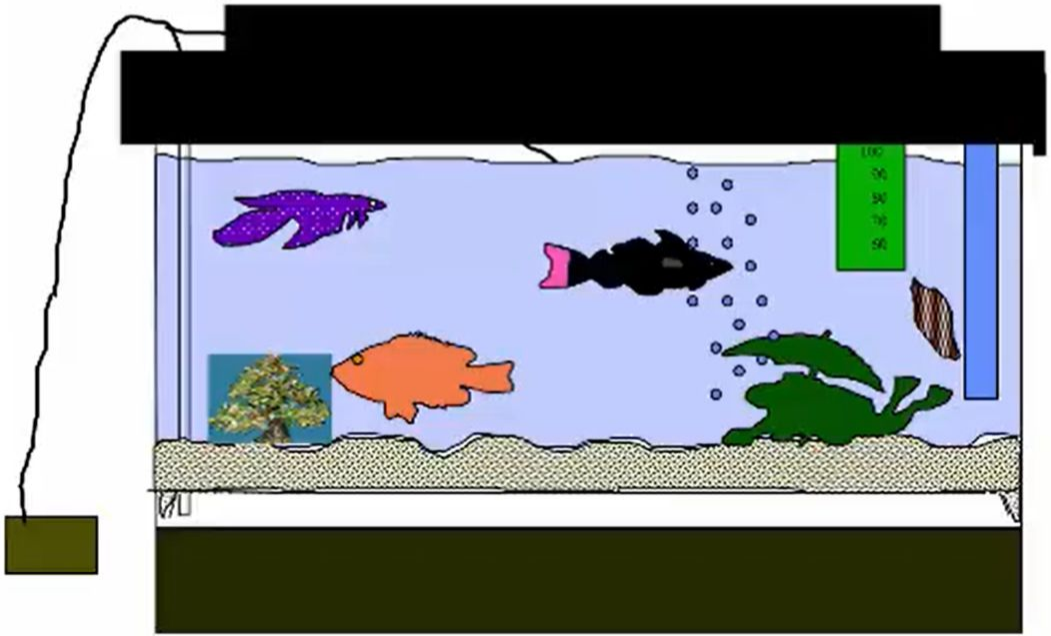
PLANTS

- Live plants (with adequate light)
  - add oxygen
  - remove some wastes
- Rotting plants (or without adequate light)
  - consume oxygen
  - add more wastes

How Many Fish?

- Two ways to measure capacity
  - one inch per gallon
  - use surface area
    - 3 square inches for small fish
    - 4-8 square inches for larger fish
- Aeration and plants may increase it slightly
- Keep in mind that the fish will grow some
- Don't judge by what you see at stores
- Best to add fish a few at a time (more later)

