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Progressive Science Initiative

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AP BIOLOGY

Big Idea 2
Part E

January 2013

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Big Idea 2: Part E

Click on the topic to go to that section

- Evolution of Ecosystems
- Implications of Ecological Evolution
- The Evolution of Bioenergetics

Evolution of Ecosystems

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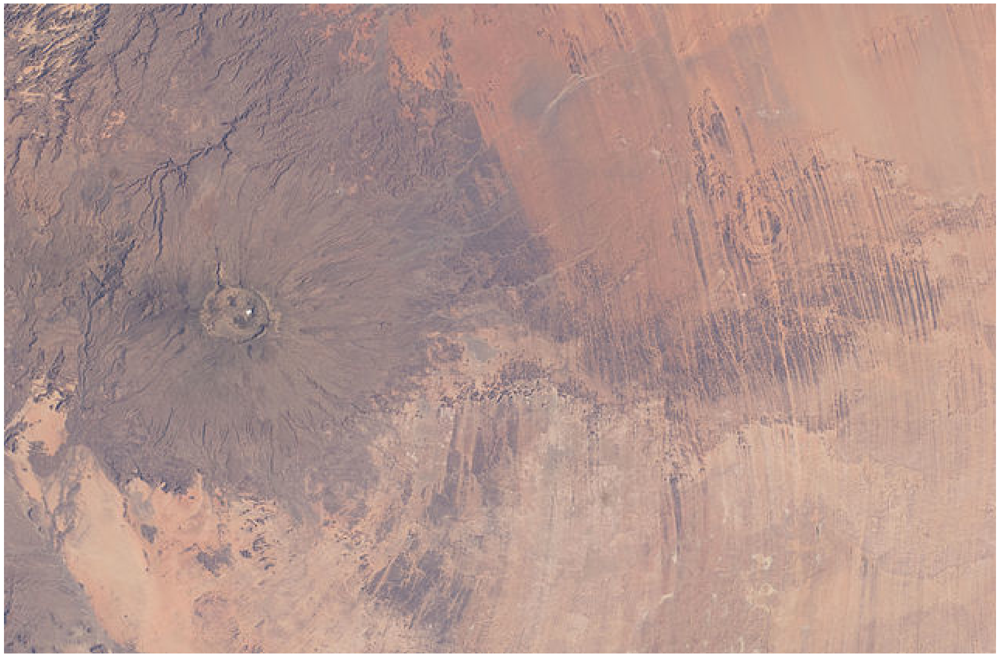
Where Did it All Come From?

We just surveyed the levels of life from population to biosphere and saw that the basis for an ecosystem is the way in which energy is passed from life form to life form.

But how does such a system evolve? As with all systems that evolve it starts simply and increasing layers of complexity are added.

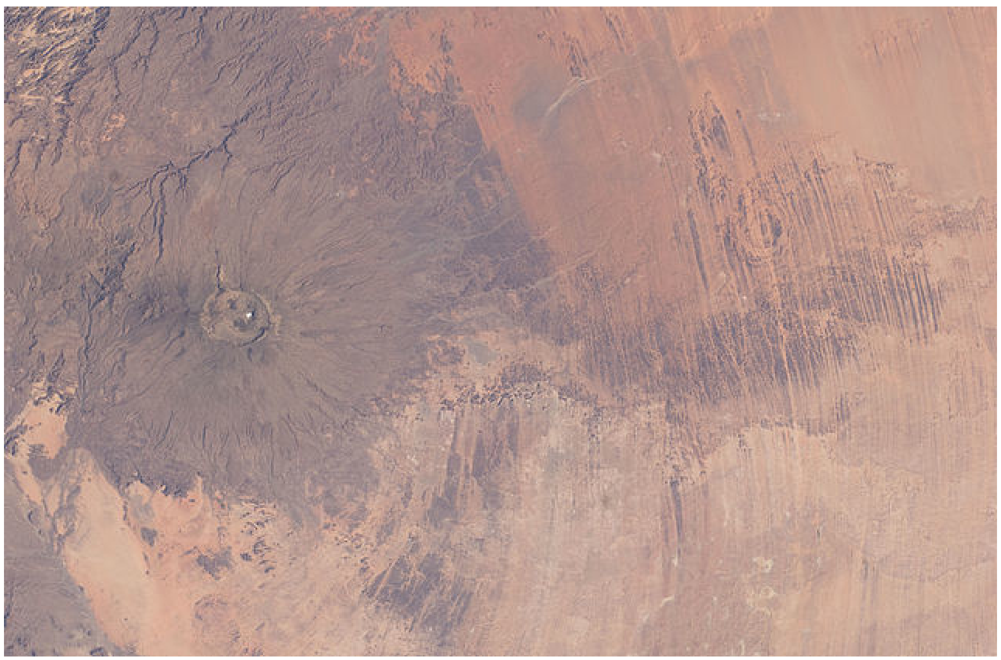
Primary Succession

Primary succession refers to the founding of new communities in environments that initially had no living organisms, like rocks or new surfaces formed by movements of glaciers or volcanic eruptions.



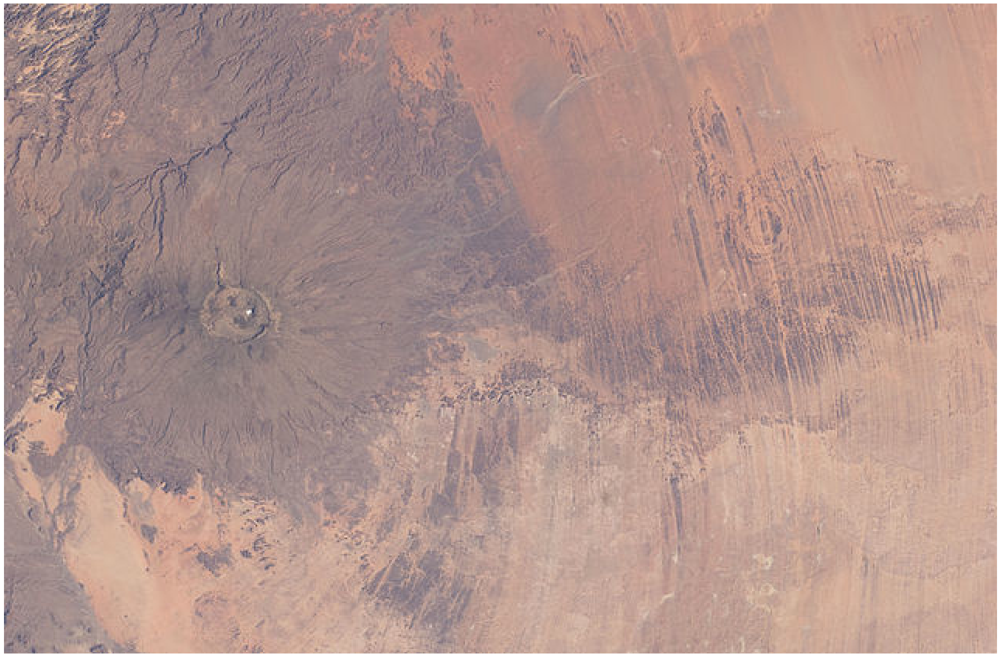
Primary Succession

What would have to be the first step to producing a community in this sterile environment? Who would be the first inhabitants?



Primary Succession

Before we could guess as to what specific organisms would be able to inhabit this area we would need to know about the climate of this region and the resources available. **The abiotic dictates the biotic**.



Ecological Succession

Ecological succession is the term used to describe the series of expected changes that occur within the *community* of an ecosystem over time.

Change is inevitable within communities - older members die, new organisms immigrate, sudden disturbances force change, etc.

Pioneer Species

In primary ecological succession, the first organisms to populate an uninhabited environment are called the **pioneer species**.

A good example is lichen - an organism formed by a symbiotic relationship between fungi and algae that can grow on rocks.

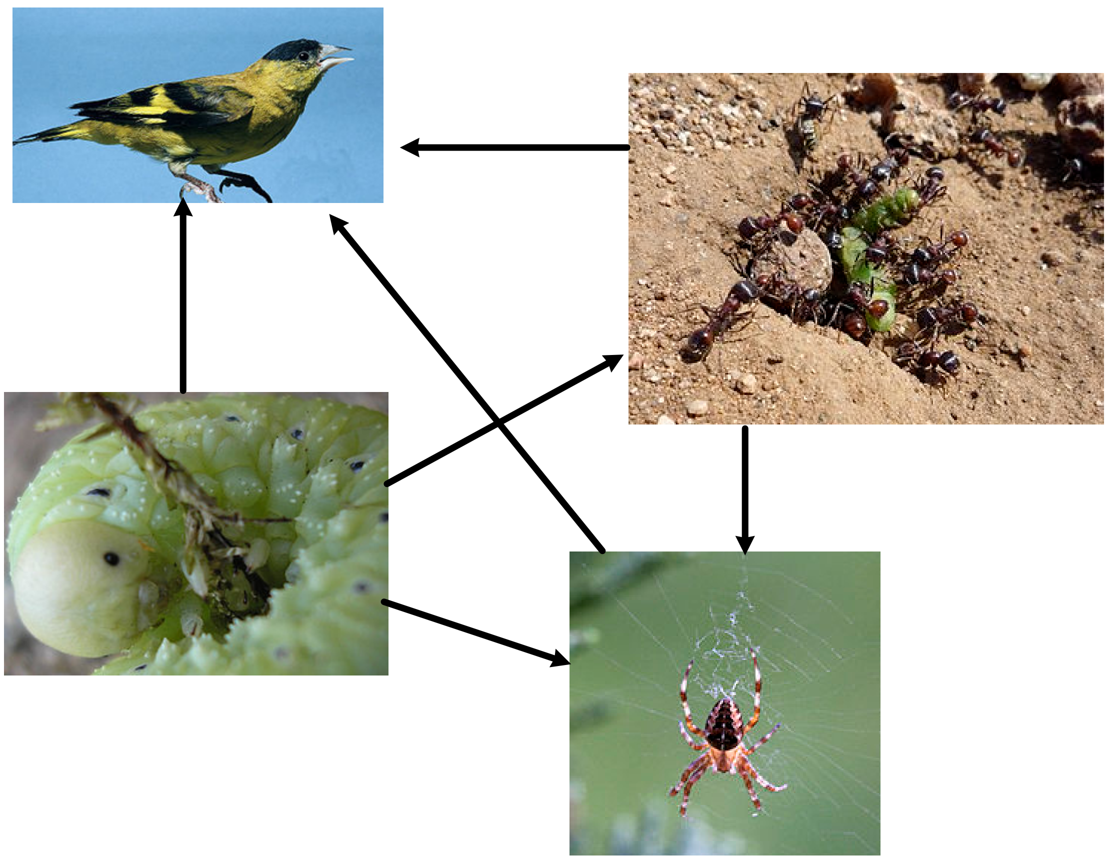
Lichens begin growing on the rock. As they die, the decaying matter is added to the eroding rock and the start of nutrient rich soil begins.

Pioneer Species

Lichens act as a foothold for species like moss and they begin growing on the rock. The first heterotrophic animal life can begin to move into the area because small worms and caterpillar like creatures eat moss. As the mossesdie, the decaying matter is added to the rock, producing thicker soil.

Pioneer Species

Carnivores and omnivores can now move into the area to feed on the small herbivores. The random chance process that leads to each new animal adds to the diversity of the area. A food web begins to form and **habitats** are defined.



Habitat

The term **habitat** describes the specific area - including biotic and abiotic factors - where an organism lives within an ecosystem. A habitat is an organism's home within an ecosystem.

Primary Succession

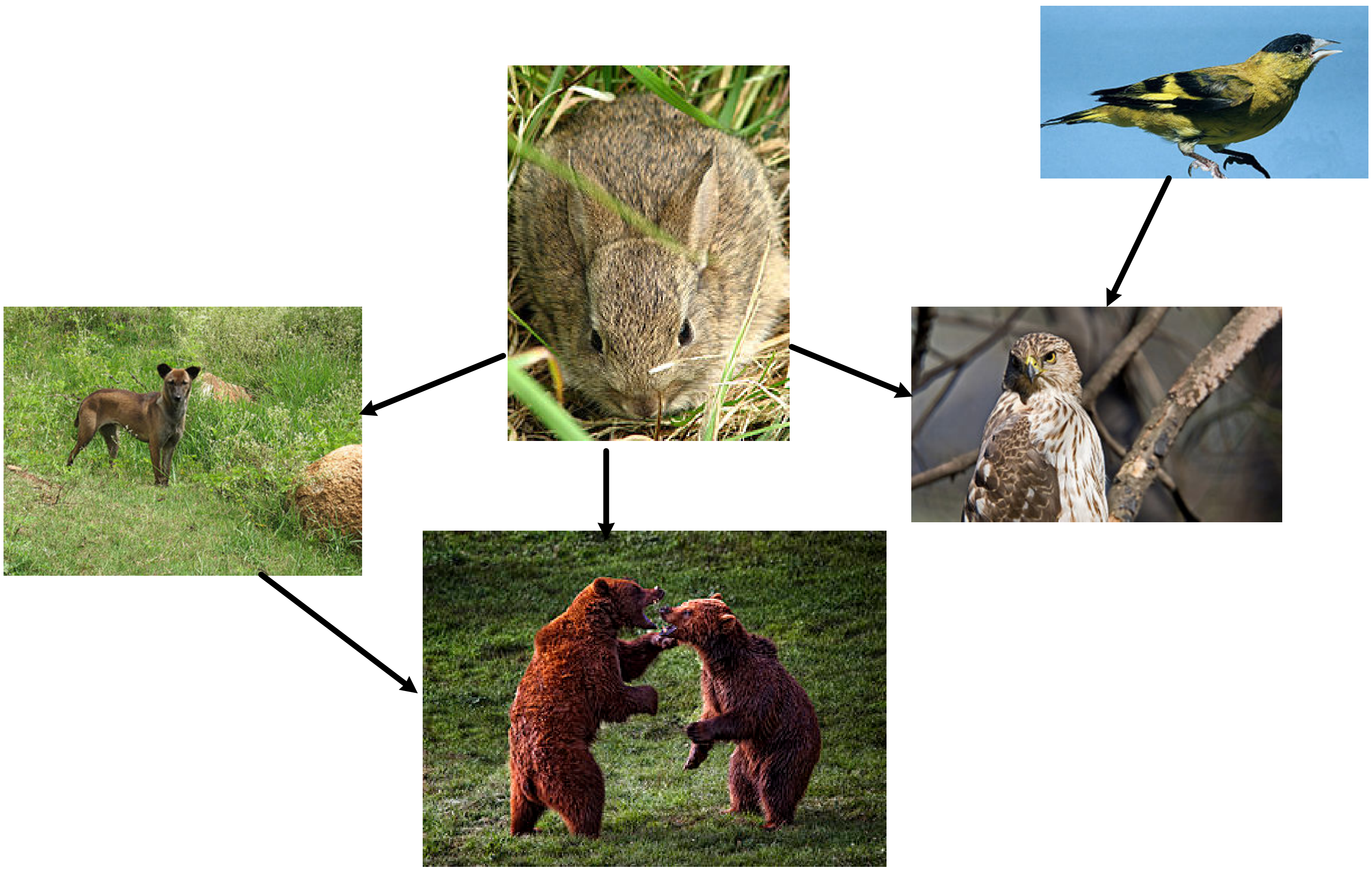
Nutrients supplied by decaying organic matter support the growth of grasses and small plants. These add more organic nutrients, which form deeper more fertile soil.

