What is Biology?

What is Biology?

Biology is the study of _____.

There are many branches or divisions of biology, each specializing in the study of a specific group of living things.

Division	Area of Specialty

What is a living thing?

In order for something to be considered alive it must show certain characteristics. Living things:

-
-
-
-
-
-
-
-

Living things will show all of these characteristics but there are some exceptions. For example, _____.

Non-living things may show one or a few of these characteristics but not all.

Development of the Cell Theory

Throughout history people have wondered what causes life and how life is maintained. It was not until the invention of the microscope and improvements on the microscope that we were able to look at living tissues and make detailed observations.

With these observations scientists came up with a formal cell theory that is used to explain observations of living things.

1.

2.

3.

Historical Look at the Cell

Aristotle - Classified all known organisms into two kingdoms: plant and animal; visualizes a "ladder of life" with plants on the bottom rungs; writes that organisms can arise spontaneously from non-living matter (c334 BC)

Zachary Janssen – this Dutch eyeglass maker invented the first compound microscope, by lining up two lenses to produce extra-large images (1590)

Robert Hooke - Observed tree bark lining with a compound microscope; described the magnification as "empty room-like compartments or cells" (1665)

Anton Van Leeuwenhoek - Reports living "beasties" as small as 0.002 mm observed with a simple single lens microscope (1674)

Carl Linnaeus - Focused on discovering, naming and classifying new species from all over the world (1753)

Robert Brown - First to consider the nucleus as a regular part of the living cell (1831)

Matthias Jacob Schleiden - "All plants are made of cells" (1838)

Theodor Schwann - "All animals are made of cells" (1839)

Carl Heinrich Braun - "The cell is the basic unit of life" (1845)

Rudolph Virchow - "Cells are the last link in a great chain [that forms] tissues, organs, systems and individuals… Where a cell exists, there must have been a pre-existing cell…Throughout the whole series of living forms… there rules an eternal law of continuous development" (1858)

Loiuse Pasteur - Demonstrates that living organisms cannot arise spontaneously from non-living matter (1860)

Microscope Calculations

What every Biologist needs to know…

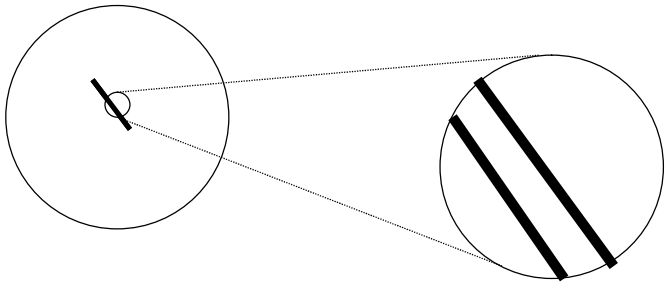
1. How to use a microscope
2. Estimating size using a microscope
3. Drawing scientific diagrams
4. Examining cells
5. Parts of the cell

Estimating Size Using a Microscope

Magnification

Refers to how many times bigger an object appears under the microscope

Total Magnification = ocular lens power X objective lens power

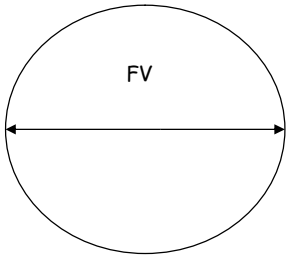


A strand of hair under two different magnifications

Field of View (FV)

Refers to the area you see through the microscope.

You can determine the FV under low power by using a ruler and measuring the area that you can see.



To determine the FV under medium and high power, you must use the following formulas:

$$FV_{MP} = FV_{LP} \times \frac{M_{LP}}{M_{MP}}$$

OR

$$FV_{HP} = FV_{LP} \times \frac{M_{LP}}{M_{HP}}$$

FV = Field of View
M = Magnification
HP = Higher power
MP = Medium power
LP = Lower power

OR:

Example calculation

Calculate the high power field of view (x) for a microscope with:

- eyepiece lens = 10x
- low power lens= 4x
- high power lens = 40x
- low power field of view = 4.1 mm (= 4100 um)

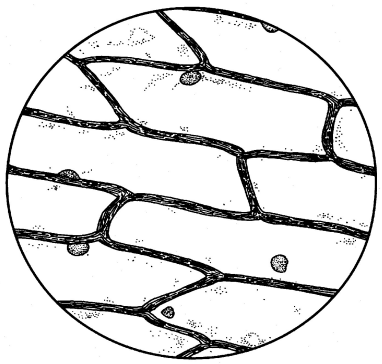
Estimating Length & Width

To estimate the size of an object under the microscope you can use the following equations:

$$\text{Estimated Size} = \frac{\text{FV}}{\#\ \text{fit}}$$

Example calculation

Estimate the length and width of an onion cell below. The cells were observed under high power using the same microscope in the previous example.

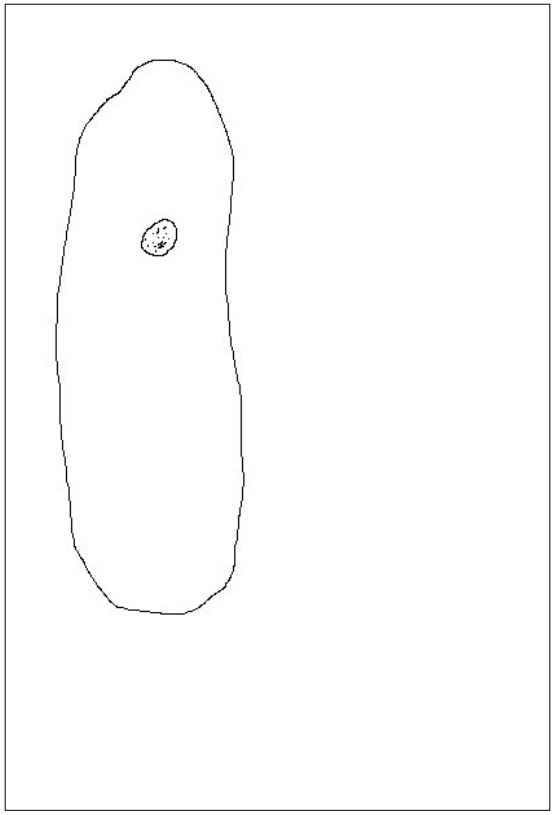


Drawing Magnification

The drawing Magnification represents how big your diagram is in relation to the actual cell size. Example: a model car