ADD COVER, LIGHTS

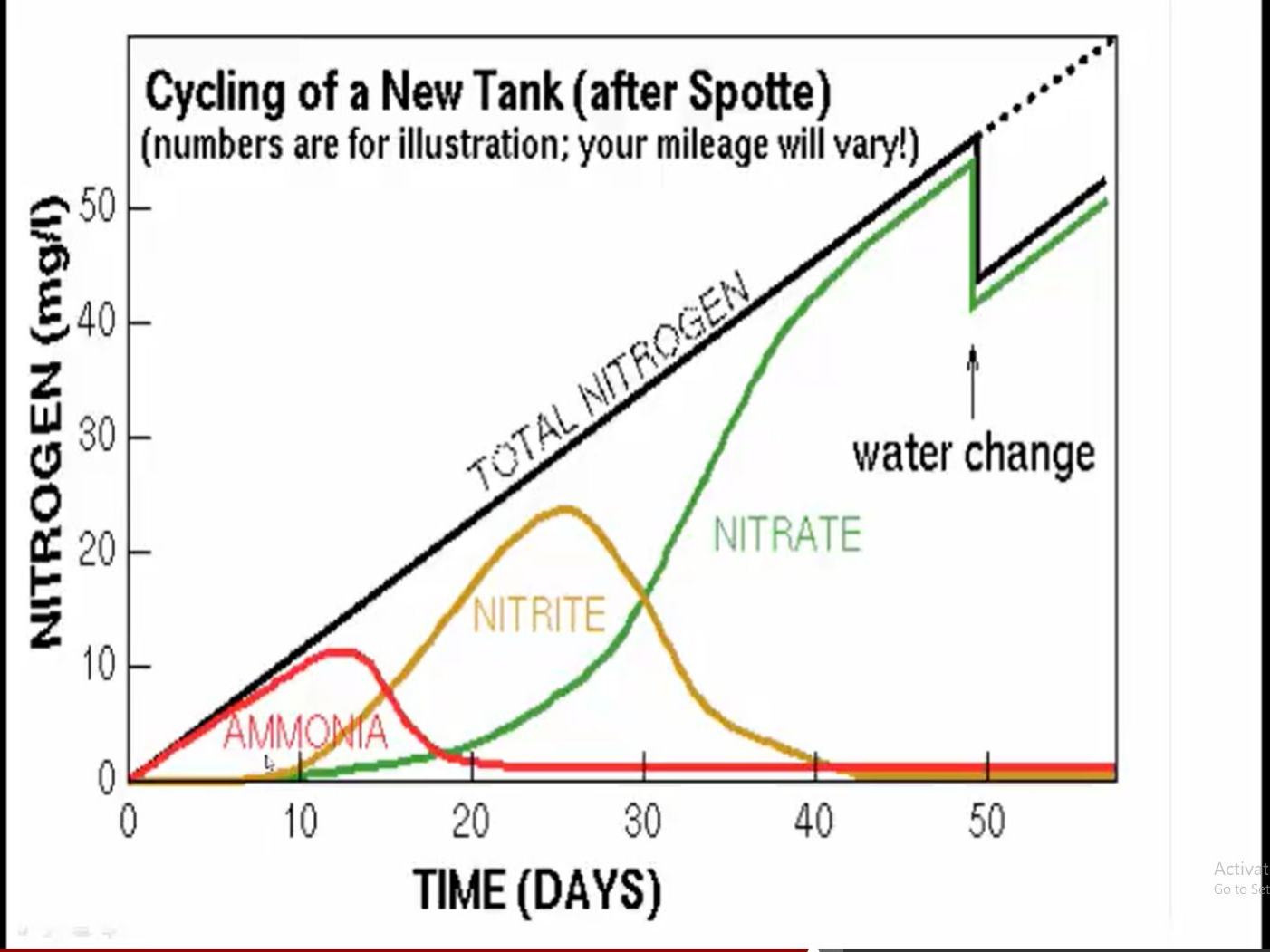


Foul odor is a bad sign.

- Caused by decomposition of:
  - fecal matter
  - dead plant material
  - dead fish, snails, etc.

Relatively little energy required.

- Streamlined movement.
- Decreased need to overcome gravity
- **Little lost heat to environment.**



WHY SHOULD FISH BE ADDED A FEW AT A TIME (THEN WAIT A FEW WEEKS BEFORE ADDING MORE)?

A. Saves money to buy just a few at a time.

B. There is less fighting among the fish.

C. It gives biological filtration time to multiply to handle excess waste production.

D. It doesn't matter. You can add them all at once.

C

Cleaning your Aquarium

- Scavengers (snails, catfish, crayfish, etc.)
- **Partial water changes** every two weeks
  - (20-40%)
  - Use a gravel vacuum
- Scrape off algae
- Clean/change filters as necessary
- Remember biological filtration

ADDING NEW FISH

- Feed “old” fish first
- Float bag on top for 20-30 minutes or longer
- Put fish in
  - Add tank water to bag (?)
  - Remove fish from bag with net (?)
- May want to consider quarantine tank

MARINE ANIMALS & KEEPING A MARINE AQUARIUM

MARINE AQUARIUM

- Requirements differ quite a bit from fresh water
- Conditions must be monitored more closely
- Organisms are more fragile, generally
- More important to have a quarantine / hospital tank

A MARINE AQUARIUM

- pH is very important
  - 8.0 to 8.3
  - below 8.0, add sodium bicarbonate
  - change gradually
  - use calcium carbonate sources
    - dead coral, seashells, limestone
    - slowly break down in water
    - buffer against acids

SIDE NOTES ON pH

- Distilled water – pH 7
- Acidic – lower than 7
- Basic – higher than 7
- Fresh water aquarium – usually between 6 and 7

A MARINE AQUARIUM

- Salinity is very important
  - measured by density
  - measured with an hydrometer
  - density should be 1.023 at 81 F (27 C)
  - equivalent to about 35 ppt salt

FILTRATION

- Same basic principles as with fresh water
- Very susceptible to ammonia toxicity
- Usually need protein skimmers, too
  - remove foam from the top
- Also use live rock and live sand
  - Small organisms help with biological filtration
  - Can buy cultured live rock now (not collected from wild)
- May also use UV or ozone sterilizers