Primary Succession

The bigger producers attract bigger primary consumers.

Primary Succession

The larger herbivore brings larger carnivores and the complexity of the food web continues to grow.



Primary Succession

As deeper soils formed by decaying organic matter hold more water, small shrubs begin to grow.

Climax Communities

Finally, larger trees can grow, and**climax communities** form. Climax communities are groups of organisms that remain stable in an ecosystem over time. The food web may shift and evolution will continue, but the climax community will remain if no catastrophic event occurs.

Climax Communities

Inside this community symbiotic relationships will form as evolution continues to act on the ecosystem. Variations will give advantage to some plants or herbivores or carnivores and the balance of inhabitants will shift.

Community Interactions

Communities interact in a variety of different ways that enable the organisms within them to establish a niche and shape the ecosystem in which they live. The following are types of interactions within communities:

Competition

Predation

Symbiosis → Mutualism
Symbiosis → Commensalism
Symbiosis → Parasitism

Competition

When organisms try to obtain food, water, space, sunlight, and other resources in the same place at the same time, **competition** occurs.

Competition in nature drives biological evolution. The ability to compete for resources is dependent upon whether an organism has adaptations that enable it to thrive in its environment.

Trees in this forest are in competition for light. The tall, broad-leafed trees outcompete the smaller trees for sunlight.

Predation

Predation occurs when one organism captures and feeds on other organisms. The organism doing the eating is the **predator** and the organism being eaten is the **prey**.

Ladybird beetle eating aphid

Cheetah stalking gazelle

Great white shark capturing prey

Predation and Co-evolution

Predation is a driving factor in co-evolution. The prey evolves to better escape the predator. In turn the predator evolves to better capture the prey.

Symbiosis

The term **symbiosis** means "living together." When two species live closely together they are said to be in a symbiotic relationship.

There are three main categories of symbiotic relationships:

Mutualism

Commensalism

Parasitism

Mutualism

In **mutualism**, both species benefit from the relationship.

In this example,
the flower provides the hummingbird with nectar and the hummingbird helps the flower reproduce by transporting pollen from one flower to the next.

Mutualism: a win/win situation

Commensalism

In **commensalism**, one species benefits from the relationship while the other is neither helped nor harmed by it.

The bird gets a free ride from the cow and a vantage point for spotting prey.

Barnacles attach to the whale and help themselves to small amounts of plankton (whale food) with no harm done to the whale.

Commensalism: a win/neutral situation

Parasitism

In **parasitism**, one organism lives on or inside another organism and harms it.

Parasites are organisms that obtain all or most of their nutrients from other organisms, called hosts. The host-parasite relationship benefits the parasite at the cost of the host.

Mosquitoes feed off of the blood of other organisms. Mosquitoes also carry various types of parasites and viruses that cause diseases like yellow fever and malaria.

Parasitism: a win/lose situation

1 Tapeworms live in the intestines of mammals and "steal" nutrients from them. This is an example of

- A Competition
- B Mutualism
- C Commensalism
- D Parasitism

2E. coli live in the human colon where they absorb nutrients and produce vitamin K and sodium that benefit their human hosts. This is an example of

- A Competition
- B Mutualism
- C Commensalism
- D Parasitism

3A relationship in which one organism is helped and another organism is neither helped nor hurt is called

- A Competition
- B Mutualism
- C Commensalism
- D Parasitism

4 Which of the following types of community interactions leads to coevolution?

- A Predation
- B Mutualism
- C Parasitism
- D All of the above

Implications of Ecological Evolution

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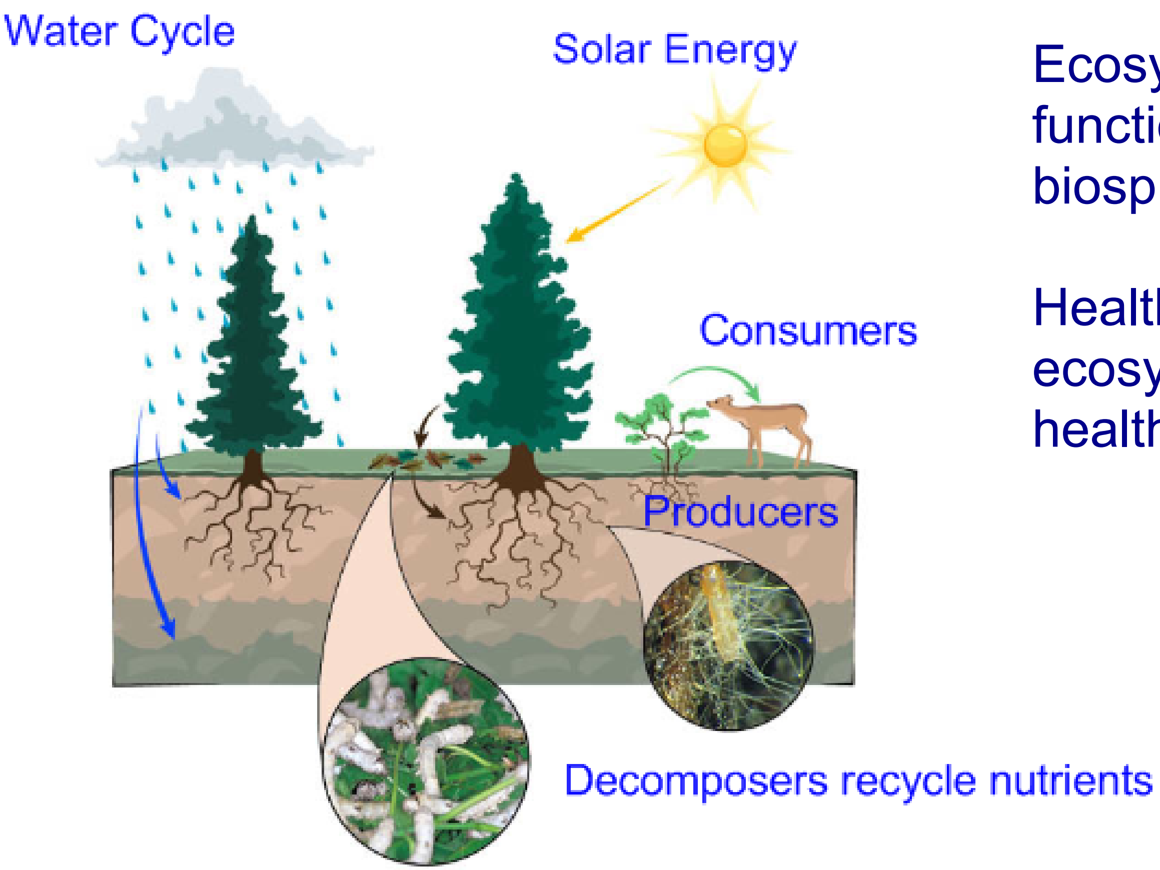
Ecosystems



Ecosystems are the functional units of the biosphere.

Healthy, productive ecosystems result in a healthy planet.

Implication of Ecological Evolution

As we have just seen, ecological systems arise by evolution. This means that the organisms that live within each ecosystem have adapted to the specific climate and conditions of their habitat.

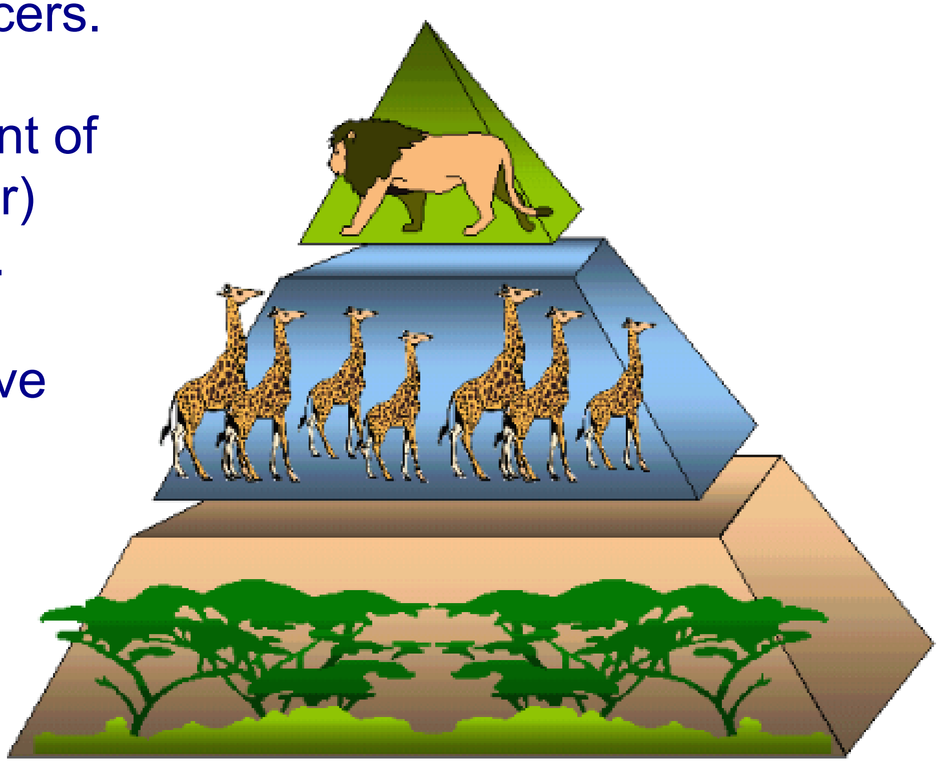
Any changes, especially sudden changes can be detrimental to the health of the ecosystem residence.

Ecosystem Productivity

The primary productivity of an ecosystem is measured by the rate at which organic matter is created by producers.

Biomass is the total amount of living tissue (organic matter) within a given trophic level.

Productive ecosystems have an optimal balance of biomass in each trophic level.



Available Reproductive Energy

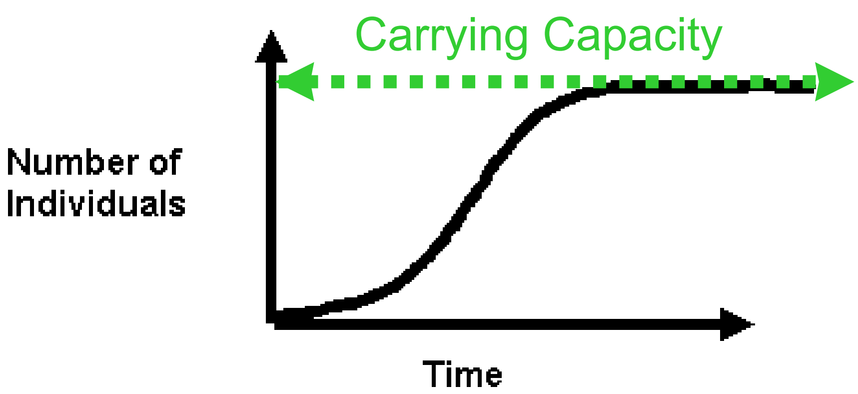
The balance of carrying capacity is established by the ecological residences' rate of reproduction.

Reproduction and raising offspring requires free energy beyond that used for maintenance and growth. For some species this may be very high.

The energy available within an ecosystem dictates how many offspring any given species can produce. Different organisms use various reproductive strategies in response to energy availability.

Resource Availability

Availability of sunlight, nutrients, water, and minerals effects the ability of producers to create organic matter. If any of these factors are limited in an ecosystem, organismal, population, and community growth will also be limited.



There are limits to growth.

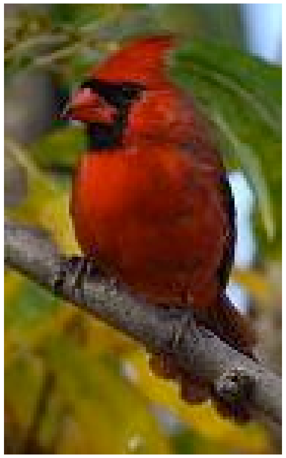
Available Reproductive Energy

Humans are a good example of increased energy consumption for reproductive purposes.

This is Corey. He has decided he wants to produce offspring. What is the first thing Corey needs to do?

Available Reproductive Energy

In nature organisms have to prove they are good potential parents to attract a mate. This requires energy expenditure in many forms.



Some birds have complex courting rituals and songs

Some animals must compete for territory or control over the opposite sex

Some species grow ornate features that have no use but mate attraction

If an individual cannot get enough energy to do these things they are not fit enough to attract a mate.

Available Reproductive Energy

Back to Corey...
Corey has successfully attracted a mate, Jane. Jane has also used energy to show Corey that she would be a good mating partner.

Now that Corey and Jane have decided to produce offspring together, the next step...

Available Reproductive Energy

In nature the physical act of sex accounts for the largest single expenditure of energy. Sex organs and sex cells are produced, various mechanisms for ensuring fertilization are needed.

Plants use a variety of methods for ensuring the spread of pollen and the acceptance of the pollen.

Available Reproductive Energy

Corey has successfully fertilized one of Jane's eggs. For the next 9 months Jane will do most of the extra energy expenditure but Corey must also contribute.

Humans have used the reproductive strategy of **monogamy.** This strategy is used by complex animals because the rearing of complex offspring requires more energy. If a relationship is successfully monogamous then the offspring have a better chance at survival.

Available Reproductive Energy

Song birds also are a highly monogamous species. They require participation from both parents or the offspring will not survive because one parent cannot gather enough energy by themselves.

Our early hominid, nomadic ancestors would have experienced this as well. If an individual tried to raise an offspring alone they would have to choose between protecting the child or hunting, they could not do both at the same time.