$$\text{Drawing Magnification} = \frac{\text{dimensions of cell diagram}}{\text{dimensions of actual cell}}$$

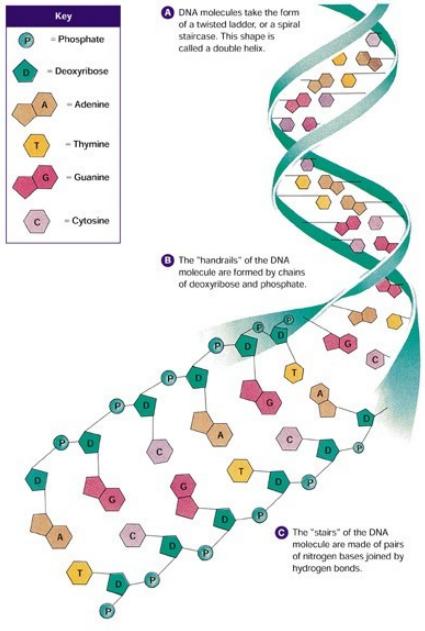
You must use either length or width for your dimensions.



What is DNA?

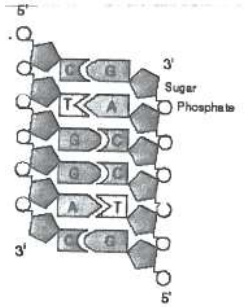
DNA stands for _____. It is a large molecule that is used as a storage site for genetic information and contains all of the instructions needed for the proper _____, _____ and _____ of an organism.

DNA is found within the _____ and comes in a few different forms, most notably in the form of a _____. Every plant and animal species has a specific number of chromosomes in the nucleus of each cell. Human cells have _____ chromosomes in each body cell; 23 that originated from the mother's _____ and 23 from the father's _____.

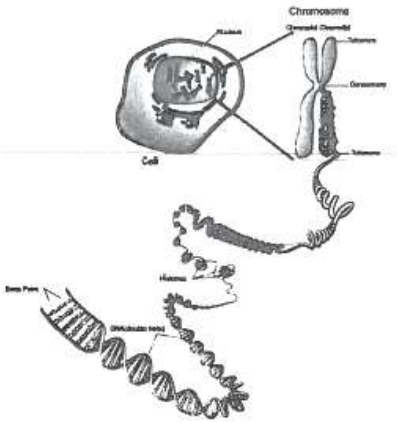


DNA is made up of paired _____, which are arranged into a _____ structure. A nucleotide is composed of three parts; a _____ molecule, a _____ molecule and a _____ base. There are 4 different types of nitrogenous bases found in DNA; _____, _____, _____ and _____.

The structure of DNA is similar to a twisted _____. Alternating sugar and phosphate components make-up the "_____" of the DNA double helix. The nitrogenous bases pair-up to make what looks like _____. The nitrogen bases fit together like _____ pieces. Adenine will always pair with thymine, while guanine will always pair with cytosine.

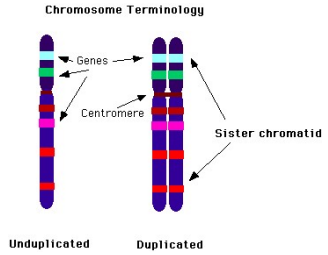


This means if you know what one strand of the double helix is, you can determine the _____. It is the _____ of A, G, C and T that will determine the type of _____ that is produced.



If the DNA contained in one single human cell was stretched out it would be about _____ long. In order to fit into the cell, DNA coils up into a tight structure called _____. When cells are preparing to divide, they make an exact copy of their DNA through a process called DNA _____. The DNA then arranges into _____ in which two pieces of tightly wound DNA associate together and are attached at the centre by a structure called a _____.

DNA is separated into sections called _____. Genes are located in specific places on a DNA molecule and provide the instructions for making _____. Therefore, DNA and genes control a cell's activities by controlling what proteins are made when. Humans have approximately _____ genes. One of the first animal's sequenced back in 2000, was the fruit fly and it has approximately _____ genes.



Each individual human has a unique sequence of DNA from all other humans (except identical twins), however _____ of our DNA is the same. All human DNA is arranged into the same set of genes, however there are small differences in the _____ of nitrogen bases within these genes that result in differing traits. Between humans and one of our closest related species, the chimpanzee, approximately _____ of our DNA is the same.

Cell Division

You are made up of approximately _____ cells. This is amazing considering that all these cells started from one fertilized egg. Even now cells are dividing in your body! Cell division is needed for:

1. Growth -

2. Repair and Regeneration-

3. Reproduction –

How does cell division occur?

Cell division occurs in three stages:

1. Replication –

   The replication process must be relatively _____ and it must be _____ for cells to survive. Remarkably, cells are able to duplicate their DNA in a few _____, with an error rate of approximately _____ per _____ nucleotide pair!

