BEACH CHANNEL HIGH SCHOOL

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REVIEW NOTES

for

THE LIVING ENVIRONMENT

Exam date and time:

FRIDAY, JANUARY 26, 2007 at 9:00 AM

DIRECTIONS: HOW TO DO WELL ON THE LIVING ENVIRONMENT EXAMINATION!

1. **READ THIS BOOKLET FROM COVER TO COVER AT LEAST 3 X BEFORE THE REGENTS EXAMINATION. (ANYONE THAT KNOWS THESE NOTES WILL PASS!)**
2. **READ YOUR LAB STUDY GUIDE COVER TO COVER, REVIEWING ALL QUESTIONS AT LEAST 3 X BEFORE THE REGENTS EXAMINATION.**
3. **DO EVERY REGENTS EXAMINATION, AS DIRECTED BY YOUR TEACHER, IN THE BARRONS REGENTS REVIEW BOOK.**
4. **LOOK OVER THE QUESTIONS IN THE 3 REVIEW BOOKS THAT YOU REVIEWED IN CLASS.**
5. **GO TO TUTORING. IT IS AVAILABLE MOST SATURDAYS TILL THE REGENTS EXAMINATION.**
6. **STUDY YOUR CLASS NOTES.**
7. **STUDY - STUDY - STUDY - STUDY - STUDY - STUDY!**

Topic 1A Characteristics of Life

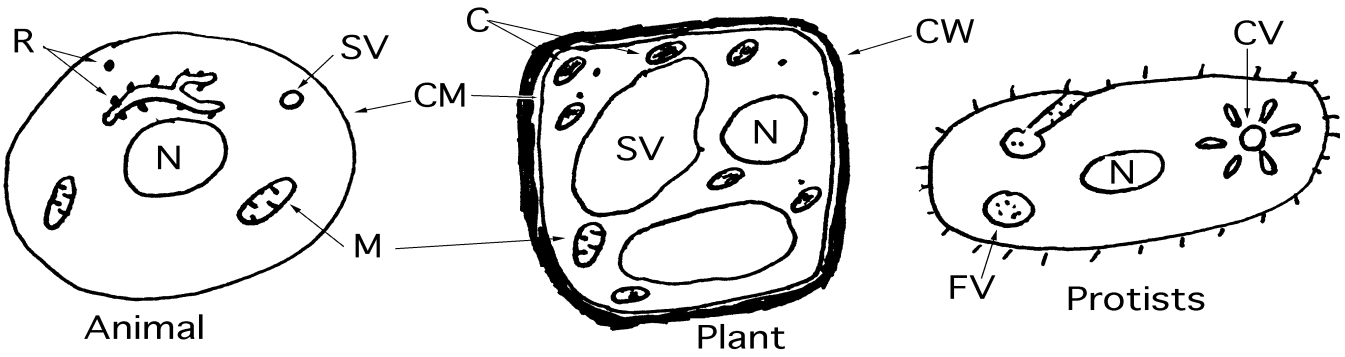
Areas Stressed On Past Regents Exams

A. All living things have similar characteristics which we use to define life. Living things
- are made up of **cells** (basic unit of structure and function of all organisms).
- have a **metabolism** (all chemical activity in the body).
- maintain **homeostasis** (Internal environment stays within limits even when external environment changes).
- **reproduce** (Make more like themselves).