A MARINE AQUARIUM

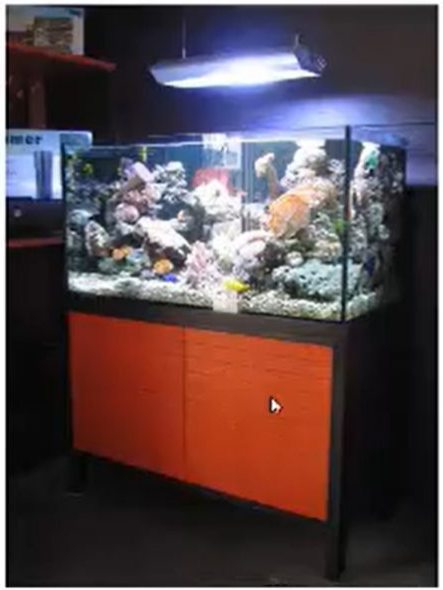
- Good to add water from an established tank
- Even more important to avoid metals
- Probably need some water monitoring kits
  - May be fairly simple to quite elaborate

CORAL REEF TANKS

- Need strong lights
  - Many coral have symbiotic relationship with algae
- Some will need wave motions

VERY IMPORTANT KEY

- Patience, patience, patience



Sea Horse *Hippocampus erectus* *(spiny fish)*

- Swim erect -fins vibration 35 times per second
- Prehensile tail - secure while resting and feeding
- Color - often change from brown to bright red
- Captive bred seahorses will eat frozen food

Reproduction

- Rivaled only by its fascinating appearance is the extraordinary reproductive process.
- When male is ready to breed he pumps up his brood pouch with air bubbles
- Female approaches the male frontally

Reproduction (cont.)

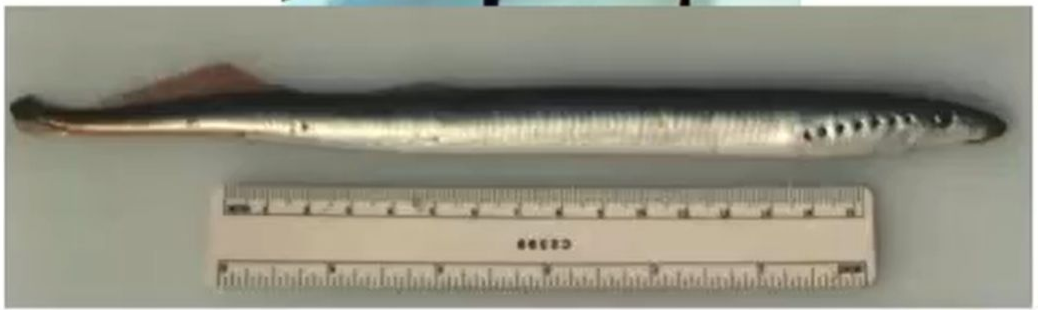
- Female inserts her ovipositor and places eggs into a small opening on front side of the male's tail
- Eggs are fertilized internally and the opening is sealed
- Gestation period will be at least 10 days, if cold water it may be 30 days
- Through an exhausting process, the male Sea Horse gives birth to 60 -70 precocious babies one at a time

Introduction to Fish

- Kingdom: *Animalia*
- Phylum: *Chordata*
- Class: 3 different classes

Class *Agnatha*

- jawless fish
  - Generally problem as a parasite



Lamprey damage

Class *Chondrichthyes*

- cartilaginous fish

SHARKS AS PETS

- Generally, not a good idea
- Bamboo sharks can be kept
- 3 ½ feet long
- Minimum 200 gal. aquarium
- Carnivorous – feed shrimp, squid, etc.