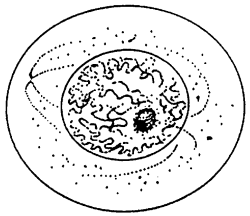
2. Mitosis –

3. Cytokinesis -

The end result of these stages are _____ from one original cell.

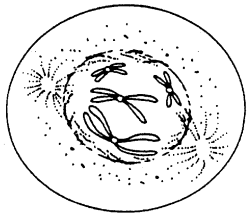
In order to describe the events of the cell cycle, the process has been divided into several phases:

INTERPHASE:



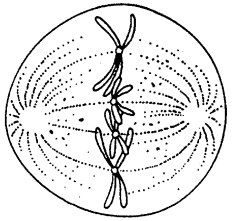
- The cell is doing its _____ (normal cell activites)
- _____ in the form of _____ - cannot be seen
- Cell grows
- At the end of interphase the DNA has _____
- Most of the cell's _____ is spent here

PROPHASE:



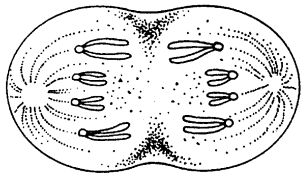
- _____ disappears
- _____ disappears
- DNA _____ and _____ and becomes visible - _____
- _____ form and can be seen
- _____ move apart

METAPHASE:



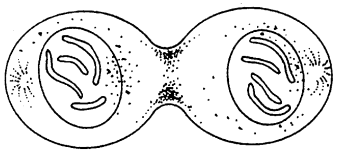
- Chromosomes line up at _____ of cell
- Centrioles are located at _____
- Spindle fibres attach to _____ and centrioles

ANAPHASE:



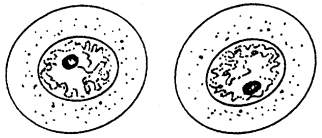
- Centromeres _____ and single-stranded _____ move to opposite poles
- Pulled by spindle fibres

TELOPHASE:



- Opposite of _____:
  - _____ reappears
  - _____ reappears
  - _____ disappears
  - Chromatid become _____ and _____ and cannot be seen (_____)

FINAL RESULT OF CELL DIVISION:



- _____ occurs (division of cytoplasm)
- Two _____ _____ cells are produced

Cancer

The DNA in the _____ of each of the cells in your body is _____. DNA is like software that determines what you look like. It also controls all of the _____ within the cells and in your body. The information encoded in this software comes from both of your _____. Usually, the software runs smoothly and the program works as it should. However, sometimes "_____" develop in the software and problems occur.

The cell cycle is controlled by a communication system that involves _____ signals. If a cell ignores a signal to stop dividing, unchecked cell _____ can result…called a _____.

A _____ is a permanent change in a cell's _____. All tumours start with a mutation that affects a cell's response to division signals. This mutation is passed on to other cells during _____.

Mutations may be:

(i) _____ (i.e., breast cancer)
(ii) _____
(iii) A result of exposure to _____ (i.e., UV light and radiation)
(iv) Due to exposure to _____ (i.e., cigarettes, alcohol, drugs)
(v) _____ (i.e., HPV)

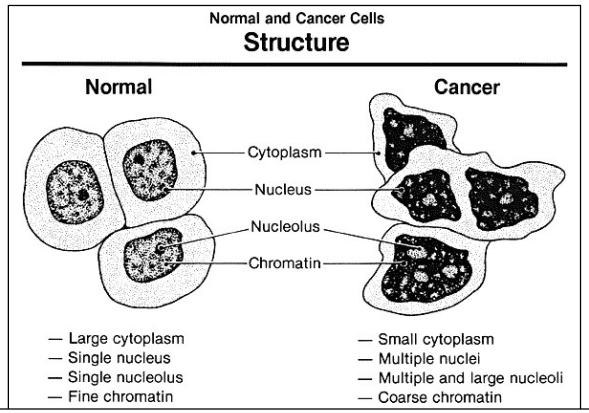
Normal body cells _____. Cancer cells just _____ _____. Some mutations are _____ (not life-threatening), while others are _____ or cancerous.

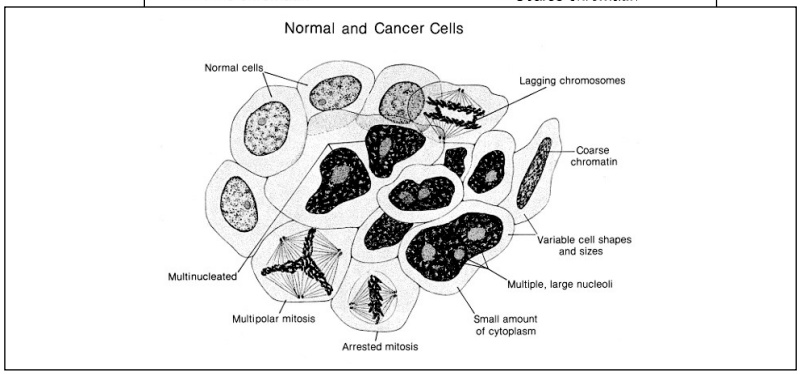
Tumour	Characteristics
Benign	• Cell division is _____ and proceeds at a _____ rate • Does _____ surrounding cells, but may _____ nearby cells out of the way • Does _____ to other parts of the body • Relatively _____ unless found in a part of the body, such as the brain, where it may press on other cells
Cancer (Malignant Tumour)	• Cell division is _____ and occurs very _____. Cells spend little time in _____ • _____ surrounding cells by invading them • Can _____ to other parts of the body • May _____ with the function of other cells, sometimes resulting in death if the tumour is not destroyed or removed

Cancer Cells

Cells are usually in _____ with other cells and tend to ____ together. This contact is required for cells to divide. _____ cells _____ divide when they are _____from one another, but _____. Another problem with cancer cells is that they _____ stick together or stick to normal cells very well. Cancer cells may separate and move and begin dividing in other parts of the body. This makes cancer _____.