Available Reproductive Energy

Corey and Jane, in oreder to give their offspring the best chance at survival and to produce its own offspring must feed, clothe, shelter and nurture the offspring until it is capable of doing these things for itself. This requires a massive amount of energy expenditure.

Available Reproductive Energy

Other species use different strategies but all require extra energy. The extreme opposite of humans would be turtles. Instead of using energy in raising one offspring, turtles use that energy to produce hundreds of offspring.

This is a game of chance. Typically only a few will survive because **no parental care** is given after birth. They must survive in their ecology with no support.

Available Energy

Wild species have a breeding season that is initiated at a time when the ecology will allow for the best survival of the young. Spring is usually the optimal season for birthing and rearing. Time of breeding is then dependent on gestation length.

Sheep are short-day, or fall breeders. Their gestation period is about 6 months so they will have their offspring in the spring when food will be plentiful for the longest period.

Available Energy

Chimpanzees that live in equatorial regions do not have a **breeding season**. Unlike sheep and other typical seasonal breeders they usualy only care for only 1 or 2 offspring at a time. Speculate as to why chimpanzees have taken on this reproductive strategy.

Reproductive Diapause

Diapause is the delay in development in response to regularly and recurring periods of adverse ecological conditions. It is considered to be a physiological state of dormancy triggered by specific conditions.

Diapause is a mechanism used as a means to survive **known and unfavorable** ecological conditions, such as seasonal temperature extremes, drought or reduced food availability.

Reproductive Diapause

The mosquito species *A albopictus* enters diapause as an egg. The eggs are laid in tree holes, bamboo stumps, containers and discarded tires etc. The eggs laid in these water containing bodies in late autumn or early winter remain there until ecological conditions become favorable for hatching.

Energy Management.

After birth, an organism inherits the energy strategy that its ancestors used. Many strategies exist and no two species use exactly the same one to survive.

However, there are some common themes.

Ectotherms

Ectotherms are "cold blooded" animals. Most animals fit into this category.

Most of their heat energy escapes into the environment so their body temperature is close to that of their surroundings. Activity of these animals is drastically affected by temperature changes in their environment. When outside temperatures rise, they become more active. When external temperatures drop, they become more sluggish in their activity.

Endotherms

Endotherms are the "warm blooded" animals, such as mammals and birds.   These animals have evolved homeostatic mechanisms that allow them use the heat they generate.

They have adaptations such as hair, fur, feathers, and fat that help prevent heat loss. They maintain constant body temperatures that are higher than their environment.

Body Size and Ecology

Kleiber's law, named after Max Kleiber's work in the early 1930s, is the observation that an animal's metabolic rate scales to ¾ of the animal's mass.

$q0 \sim M^{3/4}$, $q0$ = animal's metabolic rate (kcal/day),
M = animal's mass (kg)

A cat, having a mass 100 times that of a mouse, will have a metabolism roughly 31 times greater than that of a mouse. In plants, the exponent is close to 1.

Body Size and Ecology

Bergmann's rule is an ecogeographic principle that states that within broadly distributed populations and species, larger sizes are found in colder environments, and species of smaller size are found in warmer regions.

Larger animals have a lower surface area to volume ratio than smaller animals, so they radiate less body heat per unit of mass, and therefore stay warmer in cold climates.

Body Size and Ecology

In warmer climates body heat generated by metabolism needs to be dissipated quickly rather than stored within. Thus, the higher surface area-to-volume ratio of smaller animals in hot and dry climates facilitates heat loss through the skin and helps cool the body.

Energy Storage

Since there are fluctuations in the available energy of an ecosystem, organisms have developed systems of energy storage.

Mammals have the ability to build muscle and produce fat with excess calories, and to burn the storage when less food is available.

5 Which of the following best illustrates homeostasis?

- A Most adult humans are between 5 and 6 feet tall.
- B The lungs and intestines have large surface areas.
- C When blood salt concentration rises, the kidney expels more salt.
- D All the cells of the body are about the same size.

6 A snake's activity increases when the outside temperature rises. How would you classify this animal?

- A Ectotherm
- B Endotherm

7 Which of the following is a measure of the primary productivity of an ecosystem?

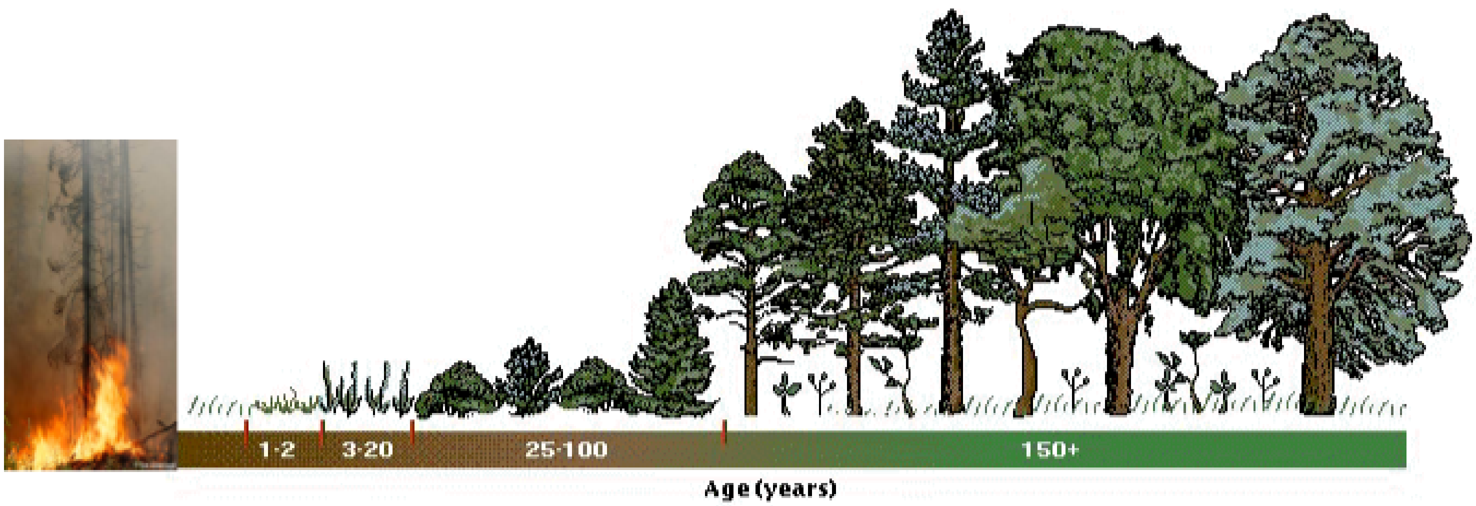
- A Rate of energy production by primary producers
- B Amount of solar radiation
- C Rate of energy production by primary consumers
- D Rate of consumption by higher-order consumers

8 In a typical ecosystem, the trophic level with the highest biomass is made up of

- A producers
- B primary consumers
- C secondary consumers
- D tertiary consumers

Ecosystem Resiliency

Some ecosystems are very resilient and can bounce back from damage over relatively short periods of time. Secondary succession is one example of that recovery process.



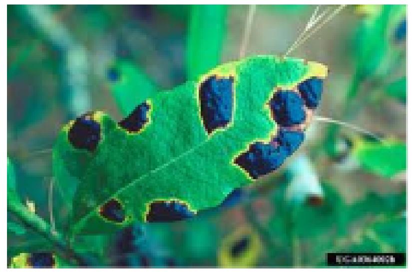
Ecosystem Resiliency

Other ecosystems that support a diverse array of organisms in a delicate balance, take a long time to recover from damage and may never be fully restored.

Wetland damaged by water pollution.

Many species are not able to survive the degradation of their habitat, which leads to reduction of biodiversity within ecosystems and, in some cases, extinction.

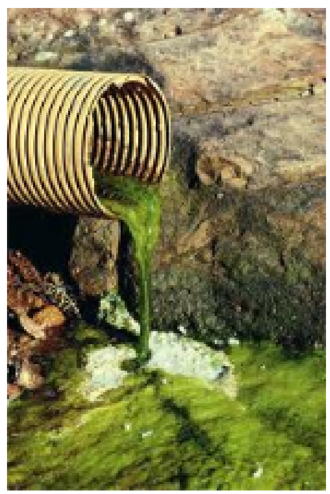
Factors that Disturb Ecosystems



Disease

Predation

Fire



Human Activity

Drought

Flooding

Volcanic Eruptions

Bioaccumulation

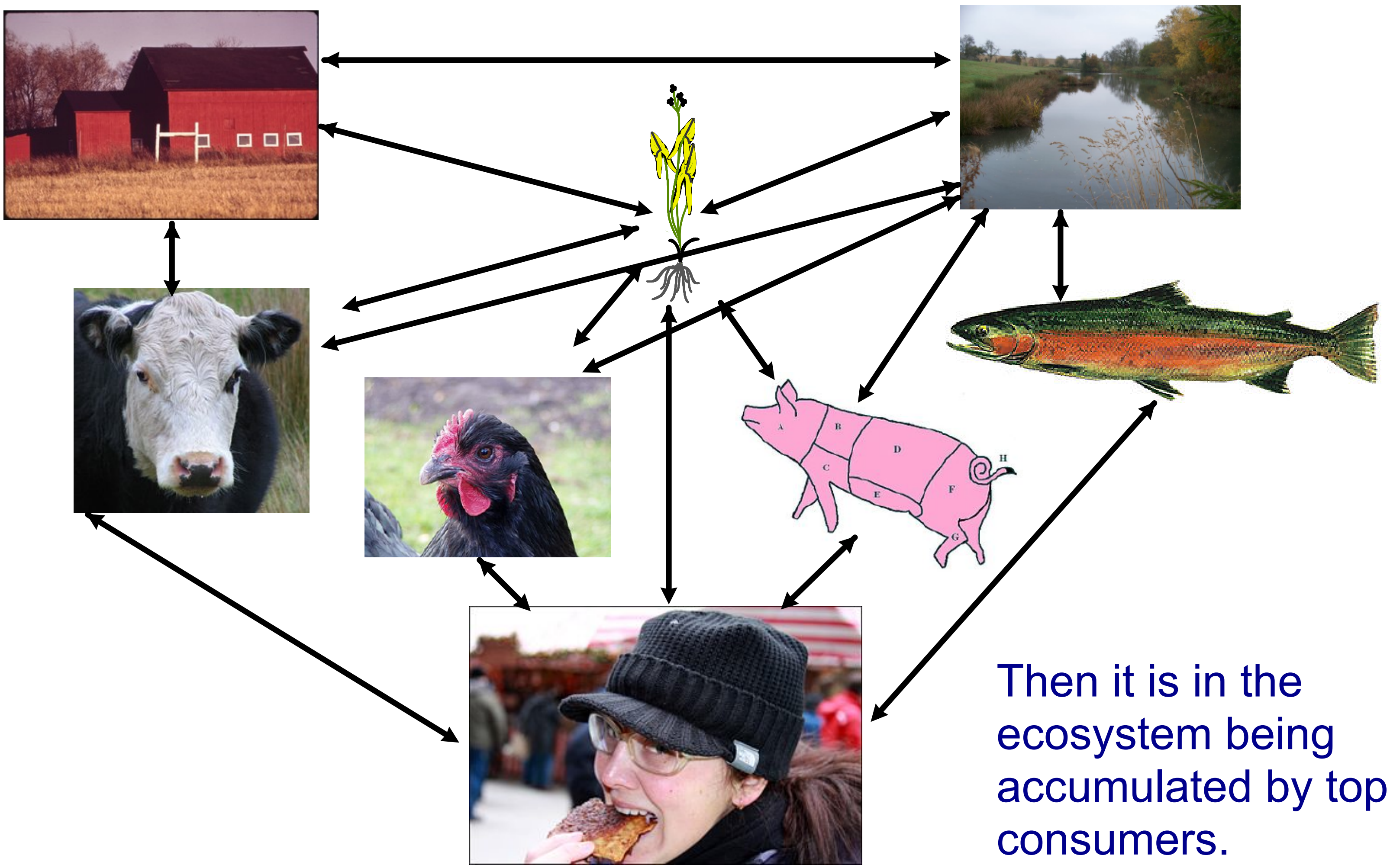
Bioaccumulation refers to the accumulation of substances, such as pesticides, or other organic chemicals in an organism. This occurs when an organism absorbs a toxic substance at a rate greater than that at which the substance is lost.

This is mostly a problem for top consumers because they accumulate all the toxins that have been absorbed by lower levels of the food web.

Bioaccumulation

Example:
Farms use pesticides to ensure that they have a high yield of produce. Because the pesticide runs through rain and irrigation channels the poison does not stay contained to the farm and winds up in water and soil outside the farm.

Bioaccumulation



Then it is in the ecosystem being accumulated by top consumers.

Invasive Species

Invasive species reproduce rapidly and disrupt community interactions in their new environments because their new habitats do not have the same predators or parasites that regulated their population size in their original habitats.

The kudzu plant was brought to the US from Japan. Its out of control growth makes it an infamous invasive species.

The Northern Snakehead fish is native to China and now lives in the US. It can survive out of water for up to 4 days, and will kill and eat anything in its path.

Invasive Species

Rabbits were introduced to Australia in 1859. By the 1930's the population had exploded to over 600,000,000. Native plants, animals, and soil were on the verge of being destroyed before a virus was introduced to wipe them out.

Are Humans an Invasive Species?

Industrial development demanded increased use of renewable and nonrenewable resources.

It also provided access to new goods and services and a new niche for humans.

Urban areas become centers of industry and people began leaving agrarian societies to work and live in cities.