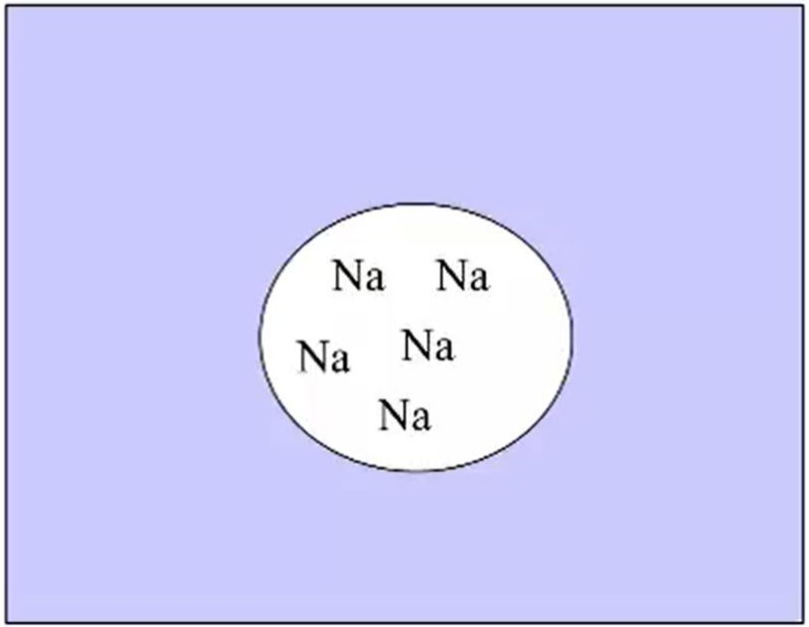
Class *Osteichthyes*

- bony fish

FISH EVOLUTION

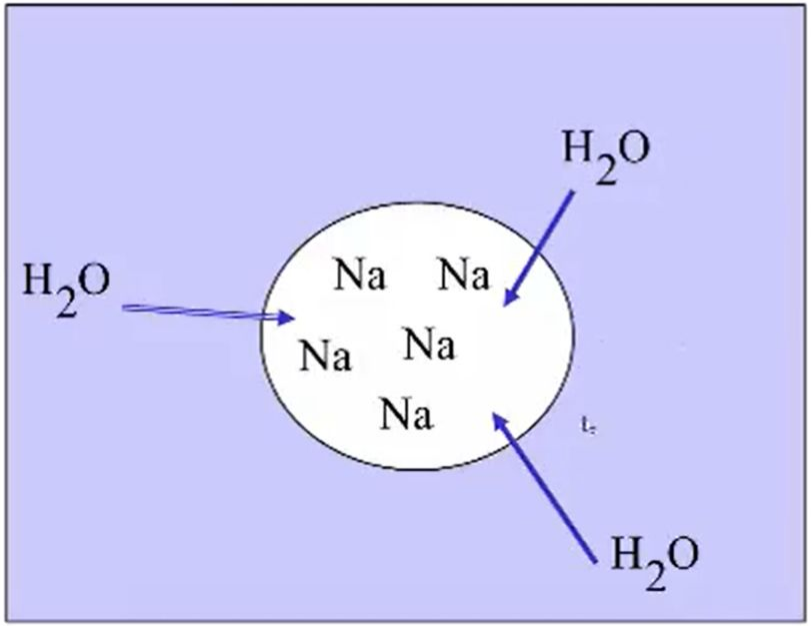
- About 25,000 living species
- Interesting to think about life in water
  - cells have some salts in them
  - more than fresh water
  - less than salt water
  - (fresh water < cells < marine water)
  - fish have developed methods of handling this

Cells in fresh water

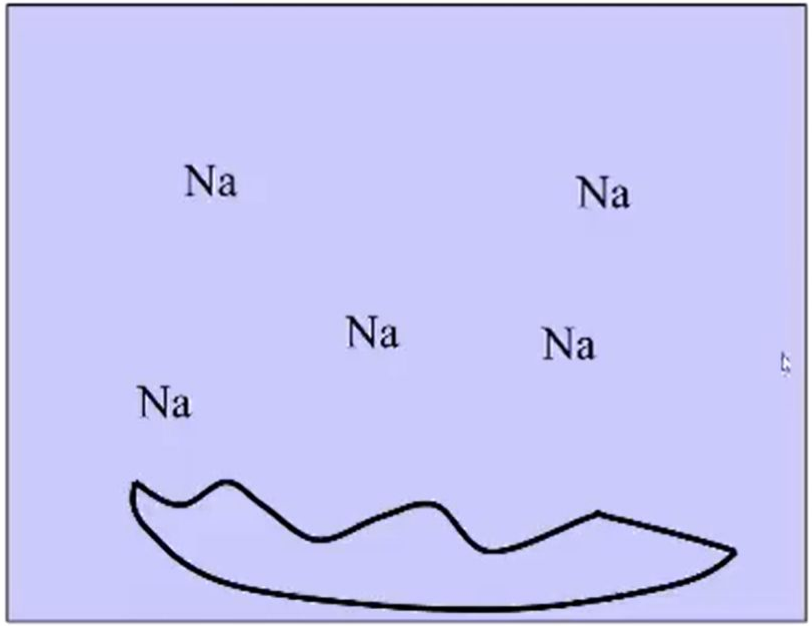


Assume cell membrane won't allow salt to pass through.