There are many different types of cells in the body. Each type carries out a _____ _____. One important difference between cancer cells and normal cells is that _____ _____ as they grow. They _____ from food but do not carry out the work of normal cells. Also, if a tumour grows large enough, it can _____ with the normal function of other _____.





Cell Specialization and Stem Cells

Cell Specialization

Single celled organisms, like the amoeba, are simple organisms and are able of carrying out all of the essential life functions to survive on their own. Complex, multicellular organisms, like plants and animals divide the tasks needed for survival into groups of _____ _____.

Following cell division, each new daughter cell that is created is an exact copy of each other. Each cell contains an _____ copy of _____ and the ability to perform any function within the organism. ***So what determines how each cell will become specialized?***

In animals, three main factors influence the differentiation of cells:

-
-
-

When a cell becomes specialized, some of the non-essential _____ (coding areas of DNA) get, "_____". Those genes that are required to carry out their specific job (ex. muscle cell) remain "turned on" and will remain that way for the cells entire life. It does not normally change to become a different type of cell.

Stem Cells

Stem cells are _____ cells that can produce various types of specialized cells.

Some animals like the starfish or salamander have stem cells that allow them to _____ some body parts. Humans can replace only a small amount of _____, such as that needed for _____ and _____ _____. Human organs are formed in the _____ and the body cannot produce new ones.

As embryos, humans have _____ stem cells, which can become _____ of cell in the body. As the embryo develops, its stem cells become _____. These cells are _____ and can produce many, but not all types of cells. After birth, humans have _____which can produce only _____ of cells. Adult stem cells can be found in various places in the body, but are abundant within the _____ _____ (interior of large bones where blood is produced).

The use of _____ stem cells has enormous potential for _____ and _____, however the means by which they are obtained are considered _____ by many.

Levels of Organization

The human body is structured into _____. Recall that cells are the smallest units of life. Cells that are similar in _____ and _____ work together as _____. The human body has four primary kinds of tissue:

Epithelial tissue –

Connective tissue –

Muscle tissue –

Nervous tissue –

Different types of tissues work together to form _____, which carry out particular functions. Examples include, _____, _____, _____ and _____.

Organs cannot do all of the necessary work to sustain the body on their own. They must work together with other organs with related functions (_____) or structures (_____). This is referred to as an _____.

The following is a list of the body's major organ systems and their functions:

Organ System	Major Organs	Major Function
	Esophagus, stomach, intestines, liver, pancreas	Physical and chemical breakdown of food
	Heart, blood vessels	Transportation of nutrients, gases and waste; defence against infection
	Lungs, trachea, blood vessels	Gas exchange
	Testes, vas deferens, ovaries, uterus, fallopian tubes	Sexual reproduction
	Kidney, bladder, ureter, urethra	Removal of waste
	Bones, muscles	Movement of body and body parts
	Pancreas, pituitary gland, adrenal glands	Coordination and chemical regulation of body activities
	Brain, spinal cord, eyes, ears, nose, tongue, nerves	Response to environment; control of body activities

Human Organ Systems

Digestive System

Digestion is a complex process, which results in food being broken down into its component molecules. It involves:

1) Mechanical (Physical) Digestion

   -
   -

2) Chemical Digestion

   -

   -

In humans, the digestion process takes about _____ hours and requires passage through an extremely long tube system (_____), separated into distinct regions that perform specific functions.

Parts of the Digestive System

Functions of the Digestive System

Part	Function
Salivary glands	
Esophagus	
Stomach	
Small Intestine	
Large Intestine Rectum Anus	

The Mouth (Ingestion)

Both **physical** breakdown and **chemical** digestion occur in the mouth. The teeth are important for **physical** digestion.

Human teeth

Type of Tooth	Number	Function
Incisor		Cutting
Canine		Tearing
Premolars		Grinding
Molars		Crushing
Wisdom		Crushing

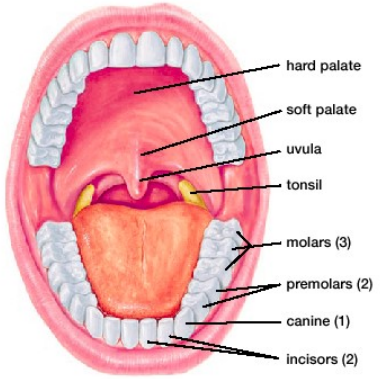


Figure 10.11 This illustration of the human mouth shows the number, type, and arrangement of the teeth, plus other details.

Chemical digestion begins as food is chewed, and it begins to mix with **saliva** produced by the three salivary glands.

Some functions of saliva include:

- It wets and **lubricates** so food can be swallowed easier
- It causes the food particles to stick together to form a food mass, or **bolus**
- It contains a digestive enzyme _____, which breaks down starch into simple carbohydrates

The Esophagus

No digestion, neither physical nor chemical occurs in the esophagus. It secretes **mucin,** a lubricant which aids the bolus of food in its journey to the stomach.

The movement of food down the digestive tube is aided by rhythmic muscle contractions called **peristalsis**.

The Stomach

The stomach is the site for temporarily storage of **food**. Both **physical** breakdown and **chemical** digestion occurs here. Physically the stomach has a **J-shaped** appearance and can hold up to **1.5 L** of food.

In the stomach, food is broken down mechanically into smaller particles by the **contractions** of the **muscular** stomach walls (**oblique** muscles). This is referred to as **churning**. The food mass is mixed with _____(_____). The lining of the stomach is covered by a layer of _____ to protect it from the acidic environment.