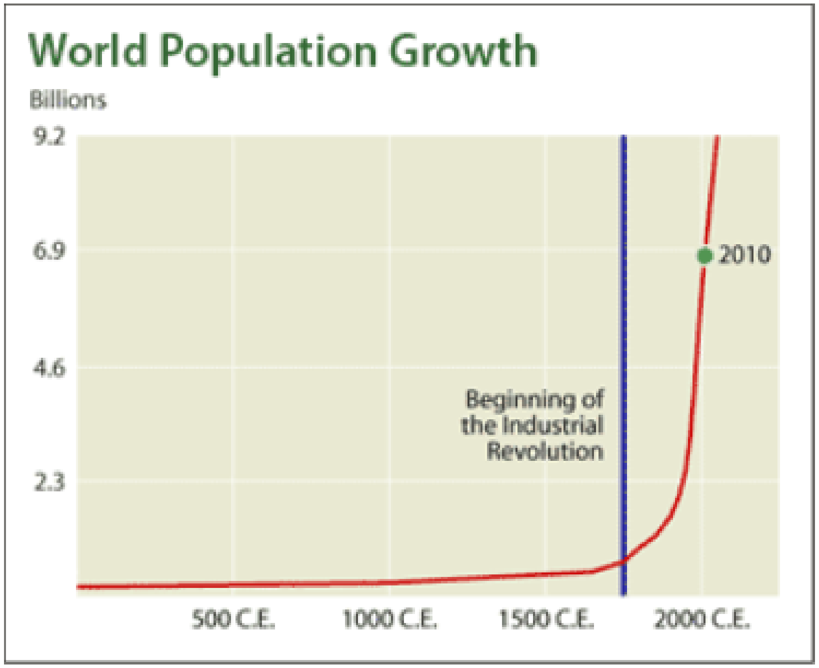
Urban Growth

In 1800 only 3% of the world's population lived in urban areas.

By 1900 almost 14% of human populations lived in cities.

In 2008 for the first time in history, the world's population was split between urban and rural areas - 50% of humans live in cities.

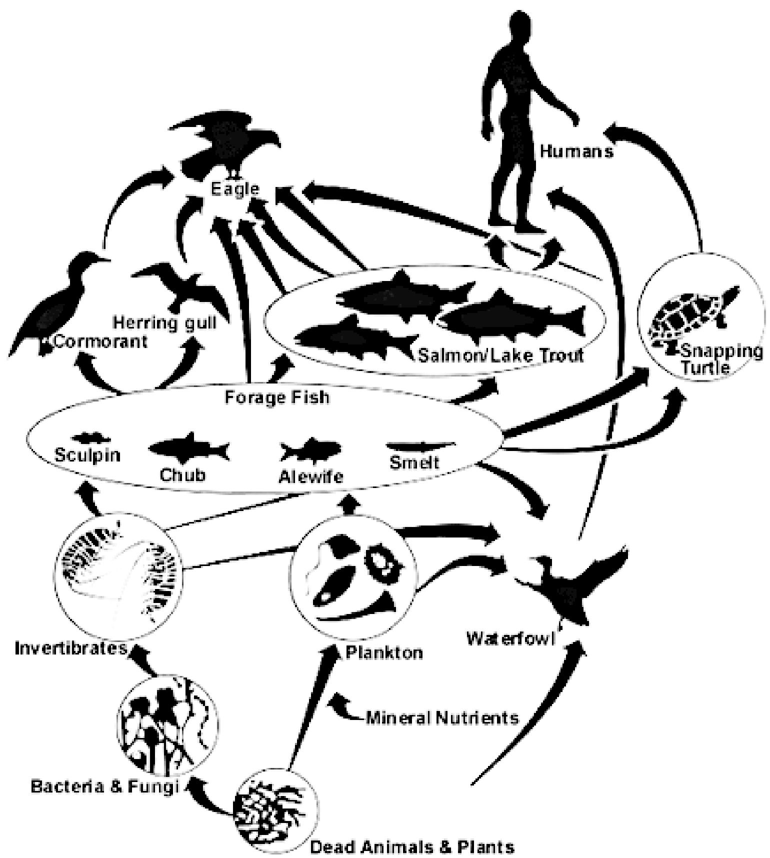
Human Population Growth



Human population growth has exploded over the past 200 years due to improvements in agriculture, medicine, sanitation, energy use, and technology.

Current world population:
approx. 7,046,994,361

Human Impact



Humans are active participates in food webs and chemical cycles within the biosphere.

Like all living organisms, we depend upon the natural environment for food, water, shelter, contribute waste, and impact our surroundings.

Agriculture

Humans began growing crops and raising animals like sheep, cows, and pigs nearly 11,000 years ago.

Farming provided a stable and predictable food supply, encouraging development of human societies.

Modern Agriculture

Farming has changed considerably over the past 200 years. Food production has increased due to:

*machinery for plowing, planting, and harvesting

*irrigation systems that carry water to previously unusable soil

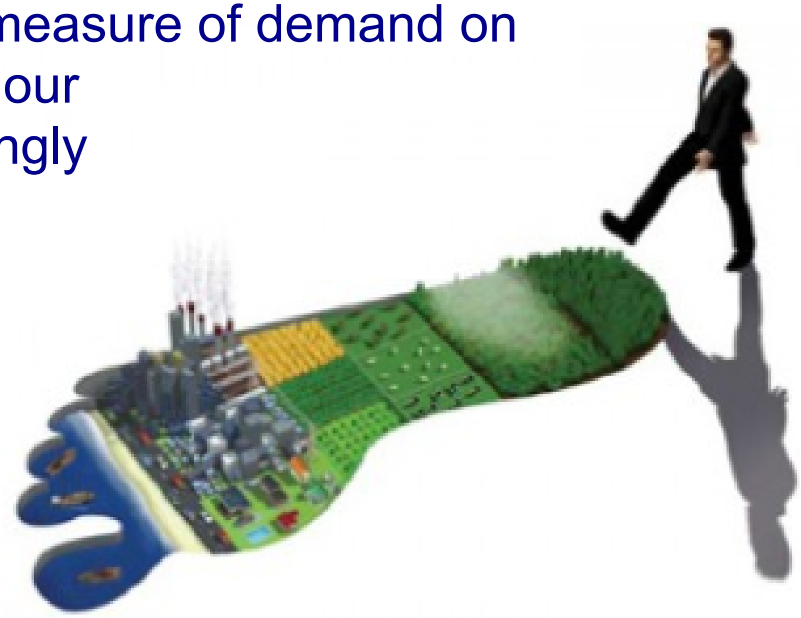
*addition of fertilizers and chemicals to soil

***monoculture** - planting a single crop in a large field

Human Impact

Due to our high consumption of natural resources and rapid population growth, humans currently use as much energy and transport nearly as many materials as all of the other multicellular organisms in the Biosphere combined.

Our *ecological footprint* - measure of demand on ecosystems - is huge and our activities have an increasingly large impact on the biosphere.



9 An autopsy reveals a high level of agricultural poison in the fat tissue of a human. This is most likely due to

- A Bioremediation
- B Bioenergetics
- C Biosphere
- D Bioaccumulation

The Evolution of Bioenergetics

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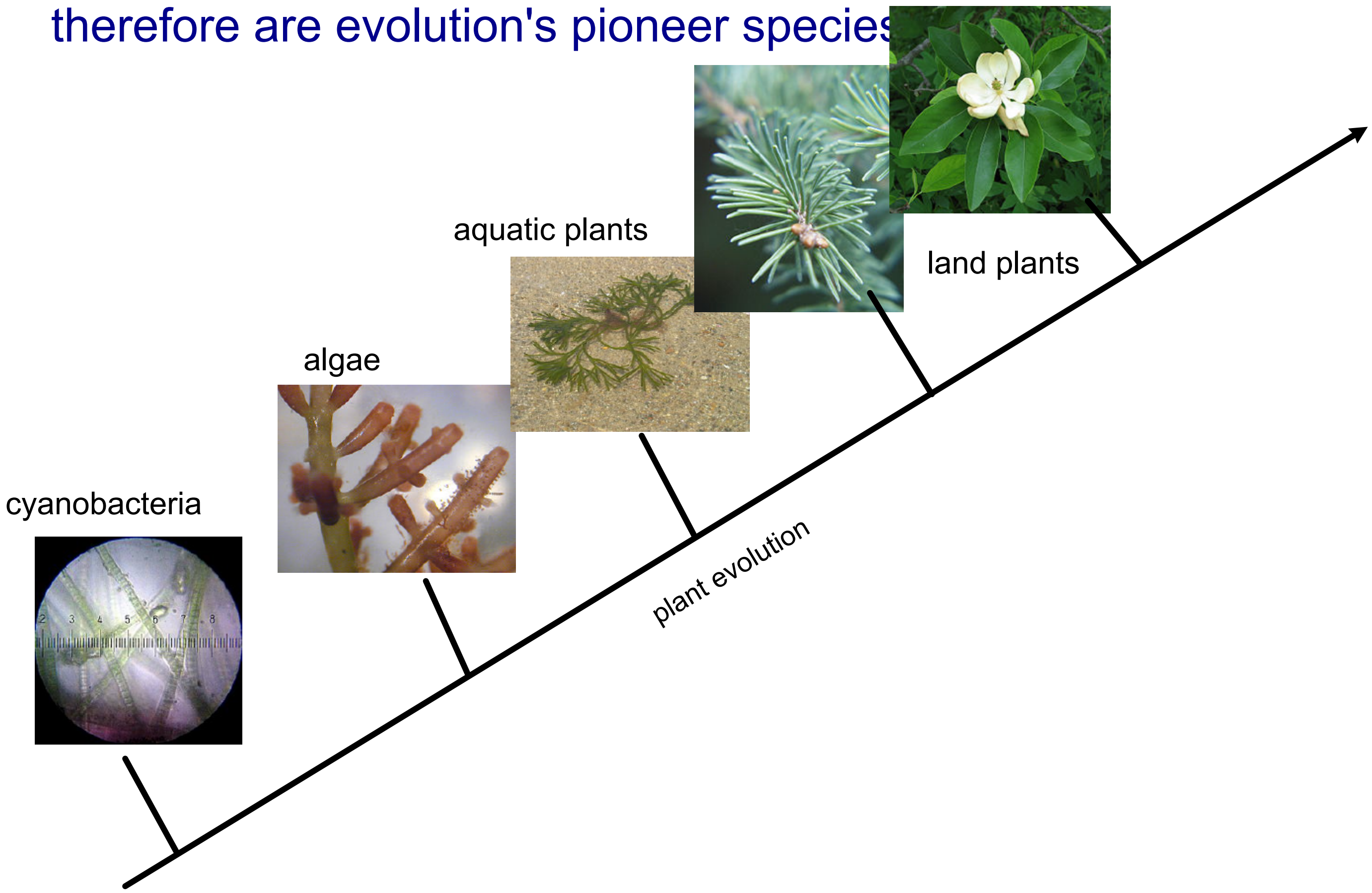
History of Life's Energy

Rewind the clock to the time of cyanobacteria about, 3 billion years ago. The success of this photosynthetic bacteria transformed the planet and shaped the evolution of the biosphere.

The ability to harness the power of the sun's energy caused a miraculous increase in available energy, paving the way for higher complexity.

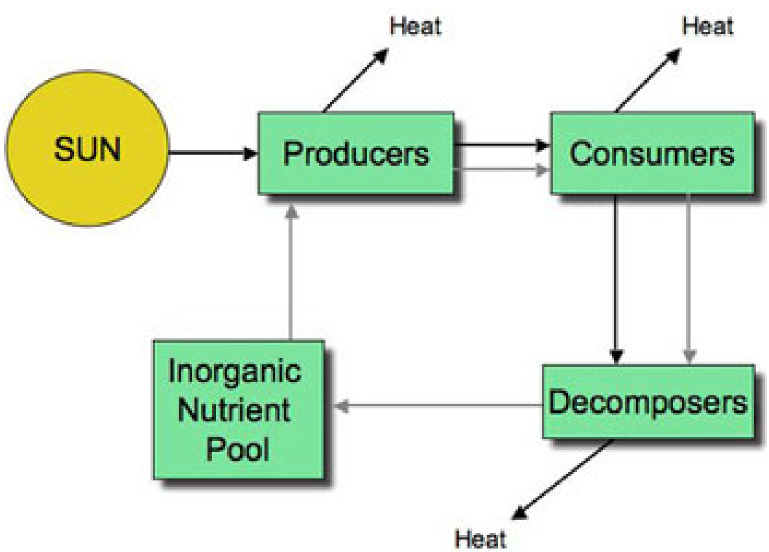
History of Life's Energy

Cyanobacteria is the ancestor of algae, algae is the ancestor of aquatic plants, aquatic plants are the ancestors of land plants. This branch of evolution represents the organisms that produce sugar and therefore are evolution's pioneer species



History of Life's Energy

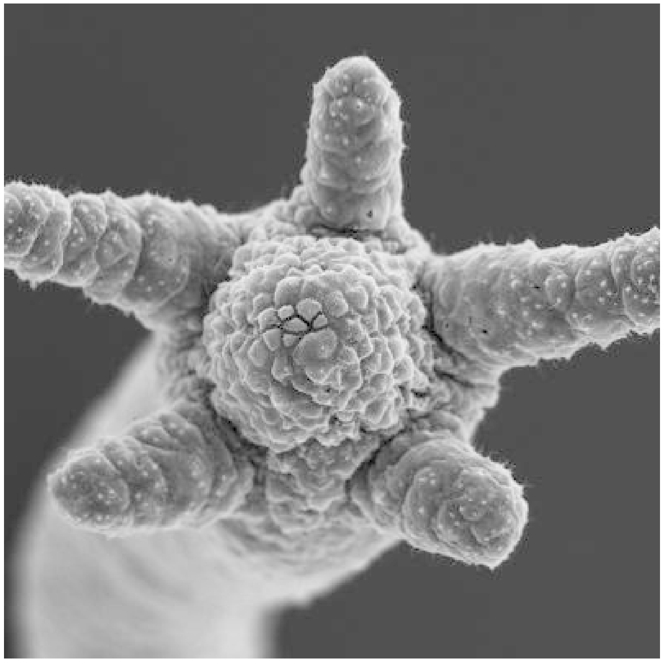
Heterotrophic organisms cannot inhabit an area until there are enough producers. Each new pioneer species sparks the evolution of heterotrophs that are capable of utilizing the energy they produce.



History of Life's Energy

The first consumers took advantage of free floating sugar in aquatic conditions. These were single celled protists and simple animals.