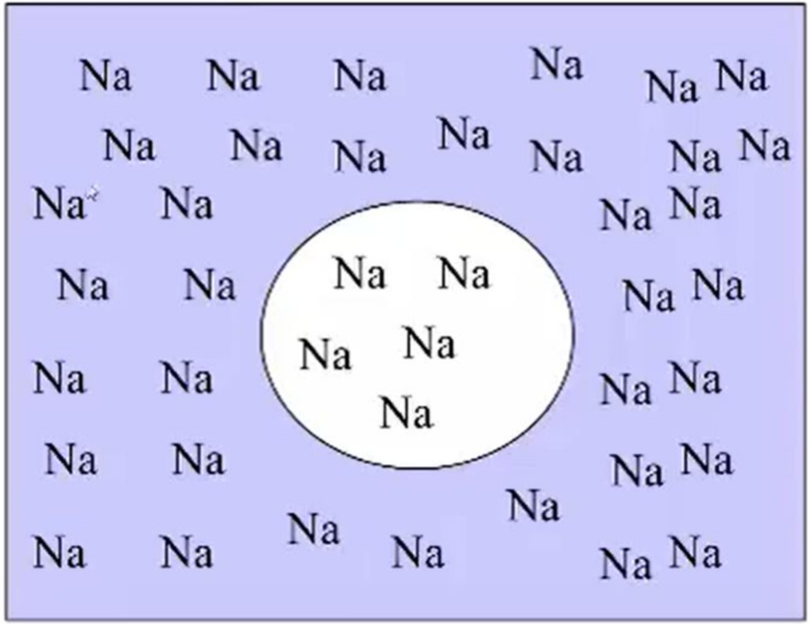
Cells in fresh water



Cells in fresh water



Cells in salt water



So, how do fresh-water fish handle this?

C

A. Excrete water from their skin.

B. Their slime coat keeps the water out.

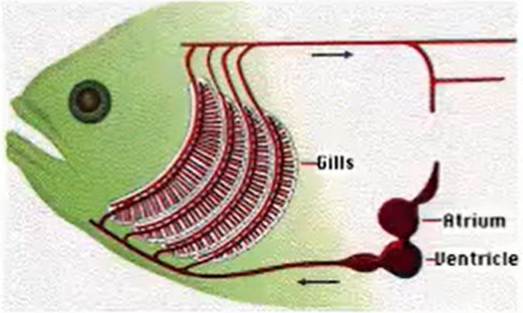
C. They drink very little and urinate a lot.

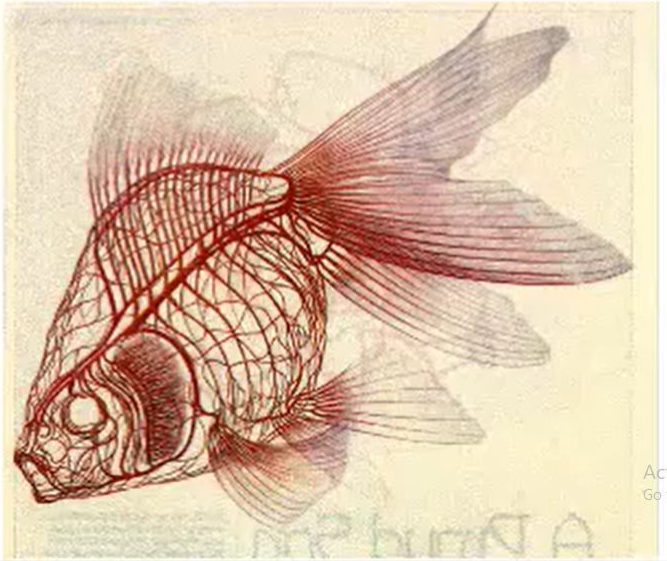
D. They excrete salt so the micro-area around them is salty.

E. They sweat a lot.

Anatomy & Physiology

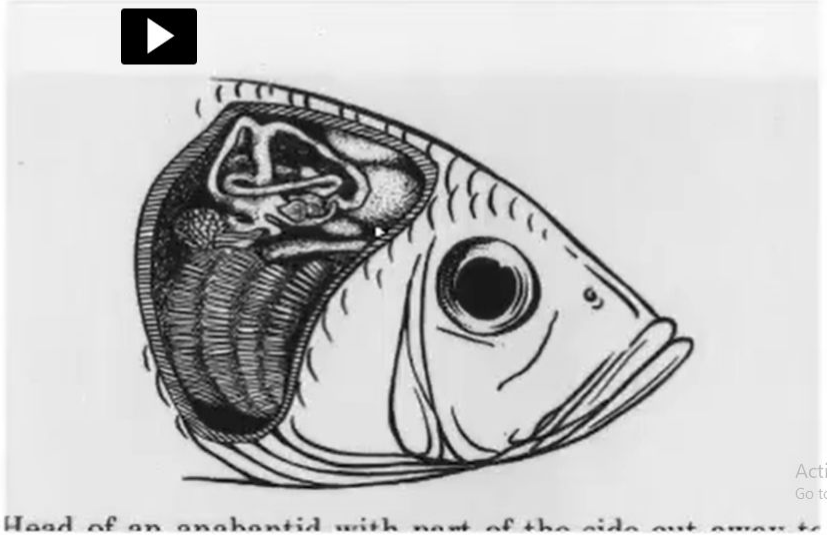
- Use gills for breathing.
- Two-chambered heart.
- Skin with scales, with a few exceptions.