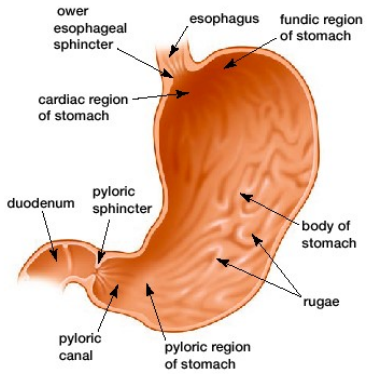


Figure 10.13 A cross sectional view of the stomach. Note the multitude of folds called rugae on the inner walls, and the esophageal and pyloric sphincters.

The Small Intestine

Most **chemical** digestion and almost **all absorption** of nutrients occur here. After food leaves the stomach, it enters the first part of the small intestine called the **duodenum**. At this stage, the partially digested food is called **chyme**. When chyme reaches the duodenum, it stimulates the production of enzymes from the **pancreas** and **liver** that aid in chemical digestion. These enzymes empty into the duodenum. The _____ produces the **most enzymes** need for digestion, along with the hormones **insulin** and **glucagon** which help to regulate _____. The _____ produces **bile**, an **emulsifying** agent needed for the physical digestion of **fats**.

The remainder of the small intestine (ileum and jejunum) is where the **absorption** of **nutrients** occurs.

The Large Intestine

_____ and _____ materials pass from the small intestine into the large intestine. No digestion occurs in this portion of the digestive system.

Functions of the large intestine include:
1. Reabsorption of **water** from the food mass
2. Absorption of vitamins **B** and **K** produced by live _____ in the large intestine

Fecal matter (undigested material) is stored in the last part of the large intestine, the **rectum**, and periodically eliminated, or **defecated**, through the **anus**.

Human Organ Systems Continued...

Respiratory System

There are several stages and forms of respiration:

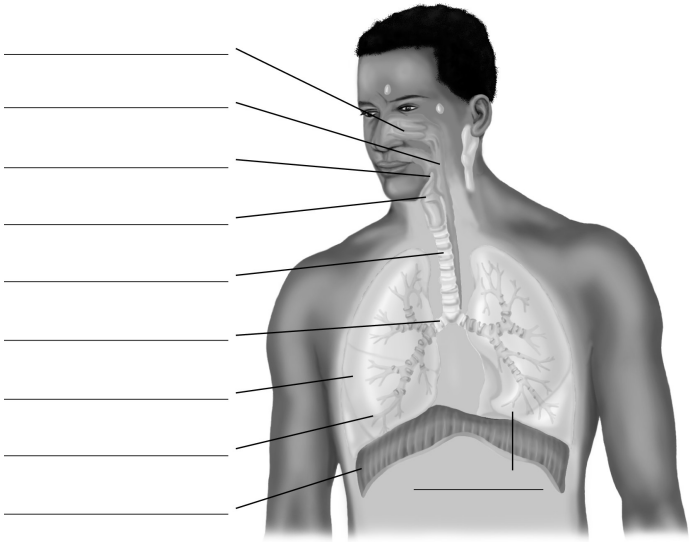
1. _____ - moving air into and out of lungs (inhalation/exhalation)
2. _____ - exchange of O_2 and CO_2 between air and lungs (blood vessels in the lungs). (Occurs by diffusion)
3. _____ - movement of dissolved gases by the blood to and from the body cells.
4. _____ - exchange of CO_2 and O_2 between blood and body cells. (Occurs by diffusion)
5. _____ - nutrients are broken down and released in the mitochondria of cells.

The Respiratory Surface

The respiratory surface must have the following characteristics:

- It must be _____ so _____ occurs rapidly
- It must be _____ so that oxygen and carbon dioxide will _____
- It must be in contact with an environmental source of _____
- In most multi-cellular organisms it must be in close contact with a _____ system
- It must have a large _____ _____

Parts of the Respiratory System



Functions of the Respiratory System

Part	Function
Nasal Cavity	
Trachea	
Bronchi	
Bronchiole	
Alveoli	
Diaphragm	

Human Organ Systems Continued...

Circulatory System

Circulation is the movement of materials within an organism.

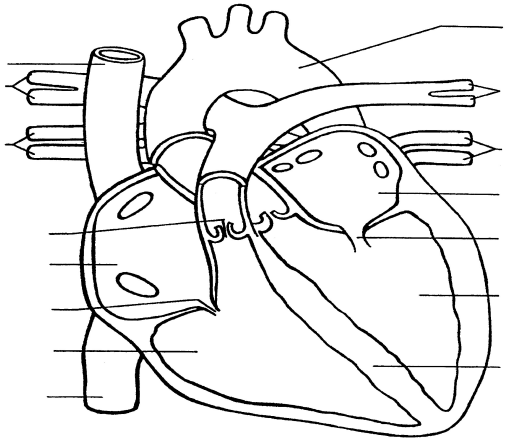
A circulatory system usually consists of:

1) A _____ in which materials are _____ (_____)
2) A network of _____ or body spaces in which the fluid flows (_____)
3) A means of driving or moving the fluid (_____)

Humans (like many other vertebrates) have a _____, _____ circulatory system:

The Heart

- The human heart pumps constantly (average of _____ times/minute)
- _____ times per day
- With each beat it pumps blood about through about _____ of vessels



Part	Function
	Chamber of the heart that collects blood flowing into the heart. The right atrium receives blood from the systemic circulation while the left atrium receives blood from the pulmonary circulation
	Chamber of the heart that collects blood to be pumped away from the heart. The right ventricle pumps blood to the pulmonary circulation while the left ventricle pumps blood into the systemic circulation
	The wall that separates the right and left ventricles of the heart
	Regulates blood flow
	The main blood vessel that carries blood from the heart into the systemic circulation
	The artery that carries blood from the right ventricle of the heart to the lungs
	The vein that carries oxygenated blood from the lungs back to the left atrium of the heart
	The main blood vessel that collects blood from the systemic circulation of the body (upper) and returns it to the right atrium of the heart
	The main blood vessel that collects blood from the systemic circulation of the body (lower) and returns it to the right atrium of the heart

- The route taken by the blood within the heart is called _____.
- The pathway of the blood from the heart to the lungs is called _____.
- The movement from the heart to the rest of the body is called _____.