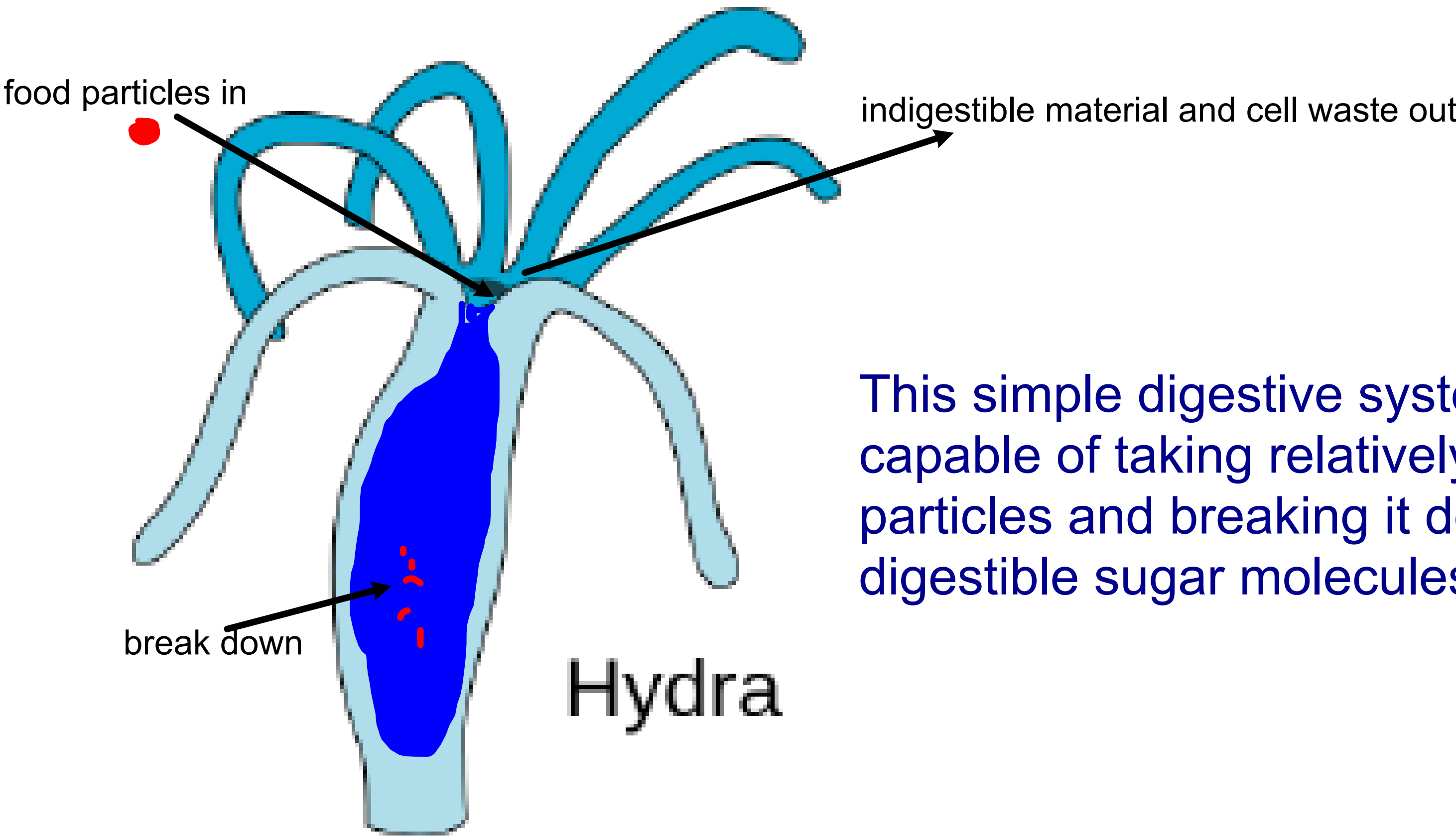
protists



Simple microscopic animal
Hydra

History of Life's Energy

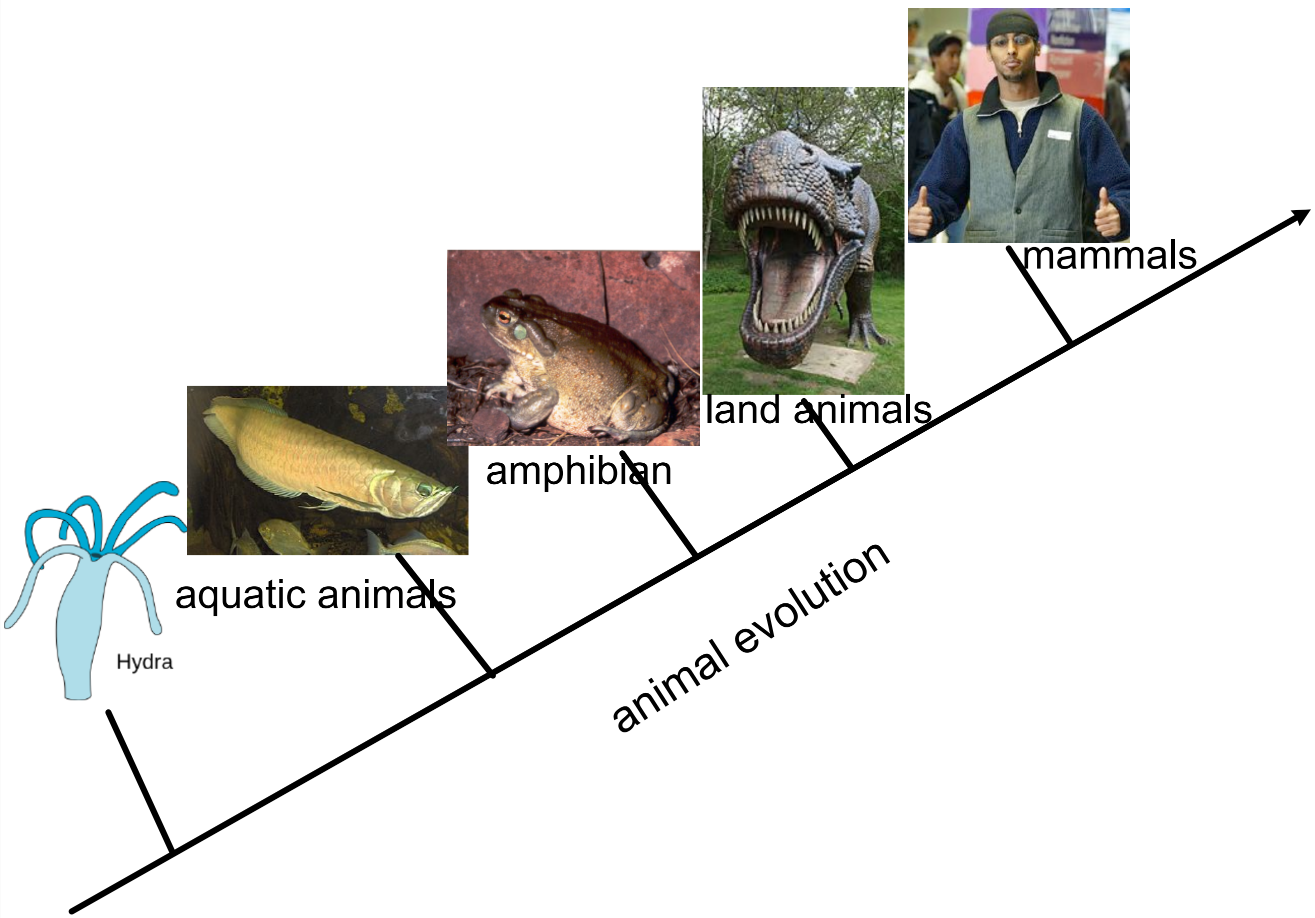
Protists could simply absorb sugars through membranes, but the more complex hydra requires higher quantities to fuel its multiple cells. To accomplish this it uses a **gastrovascular cavity.**



This simple digestive system is capable of taking relatively large particles and breaking it down into digestible sugar molecules

History of Life's Energy

The simple beginnings of digestion lead to descendants with extremely complex digestion with hormonal control.



Survey of Energy Consuming

There are uncountable evolutionary adaptations for the purpose of consuming energy. Each ecosystem presents challenges that require traits to overcome.

Remeber the basis for consuming is cellular respiration.

Cellular Respiration

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + 6\ H_2O + \text{Energy}$$

Animals and other consumers must obtain **sugar and oxygen.**

Consuming Sugar

Digestion is the mechanism for multicellular eukaryotes to obtain sugar. The function of the digestive system is ingestion and digestion of food to be converted into energy for the body.

Elimination of waste is also a function of the digestive system.

Types of Eaters

All animals fall into one of three categories when it comes to what type of food they ingest:

Herbivores: Plant eating *(herba = green crop)*
Examples of herbivores are: cattle, gorillas, and snails.

Carnivores: Meat eating *(Carni = flesh)*
Examples of carnivores are: lions, hawks, and snakes.

Omnivores: Plant and meat eating *(Omni = all)*
Examples of omnivores are: crows, raccoons, dogs, and humans

Methods of Food Ingestion

Suspension feeders extract food particles from the surrounding water. Examples: clams and oysters

Substrate feeders live in or on their food source and eat their way through it. Examples: caterpillars and earthworms

Fluid feeders obtain food by sucking nutrient-rich fluids from a living host. Examples: mosquitos and ticks

Bulk feeders ingest large pieces of food. Most animals fall into this category.

Stages of food processing

Ingestion: the act of eating

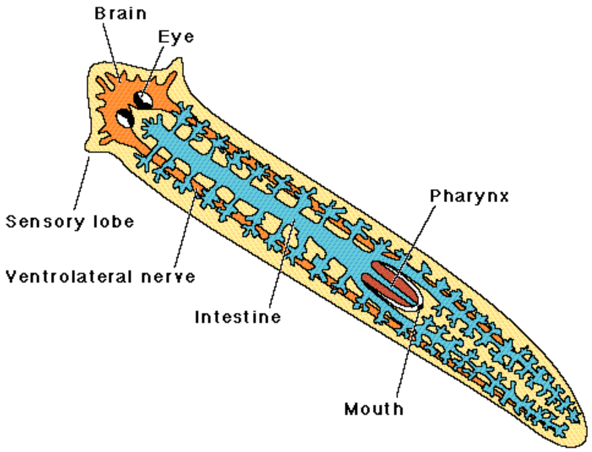
Digestion: the process of breaking food down into molecules small enough to absorb

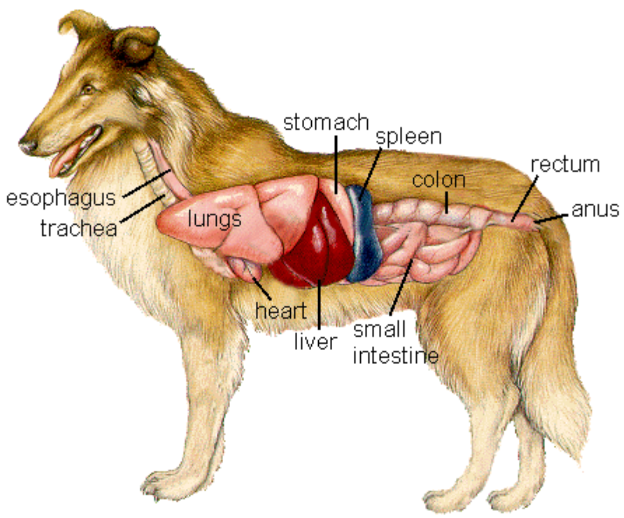
Absorption: the uptake of nutrients by body cells

Elimination: the passage of undigested material out of the digestive compartment

Simple vs. Complex Digestive Systems

Simple animals, such as **cnidarians** and flatworms, have a digestive compartment called the **gastrovascular cavity** with a single opening called the mouth.





Other animals have a digestive tube with two openings, a mouth and an anus. The tube is called the **alimentary canal**.

Alimentary canal

In the alimentary canal, food moves in one direction and specialized regions of the tube carry out digestion and absorption in sequence.

The alimentary canal is divided into the following regions:
Mouth: Where food enters
Pharynx: The throat region
Esophagus: Channels food to a compartment (such as the stomach)
Intestine: Main site of chemical digestion and nutrient absorption
Anus: Undigested material is expelled through this region

10 An animal that eats only grass would be classified as a ____________.

- A carnivore
- B herbivore
- C omnivore
- D suspension feeder

11 Female mosquitos feed by sucking nutrient rich blood from their hosts; therefore, they are considered fluid feeders.

- True
- False

12 You would be considered a:

- A suspension feeder
- B substrate feeder
- C fluid feeder
- D bulk feeder

13 The act of eating would be considered which stage of food processing?

- A ingestion
- B digestion
- C absorption
- D elimination

14 Cnidarians have a complex digestive system with two openings called an alimentary canal.

- True
- False

15 In which part of the alimentary canal does most digestion and nutrient absorption take place?

- A oral cavity
- B stomach
- C intestine
- D liver

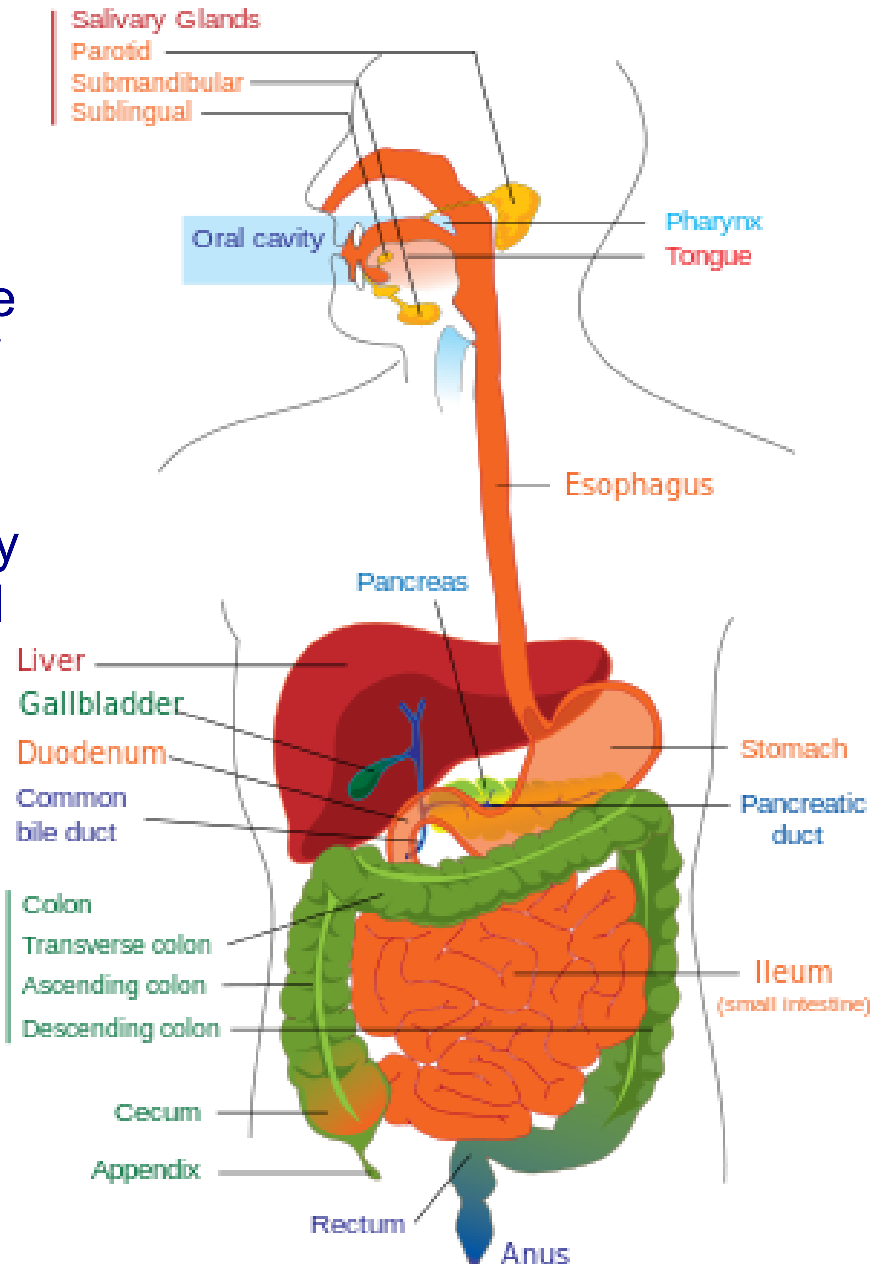
Hormonal Regulation of Digestion

As complexity increases, the need to regulate digestion and optimize the food that is being ingested becomes greater. Human digestion is an example of a highly complex digestion system. Humans are capable of ingesting a wide range of food, absorbing many nutrients and adjusting absorption to match intake and need.