Anatomy & Physiology

- Some have labyrinth.
  - Primitive lungs (?)
  - Gulp air at surface.



Head of an anabantid with part of the side cut away to

Do All Fish Have Swim Bladders?

A. Yes

B. No

B

Anatomy & Physiology

- Most are heterothermic
  - Minor exceptions

HISTORY

- 1st domesticated fish were carp in China
- Developed into what we now call goldfish.
- Different carp were developed into koi in Japan (later).

HISTORY

Most aquarium fish now are "tropical" fish.

Most are indigenous to:

- Central and South America
- Caribbean Sea area
- Southeast Asia

Many now are "farmed"

- Florida
- Southeast Asia

HISTORY

Now, feral species in many warm areas of the world.

Found in different types of water:

- fresh water
- brackish water
- salt water (marine water)

HISTORY

All fish were thought to be oviparous.
A priest in Mexico "discovered" guppies in 1769.
Sent word back to Europe that they were viviparous.
Sent fish back but nothing happened.

(or maybe Trinidad, and maybe a different year)

HISTORY

- Later, it was learned that the fish were ovoviviparous.
- Europeans didn't get excited about breeding tropical fish until 1870's.
- Tropical fish raising became popular in the 1890's to early 1900's in U.S.
- **(97% of fish species are oviparous)**

Reproductive Methods

- A. Egg-scatterers
  - May scatter eggs randomly.
  - May be adhesive to stick to things.
  - Fertilization occurs *ex vivo*.

Reproductive Methods

- B. Scoopers
  - most round out a spot in gravel.
  - female deposits eggs
  - male deposits semen
  - parents fan nest with fins
- B(1). Mouth brooders
  - eggs or fry may be moved from hole to hole
  - young may swim into parents' mouth

ovophile & larvophile

Reproductive Methods

- C. Bubble-nest builders (anabantids)
  - Can get oxygen from air bubbles.
  - Build floating nests of bubbles for eggs and young.
  - May live in oxygen-deficient biotope
  - Have quite a striking mating ritual.
  - Also have trouble with “spouse abuse.”

Reproductive Methods

- D. Live-bearers
  - actually ovoviviparous.
  - no true placenta
  - anal fin becomes a gonopodium
  - fertilization can last quite a while
    * important for hobby breeders *

D. Live-bearers (guppies, mollies, Gambusia, etc.)

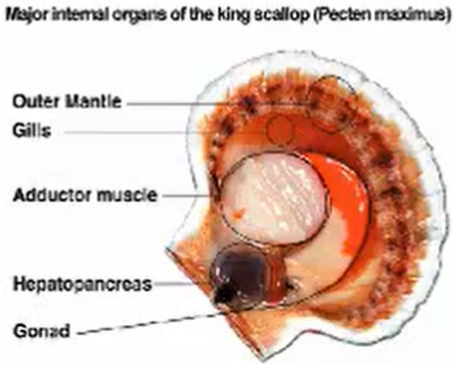
INVERTEBRATES**

(**not necessarily marine)

- Invertebrates lack vertebrae and include the remainder of the animal kingdom. The invertebrate group covers a wide range of organisms, from some single-celled (?) organisms to those members of the phylum *Chordata* that lack a vertebral column. (4.5 million species)
- They occupy all habitats;
  - Deep sea, high altitude, high temp (55°C)

Mollusks
(Second largest phylum in animal kingdom)

- About 23% of marine species are mollusks

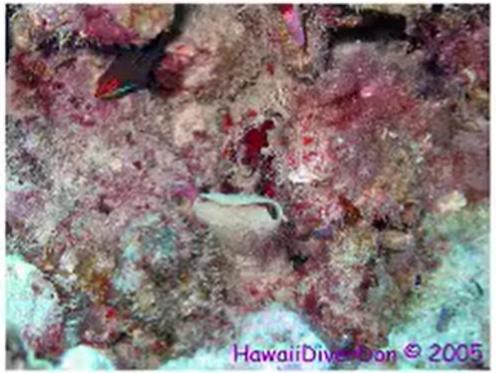


Mollusks (cont.)