Blood Vessels

Arteries (usually high O_2, low CO_2)

- Carries blood _____ from the heart to the _____
- _____ and _____ walls
- When the walls _____ then _____, they help to _____ blood through the arteries

Veins (usually low O_2, high CO_2)

- Carries blood ___ the heart from _____ and _____
- _____ and slightly _____ walls
- Contain flap-like _____ to prevent _____ of blood – defective valves can cause blood to pool and result in _____
- _____ around the veins help to keep the blood moving back to the heart.

Capillaries

- The smallest vessels
- The _____ and _____ are connected by a network of microscopic capillaries
- _____ and allow for exchange of materials between cells and the blood by _____

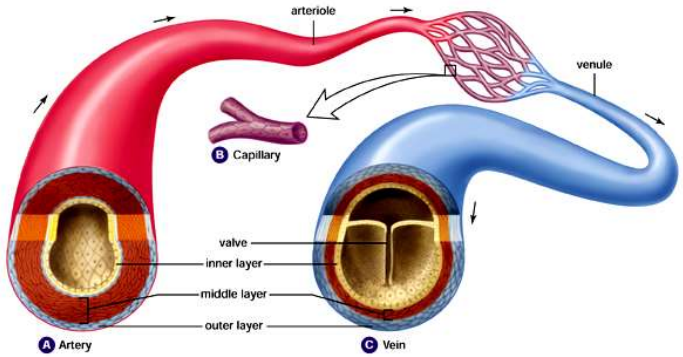


Figure 9.12. Sections through an artery, capillary, and vein. At any given moment, about 30% of the blood in your systemic circulation will be found in the arteries, 5% in the capillaries, and 65% in the veins.

Blood Components

Table 9.2
Cellular components of blood

Point of comparison	Red blood cells	White blood cells		Platelets
		Leucocytes	Lymphocytes	
Origin	red bone marrow	red bone marrow	spleen, lymph glands	red bone marrow, lungs
Cells present per mm^3 of blood (approx.)	5 500 000 (male) 4 500 000 (female)	6000	2000	250 000
Relative size	small (8 µm diameter)	largest (up to 25 µm)	large (10 µm)	smallest (2 µm)
Function	to carry oxygen and carbon dioxide to and from cells	to engulf foreign particles	to play a role in the formation of antibodies	to play a role in the clotting of blood
Life span	120 days	a few hours to a few days	unknown	7–8 days

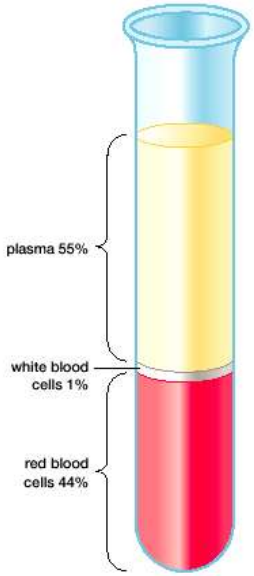


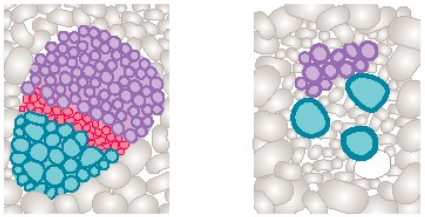
Figure 9.14 A medical device can be used to separate the three main components of the blood. When the blood is separated it settles into layers as shown here.

Plant Tissues

Recall, in Humans:
- There are nerve tissue, connective tissue, muscle tissue and epithelial tissue
- These tissues combine to make up our major organs like the heart, lungs, skin

Plants also have tissues and these tissues make up organs. The tissues of a plant are:
-
-
-

The organs of a plant include:
-
-
-



Epidermal Tissue

Produces structures such as, the _____ which is a clear outer coating. It protects against water loss, protects against infection and restricts gas exchange.

Produce specialized cells such as _____ for absorption and _____ for gas exchange.

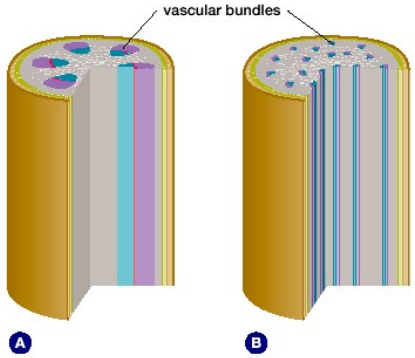


Figure 14.15 Locate the vascular bundles in the stem cross-sections of a typical dicot (A) and a typical monocot (B).

Ground Tissue (internal non-vascular tissue)

There are three types of ground tissue:

a)
b)
c)

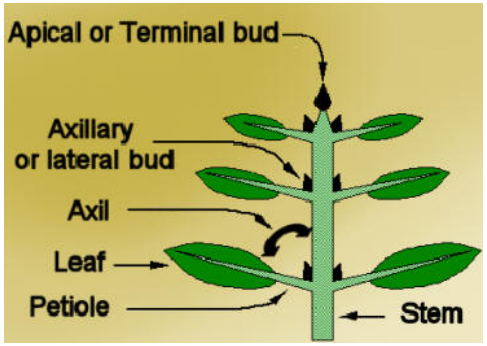
Vascular Tissue

These are specialized tissue for _____ material from one location to another.
Vascular tissues are located in the _____.