Humans are omnivorous bulk feeders.

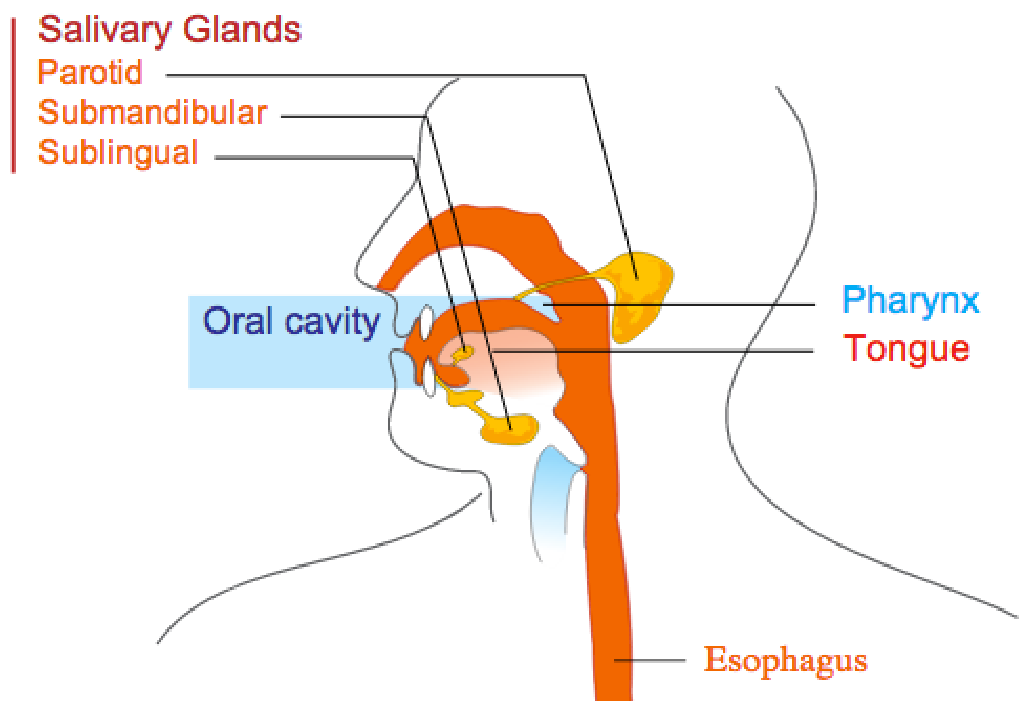
Human Digestive System

The human digestive tract is composed of compartmentalized organs. It is regulated hormonally by the pancreas and the brain.



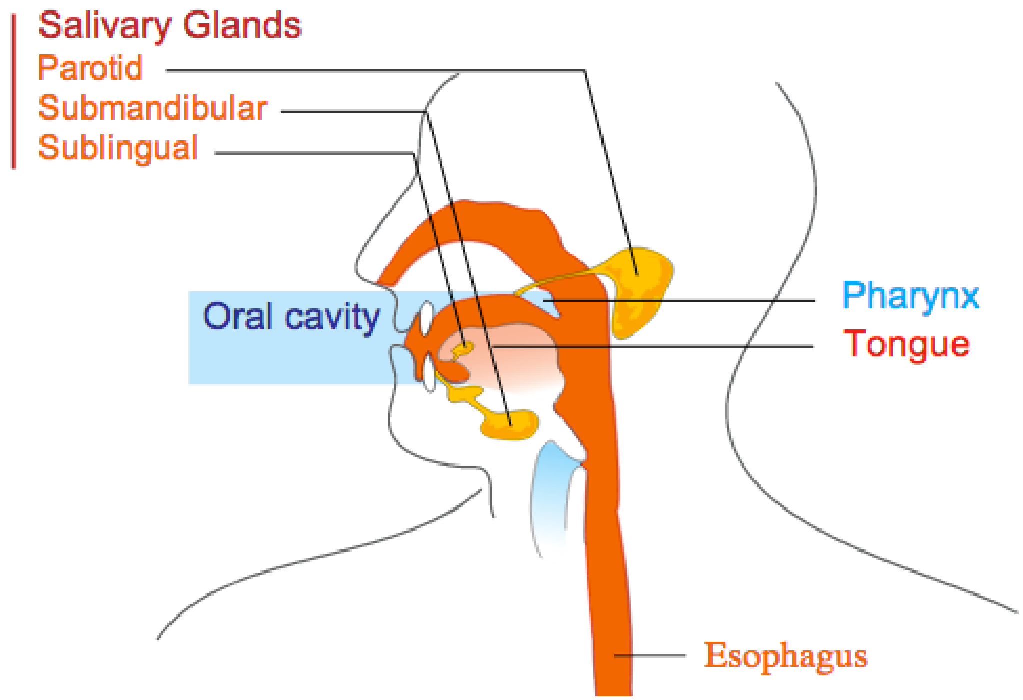
Human Digestive System

Cephalic phase - This phase occurs before food enters the stomach and involves preparation of the body for eating and digestion. Sight, smell, taste and thought of food stimulate the brain. Salivary glands are activated by neural control.



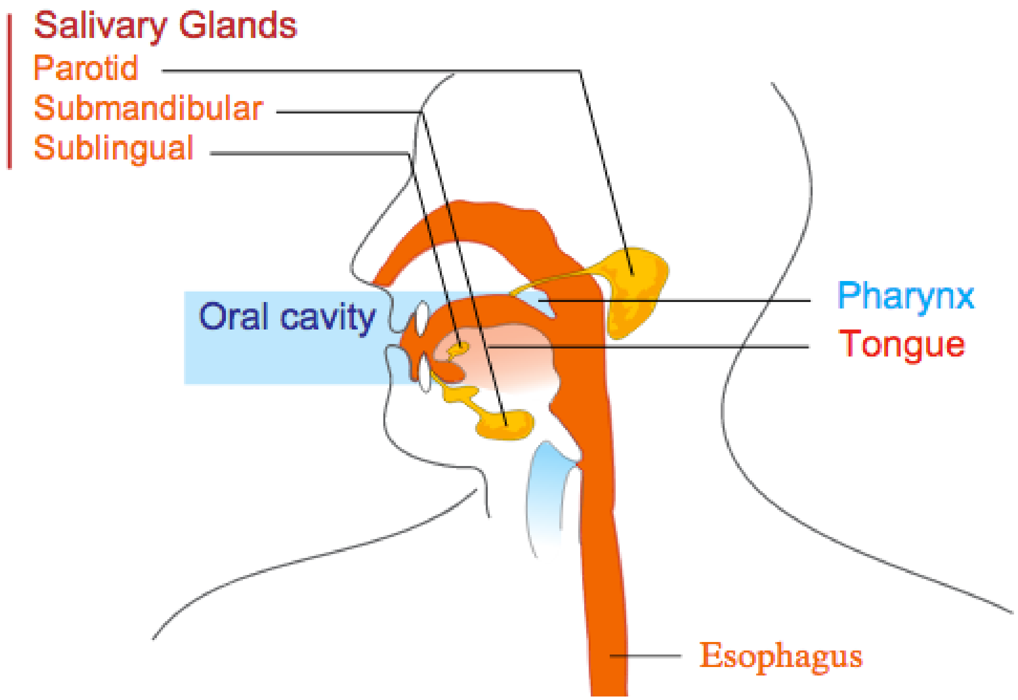
Human Digestive System

Saliva contains the enzyme amalayse which immediately starts the breakdown of carbohydrates like starch. Saliva combined with chewing and movements of the pharynx and tounge turn the food into a**bolus** a ball of partially digested food.



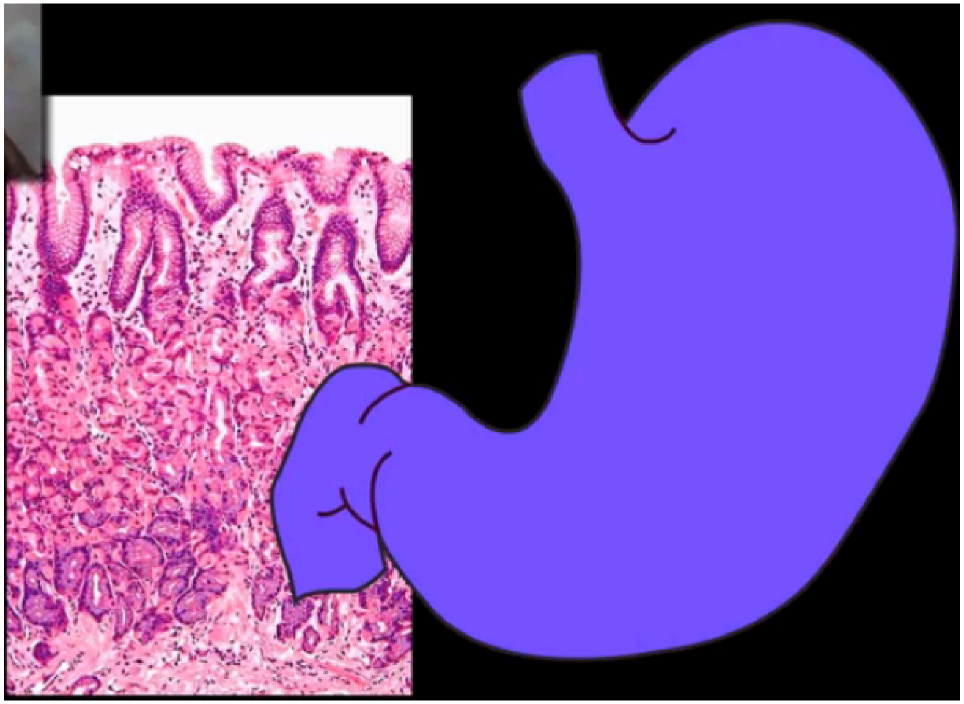
Human Digestive System

The bolus is passed into the esophagus from the mouth. Muscular contractions of the esophogus move the bolus to the stomach.



Human Digestive System

The gastric phase- The bolus is mixed into the digestive "soup" of the stomach. The stomach is muscular and it churns the food into a homogenized **acid chyme**.



Human Digestive System

The stomach produces an enzyme that becomes active in the presence of acid. To avoid destruction of stomach cells, the active enzyme **pepsin** is released into the **lumen** of the stomach as inactive pepsinogen. Another cell releases HCl to make the lumen acidic. This activates the hydrolytic enzyme pepsin.

Cell	Product
chief	pepsin
parietal	HCl

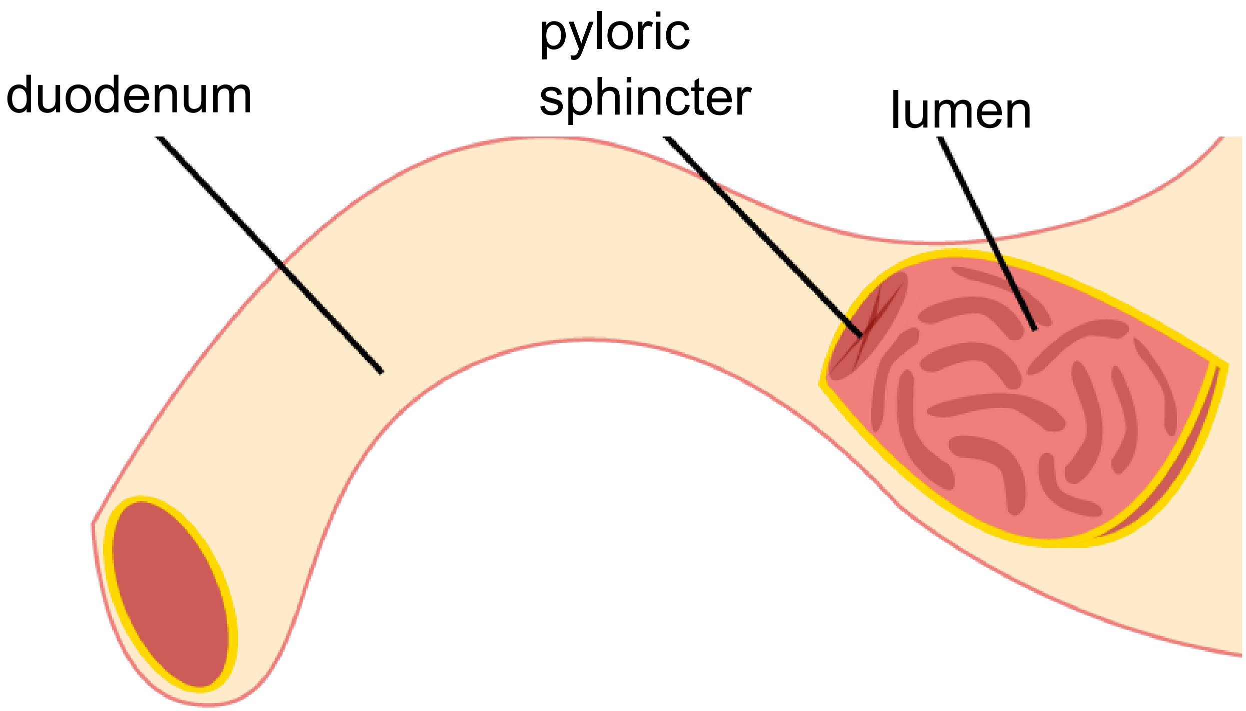
Human Digestive System

Chief cells produce pepsinogen, parietal produce HCl and all cells produce mucous to ensure a lining in the stomach that will protect the cells from the products they release. **Pepsin breaks down proteins.**