- 3 main groups
  - Gastropods
  - Pelecypods
  - Cephalopods

- Most have a mantle -- fold of tissue that covers visceral organs and secretes shell
- breathe with gills and/or lungs

ANNELIDS – segmented worms



Mollusca

a. Gastropods - Snails (80,000 species)

- Conch
- Nudibranch
- Many snails

Snails

- Snails diets are sometime specialized and one can obtain a species that will eat almost anything
- Sexes generally separated, but some cases of **hermaphroditism** found in the snails
  - Most can't really fertilize themselves
- Fertilization can be internal or external.
- Both marine and freshwater (and terrestrial)

Mollusca

b. Pelecypoda – Bi-valves (clams, oysters and scallops)

Mollusca

c. Cephalopoda - Squid and Octopus

- Octopi can be an interesting companion animal
- Very difficult to keep them in an aquarium (literally)
- Lifespan is pretty short (1-2 years)
- Males die after mating
- The female will die after she lays eggs

- Most require a large tank (50 gallons and up)
  - Produce quite a bit of waste
  - Many get quite large

Crayfish (Crawfish, Crawdad, Freshwater Lobster)

- 150 species in North America
- Jointed exoskeleton
- Size 2" to 6"
- Grow by molting (Initially soft and become hard.)
- They eat their shell
- Female lays eggs and sticks them to her body until they hatch

CRAYFISH (cont.)

- Juveniles molt weekly and adults couple times a year
- Obtain oxygen with gills
- **Omnivorous** - fish, shrimp, meat, vegetables, table scraps
- They will eat fish and uproot plants in your aquarium

Crabs

- Types (Stone, Spiral, Blue, Horseshoe and Fiddler)
- Among these the Fiddler is the most popular.
- Semi-terrestrial - It will drown if submerged all the time, for it carries its air down with its body.
- Reproduction is interesting in that the male will wave a large red claw to attract females for mating.

HERMIT CRABS

- Omnivorous diet (including wood fiber)
- Provide shallow water dish
- Breathe with gills, even on land

- Need to provide shells

HERPS

Reptiles and Amphibians

AMPHIBIANS

- Skin without scales
- Heterothermic
- Three-chambered heart
- Fresh-water and terrestrial

METAMORPHOSIS

- Have gills when young
- Breathe with lungs as adults

AMPHIBIANS

- Reproduction
  - Oviparous
  - Need water to reproduce
  - Young hatch from egg laid in or near water
  - Tadpoles are more like fish (feeding, etc.)

AMPHIBIANS

- Temperature requirement
  - Most do best at 68--72 F
  - Use evaporative cooling
  - May burrow into soil for cooling
  - May hibernate / aestivate
  - Too cold can make them more susceptible to disease

  - Interesting aside – some frogs can freeze solid over winter, then thaw out and be active.

AMPHIBIANS

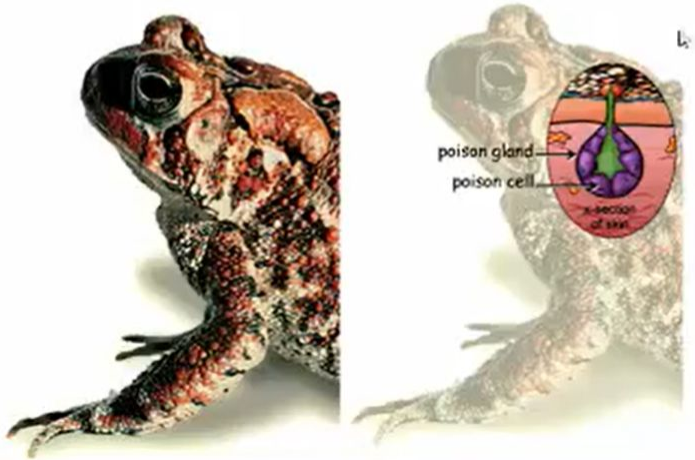
- Feed
  - Mealworms, crickets, sowbugs, flies, (pinky mice)
  - Also need to add calcium
  - May want to “gut-load”
- Water - adults absorb water through the skin

Argentine Horned Frog

- Up to 6 inches, eat mice, small reptiles, etc.

MISCELLANEOUS

- Toxins of amphibians
  - many have them
  - deterrent of predators



MISCELLANEOUS

- African Clawed Frogs
  - Common pets
  - Illegal in some states
  - May become invasive
  - Fungus ?

MISCELLANEOUS

- Thyroxin
  - causes tadpoles to metamorphose
  - can make “mini-frogs”

MISCELLANEOUS

Frogs are also game animals
and food animals.