Vascular bundles contain two groups of tissue:
a) Xylem - transports _____ and dissolved _____
b) Phloem - transports sugars in the form of _____

Specialized Cells and Tissues in Plants

A healthy plant is always growing and making new specialized cells – except when dormant during _____ or very _____ weather.



_____ cells are the ____ cells of plants. They are undifferentiated cells that can develop into a variety of cell types in the plant and are found in various locations. Unlike animals, plants form new organs periodically throughout their lives.

Meristematic cells in the roots are responsible for elongating the root; deeper or wider underground. In the stem there are _____ responsible for the plant growing ___ and _____ for developing new _____. A bud is a swelling of the stem that contains new, not yet developed tissues. A plant's most active growth occurs near the _____ bud. Plants release a chemical called _____ which controls the cells below and behind them.

Just like humans and animals, plant tissues and organs can be attacked by _____ and _____. In addition plants are also susceptible to developing _____. Plant _____ are similar to _____. Galls are produced by the abnormal growth of cells, usually in response to _____ by another organism. One major difference between plant and human tumors is that galls do not normally _____ to other tissues and is seldom ____.

Movement of Water

Water moves through a plant through the _____ and is done so in a few different ways. As water flows in through the roots of the plant, _____ builds-up in the xylem; this pressure forces the water ___. Water molecules also tend to _____ and to _____ (_____) which helps water fight the force of _____.

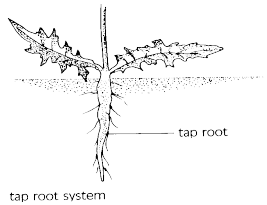
As water reaches the leaves, some of it is used for _____ and some is lost in the form of _____, through the _____ during _____. This process removes the water from the xylem, and helps to _____ the water up the plant.

Plant Organs

Roots

One of the major roles of the root is to _____ the plant in the soil and hold the ____ in place; by doing so, plants also help to prevent _____ of the soil. There are two main types of roots, _____ roots and _____ roots.

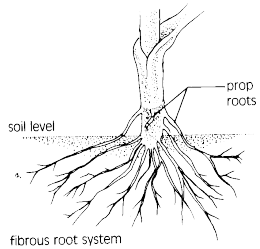
Tap Roots



a) Large main root with smaller lateral roots (_____)
b) Can access water that is _____ into the ground
c) Good for _____ of food, water and minerals

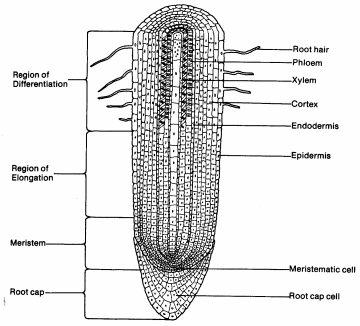
Fibrous Roots

a) Many branched roots of equal size
b) Tend to be shallower then tap roots
c) Holding the soil together, preventing _____
d) Can absorb a great deal of water very _____



The second major role of the root is nutrient transport:

a) Roots absorb water for _____
b) Roots replace water lost by _____
c) Roots absorb water to maintain _____ pressure
d) Roots absorb dissolved _____
e) Roots store _____ in the form of _____



Root Tip Zones

Root cap – forms a _____ for the delicate meristematic tissues

Meristematic Zone - region of actively dividing _____ cells (_____)

Elongation Zone - cells, _____, pushing the root tip _____

Maturation Zone - _____; unspecialized cells develop into _____ cells

Stems

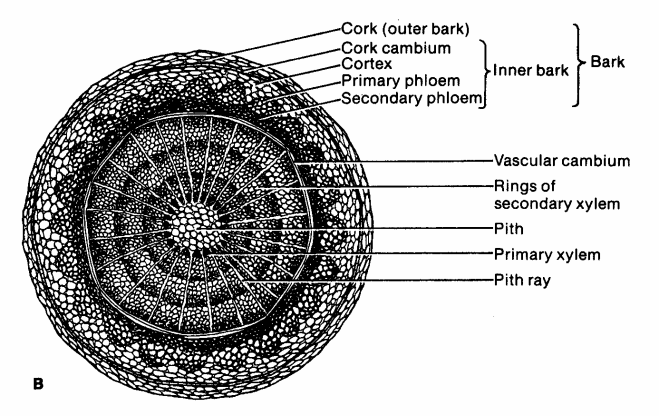
Stems play an important role in the _____ (holding the leaves up to the light) and _____ (water, minerals and sugars) of the plant.

Like the roots and leaves of a plant, the stem is composed of different _____layers. Stems can come in two other major forms; _____ or _____.