Cell	Product
chief	pepsin
parietal	HCl

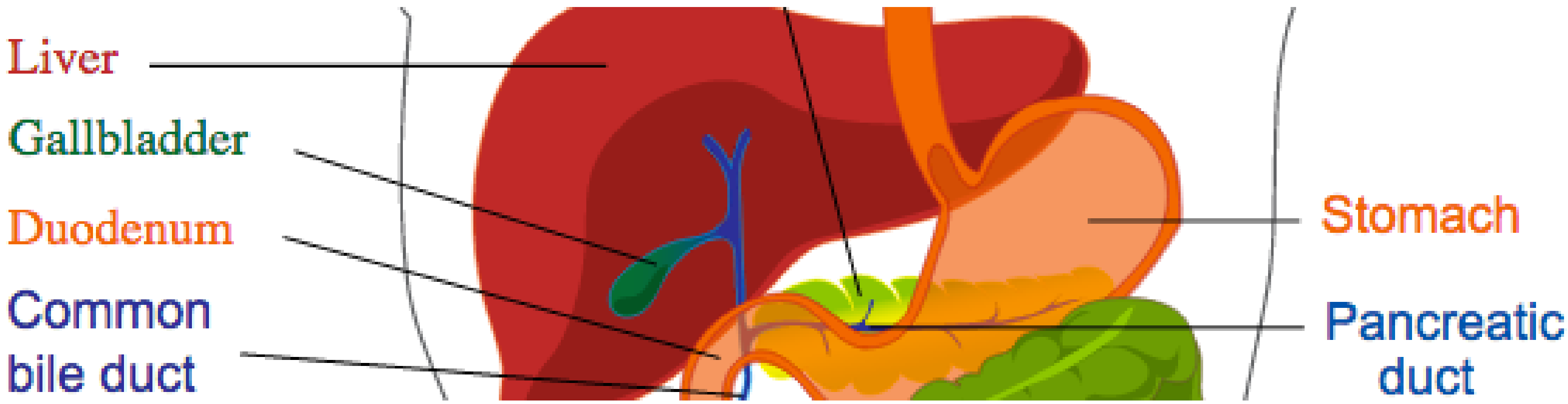
Human Digestive System

The pyloric sphincter is the transition from the gastric phase to the **intestinal phase**. The major change that happens here is that mechanical breakdown is ending and absorption is beginning.



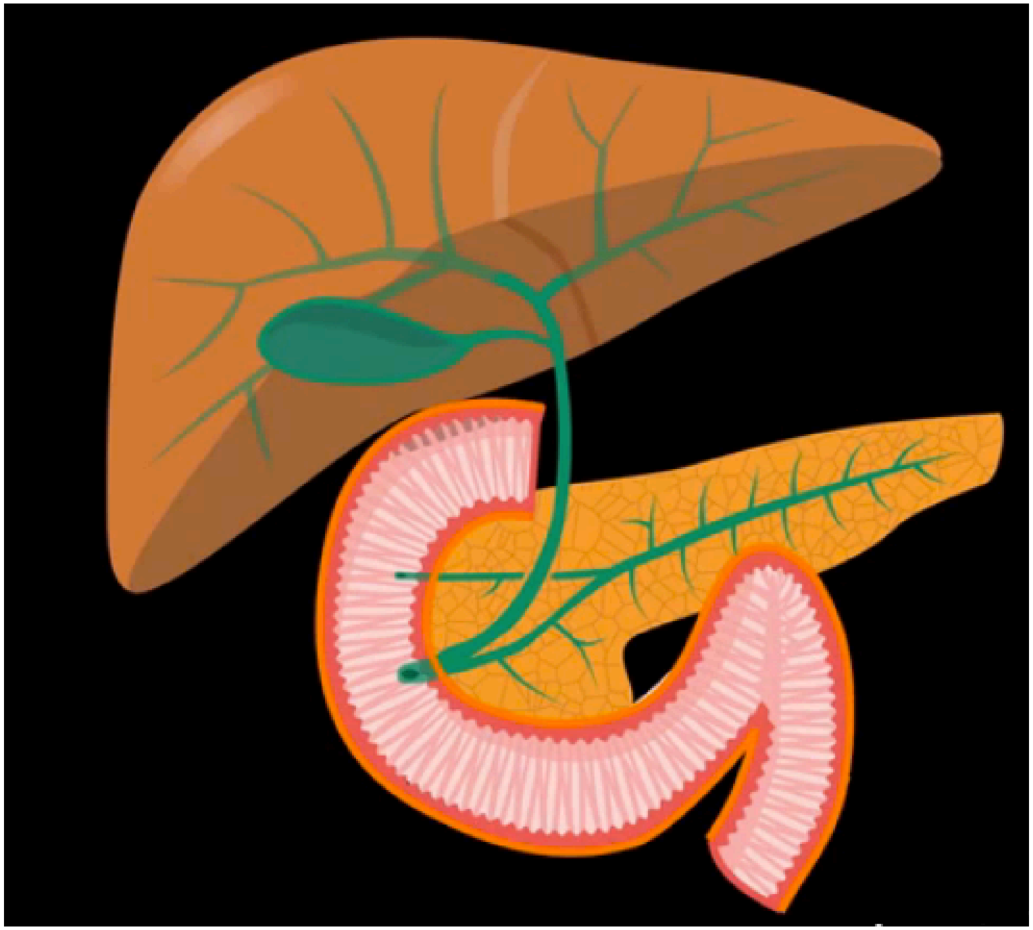
Human Digestive System

The duodenum is the central processing area for incoming food. The pancreas monitors the food entering the small intestine and releases hormones that engage multi organ responses. The liver and gallbladder release bile salts that help absorb fats, carbohydrates are given one last bath of hydrolytic enzymes and the brain is alerted to the influx of nutrients.



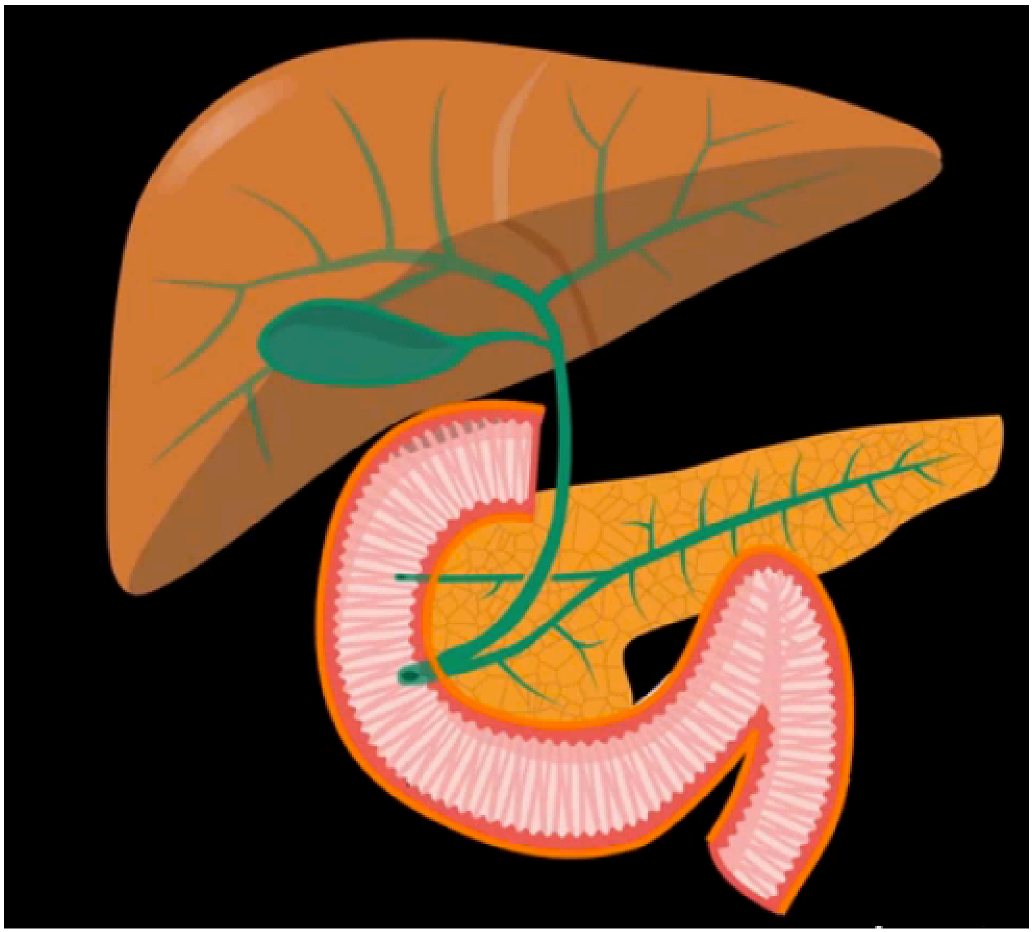
Human Digestive System

The liver and gallbladder release bile salts that help absorb fats. The bile salts emulsify the fat and make it possible for cells to absorb them.



Human Digestive System

The pancreas releases enzymes that breakdown proteins lipids and carbohydrates.



lipase -fats

amylase- carbs

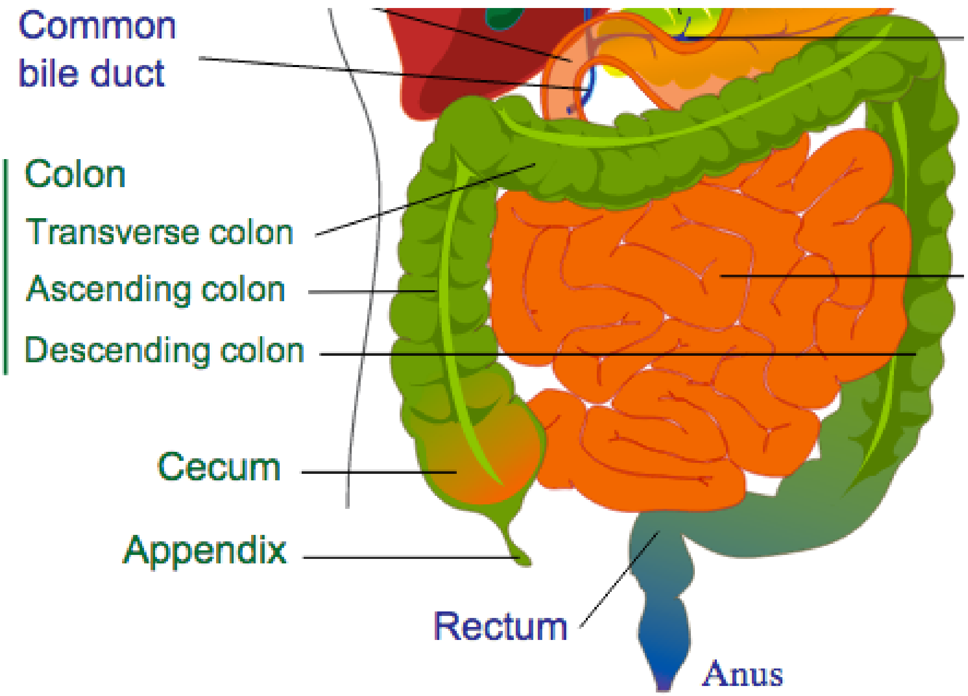
trypsin- proteins

chymotrypsin- proteins

and many others

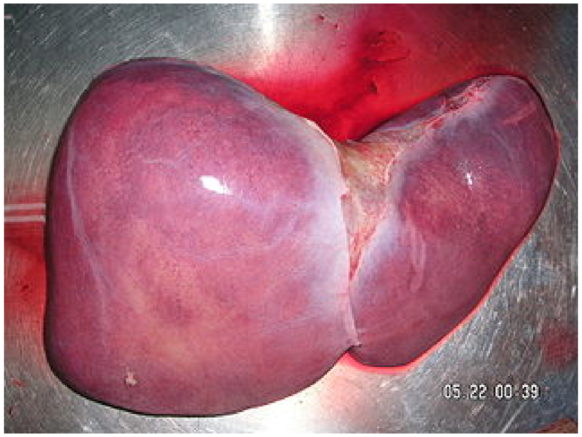
Human Digestive System

Finally the mix of enzymes and food move through the intestines where nutrients are absorbed and undigestible material is released via the anus.



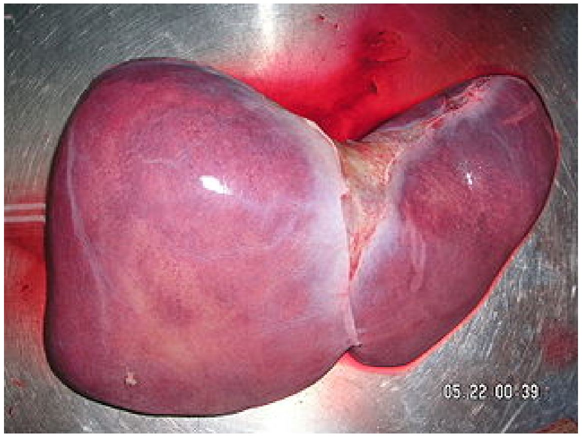
Human Digestive Hormones

As stated, the digestive system exhibits hormonal control over other systems in the body. This is largely accomplished through communication with the brain, pancreas and liver.



Human Digestive Hormones

Normal blood glucose level is 90mg per 100 ml of blood. This must be maintained for normal body function to proceed. When the pancreas recognizes an influx of glucose into the blood it releases insulin.