REPTILES

- Don’t go through metamorphosis
- Heterothermic
- Three- or four-chambered heart
- Body covered with scales
- Air-breathing (throughout life)
- Terrestrial (secondarily aquatic)

REPTILES

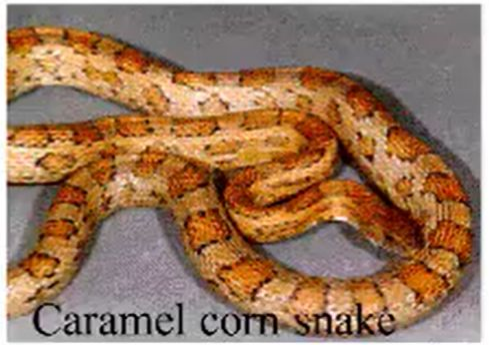
- Reproduction
  - Mostly oviparous
    - Some snakes give birth to live young (ovoviviparous)
  - Eggs are able to incubate outside of water
  - Internal fertilization
  - Incubation by parents is rare
  - Length of incubation is dependent on environmental temperature (40-80 days common)

MANAGEMENT & HUSBANDRY

- Varies greatly
- We'll look at 3 examples

1. SNAKE

- Good pet species: milk, corn, king, ball python, etc.
- Buy a captive-reared snake
- Most need to be raised separately
- Lifespans vary (usually 10-20 years, some to 40 years)



Caramel corn snake

Things to look for in a healthy snake (any kind of snake):

- firm rounded body
- clear eyes (may be a little cloudy if about to shed), no discharge from eyes
- no signs of mites (check especially around head/eyes, look for dusty specks on body, check hands after handling snake)
- no open mouth breathing or gasping for breath ***
- inside of mouth uniformly pink (reddened areas or cheesy looking matter may indicate mouth rot) ***
- shiny smooth skin with no scabs or sores
- clean vent with no swelling in area
- should move smoothly with no tremors

- Should calm down with some gentle handling
- May also want a feeding demonstration ***

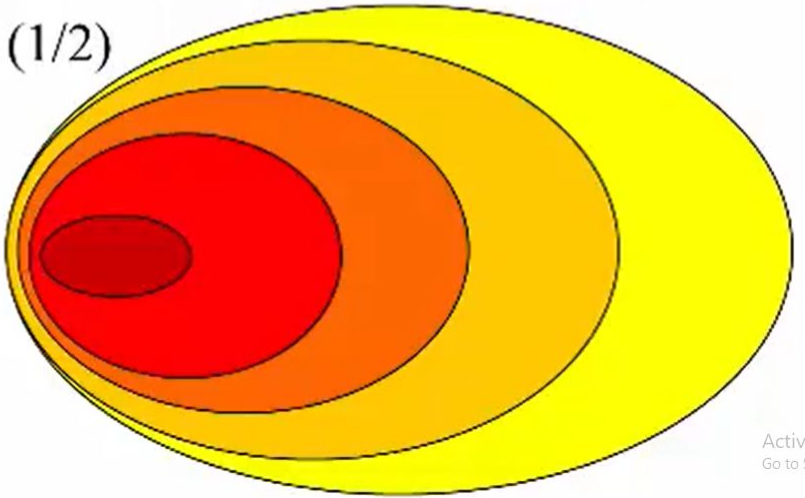
Source: exoticpets.about.com

EQUIPMENT NEEDS

- Enclosure
  - Aquarium will work well
  - Probably need at least a 30-gallon size
  - Larger snakes may need 60-gallon or larger
  - Need SECURE lid
- Hiding places
  - Give several
  - Different places (both vertical and horizontal)

EQUIPMENT NEEDS

- Temperature control
  - Use a temperature gradient
  - 75-90° F
  - Ideally, dropping to 70-75° at night
  - Heat mat under tank (1/2)
  - Hot rocks?



EQUIPMENT NEEDS

- Humidity
  - 40-60% usually good
  - May want to increase during molting
- Shallow dish for bathing
- Substrate
  - Indoor-outdoor carpeting
  - Shavings
  - Shredded bark
  - Newsprint

FEEDING

- Snakes are carnivores
  - May eat mice, chickens, rabbits
    - note hinged jaws
    - need whole animals
    - **pre-killed prey is best**
  - Usually feed once every week or so
    - Young snakes every 5-7 days
    - Older snakes every 10-14 days
  - Snakes don't eat during molting (shedding of skin)
  - Snakes can live several months without feed

FEEDING

- Snakes are carnivores
  - May eat mice, chickens, rabbits
    - note hinged jaws
    - need whole animals
    - **pre-killed prey is best**
  - Usually feed once every week or so
    - Young snakes every 5-7 days
    - Older snakes every 10-14 days
  - Snakes don't eat during molting (shedding of skin)
  - Snakes can live several months without feed

CLEANUP

- Cleanup is usually pretty simple for snakes
- Not uncommon for them to defecate in water dish