A) Herbaceous Stems (_____)
- Generally _____, _____ and _____
- Must be planted from _____
- Examples include _____ and _____ plants

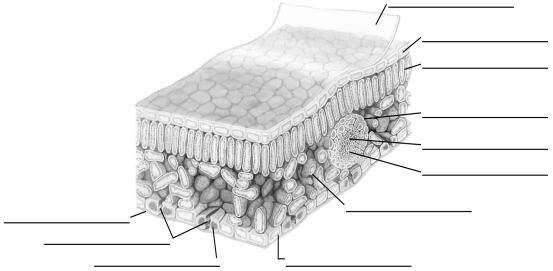
B) Woody Stems (_____)
- Generally very _____ and _____ in colour
- May live for over _____ years
- Examples include _____ and _____ **trees**

Woody stems contain:
a) Bark: A _____ tissue (epidermal)
b) Vascular bundles: transport of water, minerals and sugars
c) Vascular cambium: cells accumulates on the inside of the cambium as _____, _____ of wood that increase the _____of the stem (forms _____)



The Leaves

_____
Regulate the movement of water & gases into and out of the leaf through the epidermis



_____
(Photosynthetic tissue)
Stomates open into these spaces.

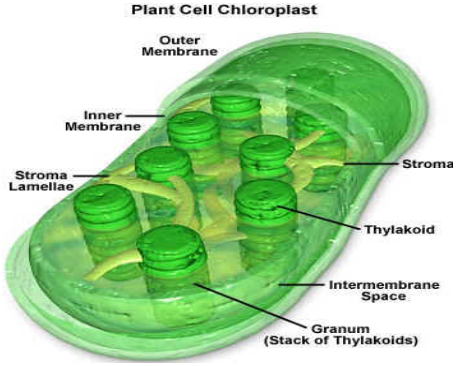
Two types:
i) _____ mesophyll (upper portion)
Tall, tightly packed cells filled with chloroplasts

ii) _____ mesophyll (lower portion)
Irregular shaped cells separated by large air spaces for storage of gases

_____
Consists of a complex network of vascular bundles or veins. Each vein consists of a strand of xylem above and a strand of phloem below.

Most leaves have a _____ that also allows for easy gas exchange and are _____ so that sunlight can reach the photosynthetic parenchyma cells. Inside these cells are high concentrations of _____. Chloroplasts are responsible for conducting photosynthesis; the process that takes carbon dioxide from the air and water from the soil and light energy to produce glucose and oxygen.

Chloroplasts contain sacs called _____, which when stacked upon one another are called _____. Inside each thylakoid are molecules called _____ that contain light trapping molecules. Chloroplasts are able to change their shape and or location in order to increase the amount of light they need to capture.



Genetic Engineering

Genetic engineering is the direct manipulation of _____ by humans in a way that DOES NOT occur under _____.

While there have been great advances in the field of genetic engineering over the past few _____, the use and manipulation of organisms to produce useful products has been a common practice for _____. Farmers were able to select the _____ and _____ crops to produce enough food to support a growing population. Specific organisms and organism by-products have been used to _____, restore _____, and control _____. Consequently, over the years farmers have inadvertently altered the _____ of their crops through introducing them to new _____ and breeding them with other plants to get _____ (_____ _____). This process of selective breeding has also been done with animals for generations to enhance or eliminate certain traits.

Transgenic Organisms

For years scientists have now been _____ of different species of organisms. The species whose genes are altered are often called _____ (GMO) or _____ organisms.

Examples of GMO's include bacteria injected with human proteins used for medical treatments (ex. _____), crops injected with bacteria DNA to resist specific pests and animals injected with growth hormones that promote growth.

Many people see the manipulation of genes as a way to solve various problems, others worry about the long-term consequences of such actions.

Cloning

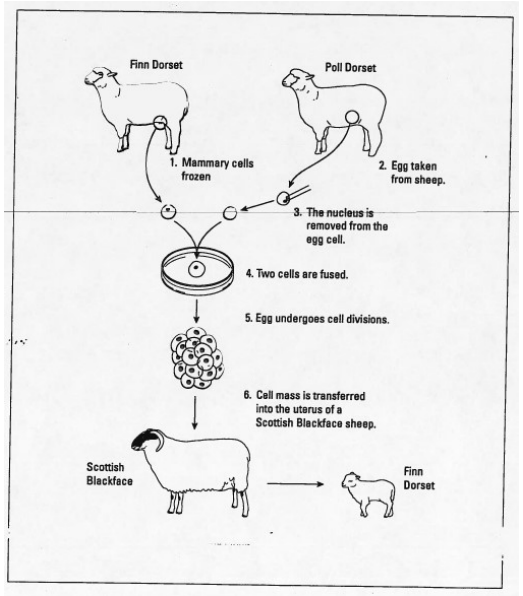
Cloning is the process of forming _____ offspring from a single cell or tissue. It can be natural or brought about by human intervention.

As a natural process, cloning is carried out by any organism that reproduces _____. It provides advantages for a species in that it requires only one _____ (_____), there is no wastage of gametes and _____ is possible. A disadvantage is that it does not allow for the genetic _____ that allows for adaptations and _____.

Different asexual reproduction strategies are employed by organisms including _____ (bacteria), _____ (plants), _____ (yeast) and _____ (algae).

Cloning experiments by humans have been occurring for over ____ years. The first successful experiment with cloning in occurred in 1958 where a plant was grown from a _____.

A few years later a _____ was cloned using _____. This experiment was successful because a stem cell was used.



In 1996 a sheep named Dolly was cloned. Many attempts and failures occurred (over 200) before Dolly was successfully cloned. This was a significant experiment because it demonstrated that a _____ cell could be changed back to a _____ cell.

Dolly showed signs of _____ _____ and eventually died at the age of six. Some people claim her life was shorter than normal because she was a cloned animal, while others argue that her death was completely natural.

Cloning is a controversial issue. Research into human cloning has been banned for over 15 years. Listed below are some thoughts in regards to cloning. Take a minute to read and think about some of the points raised.

- Clones can be used as potential organ donors.
- Scientists may attempt to create "the perfect human".
- Cloning is not an exact science and may result in many mistakes.
- Cloning is not consistent with many religious beliefs.
- Cloning could diminish the need for two sexes.
- Cloning does not allow for the genetic variation that provides for adaptations and evolution.
- Cloning could be used to restore endangered species or used to bring back endangered species.
- Who is the parent of the clone? Does someone own the clone?
- What social challenges would a clone face?