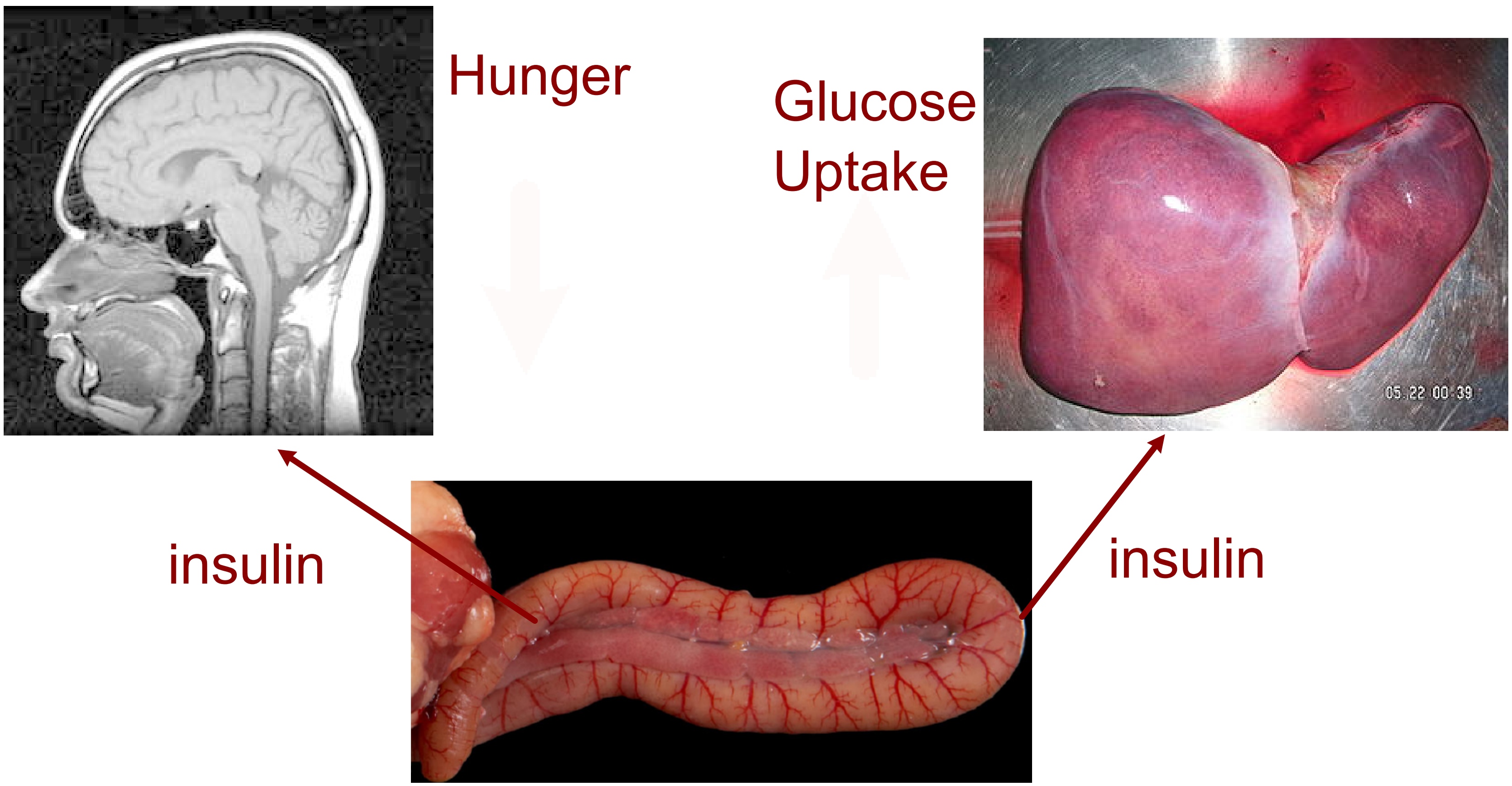


insulin

insulin

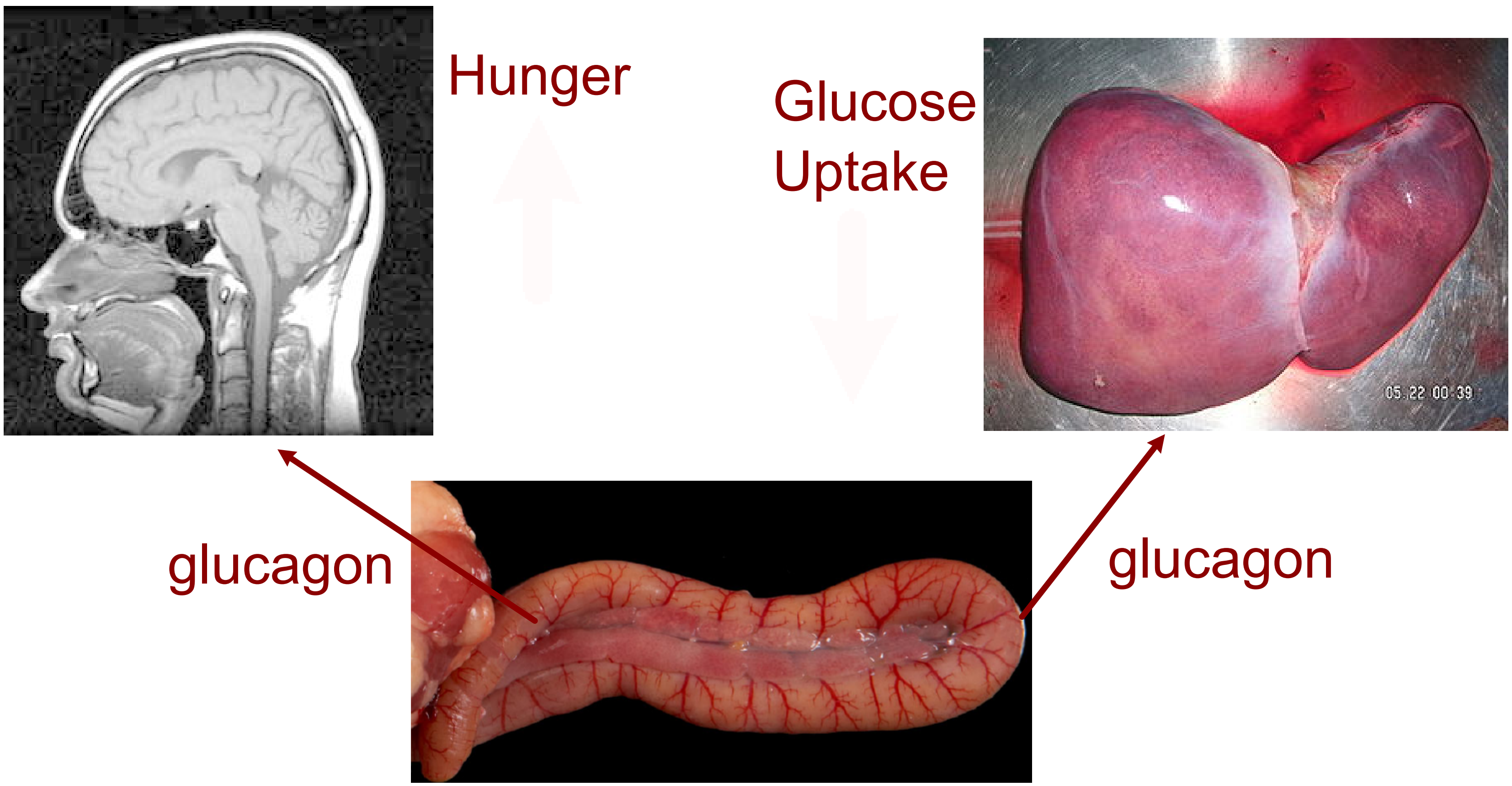
Human Digestive Hormones

This hormone causes an uptake of sugar by the liver to store and convert to fat. At the same time it suppresses hunger in the brain.



Human Digestive Hormones

If the pancreas recognizes a situation where blood glucose will drop too low, it releases a hormone called glucagon. This effect is the opposite of insulin.



16 Which of these enzymes operates in low PH

- A Trypsin
- B Amalayse
- C Lypase
- D Pepsin

17 Which of these enzymes digest proteins?

- A Trypsin
- B Amalayse
- C Lypase
- D Pepsin

18 Which of these enzymes is the first to start digettion?

- A Trypsin
- B Amalayse
- C Lypase
- D Pepsin

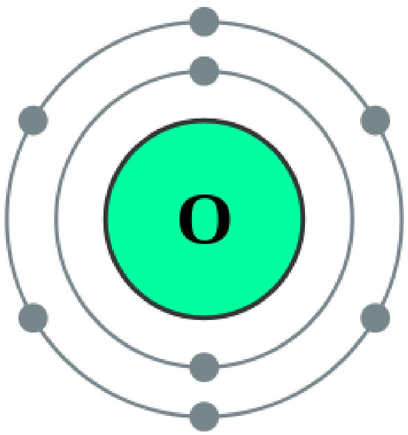
19 Which of these foods would cause the most insulin to be released?

- A Ice Cream
- B Hamburger
- C Tomato
- D Salmon

Gathering Oxygen

8: Oxygen **2,6**

We have seen how the human body absorbs and regulates glucose but we also need to extract oxygen, the other reactant in cellular respiration.



Respiratory System

The function of the respiratory system is to exchange oxygen and carbon dioxide in an organism for the purpose of maintaining cellular respiration.

The part of an animal where gases areexchanged with the environment is called the **respiratory surface**. Respiratory surfaces must be moist in order to function properly because gases are dissolved in water before diffusing across these surfaces.

Examples of Respiratory Systems

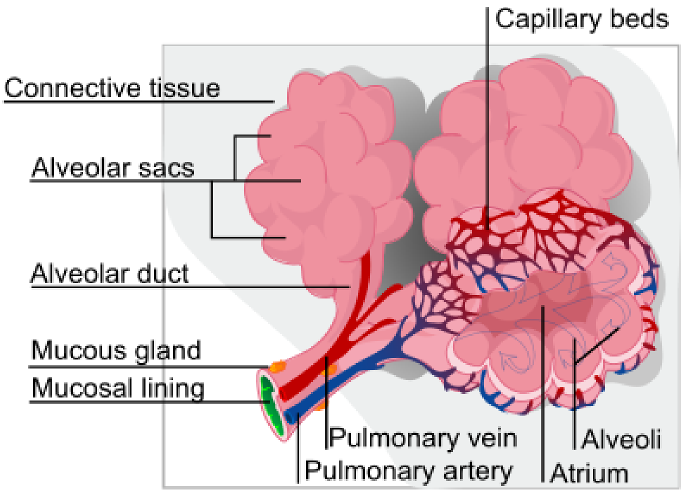
Some animals, such as earthworms, use their entire outer skin as a respiratory organ.

Other animals have body parts that are adapted for respiration because their skin surfaces are not extensive enough to provide gas exchange for the entire body. Examples of these include gills in fish, and lungs in mammals.

Homeostasis of Gas Exchange

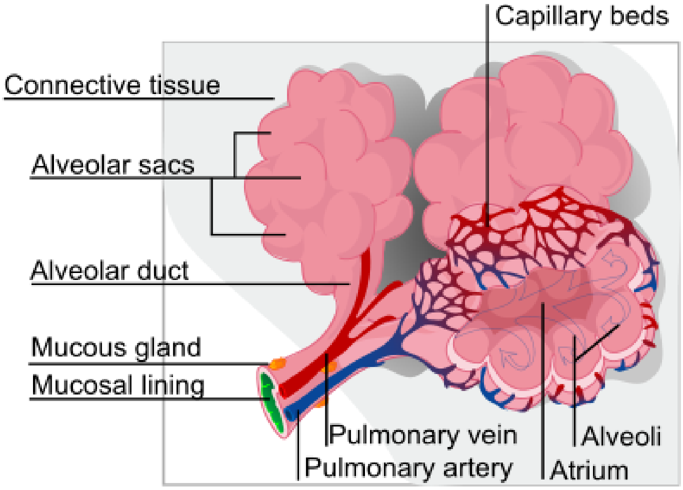
Lungs are made of tiny sacs called alveoli. These are filled with arteries and veins that drop off carbon dioxide and retrieve oxygen to disperse through the organism

In mammals, the rate at which lungs exchange gasses with the environment is controlled primarily by pH.



Homeostasis of Gas Exchange

As carbon dioxide builds in the blood, the blood becomes more acidic. The brain respond to this stimuli by quickening Alveoli contractions to expel this gas.

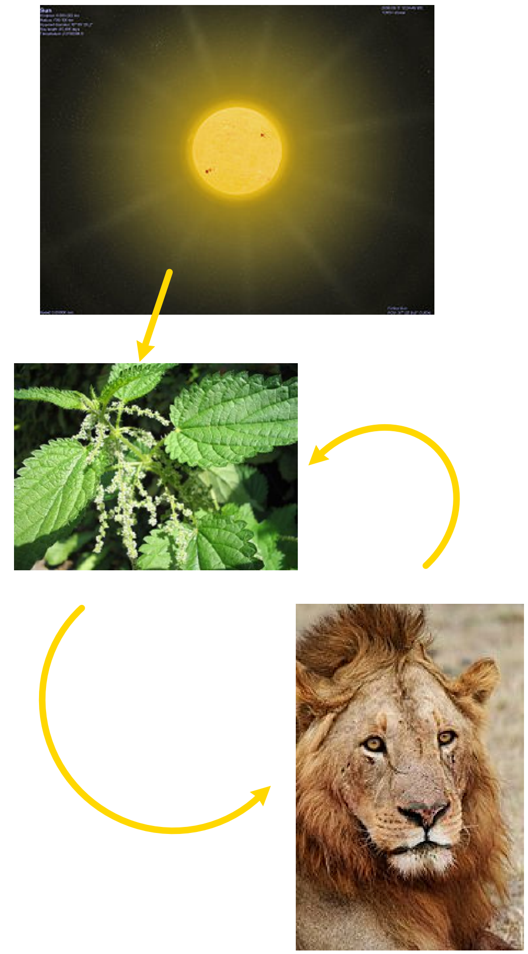


Wrap-up of Life and Energy

Living systems require free energy and matter to maintain order, grow and reproduce

Autotrophic cells capture free energy through photosynthesis. Cellular respiration and fermentation harvest free energy from sugars to produce free energy carriers, including ATP. The free energy available in sugars drives metabolic pathways in cells.

Photosynthesis and respiration are interdependent processes.



Wrap-up of Life and Energy

Homeostatic mechanisms across organisms reflect both continuity due to common ancestry and change due to evolution and natural selection.

In plants and animals, defense mechanisms against disruptions of dynamic homeostasis have evolved. Additionally, physiological and behavioral events are regulated, increasing fitness of individuals and long-term survival of populations, communities and ecosystems.