Topic 1B Cells and Organelles

Areas Stressed On Past Regents Exams

A. All cells have smaller structures called organelles. The main organelles are:



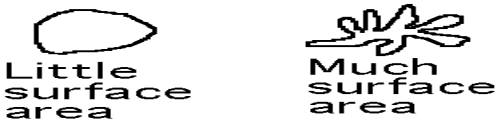
Organelle	Function	Important information
Nucleus (N)	Contains DNA which is used during cell reproduction (mitosis) and protein synthesis.	When the cells undergoes mitosis, the DNA makes an exact copy of itself so each daughter cell has identical DNA. Messenger molecules made in the nucleus carry instructions to the ribosomes directing them to make specific proteins.
Ribosome (R)	Site of protein synthesis	They are very small, often represented by dots. Amino acid molecules are combined to make proteins.
Mitochondria (M)	Sites of cellular respiration (production of ATP). It contains respiratory enzymes.	Can be identified easily by looking for the internal walls which increases surface area for enzyme action. Cells that have a high energy requirement, such as muscle cells, have many mitochondria.
Chloroplasts (C)	Site of Photosynthesis.	Only in plants and other autotrophic organisms (can make own food).
Vacuoles (Three types)	Storage (SV)	Stores materials.
	Food (FV)	Food digestion by enzyme action.
	Contractile (CV)	Removes excess water.
Cell Membrane (CM)	Separates cell from external environment. Helps regulate what comes into and out of the cell.	It is made up of a double lipid layer with scattered embedded protein molecules. It contains receptors which allows cells to communicate by molecules.
Cell Wall (CW)	Strong structure which protects and gives support to plant cells	Not really an organelle because no chemical activity occurs here. Found in plants and fungi.

B. The cell organelles need one another to function properly. Examples how they function together include:
- Food vacuoles break down food into small molecules such as amino acids and glucose, a simple sugar. The ribosomes use the amino acids to synthesize new proteins and the mitochondria break down the sugar molecules to make ATP, a high energy molecule.
- The cell membrane allows the movement of Carbon dioxide (CO_2), water (H_2O) and oxygen (O_2) into the plant cell. In the presence of sunlight, the chloroplast uses the CO_2 and H_2O to make glucose ($C_6H_{12}O_6$). The mitochondria uses the glucose and oxygen to make ATP.
- The nucleus controls the production of proteins by sending a messenger molecule to the ribosome which causes the ribosome to assemble the amino acids in a specific sequence to make the new protein.
- The mitochondria produces ATP, the form of energy necessary for living things. This ATP allows the movement of molecules through the cell membrane by active transport. ATP is also used by the contractile vacuole to pump excess water from a fresh water protozoan.

Topic 1C The Cell Membrane

Areas Stressed On Past Regents Exams

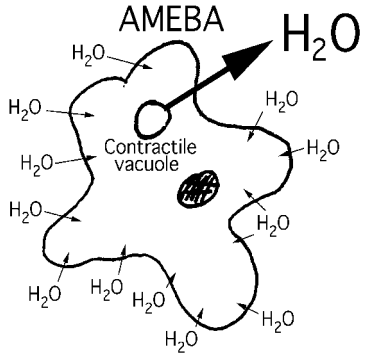
A. Substances or molecules must be able to move through membranes: The rate the molecules can move through the membrane is determined by:
- Surface area of the membrane. The greater the surface area, the greater the quantity of substances can pass through the membrane at the same time.



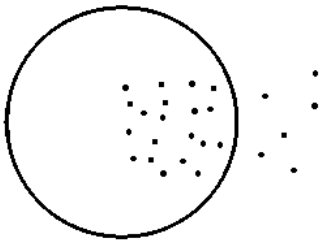
- The size of the molecule.

Small molecules - move fast through cell membrane	Medium molecules - move slower through membrane	Large molecules usually are unable to move through the cell membrane
Water H_2O Oxygen O_2 Carbon Dioxide CO_2 Minerals (I, Fe, Na, Cl, K etc.)	Glucose ($C_6H_{12}O_6$) Amino acids	Proteins Starches DNA

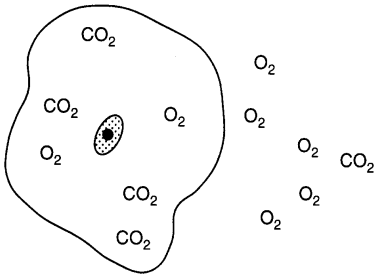
- Method of transport
  - Diffusion - Requires no energy - molecules move from a region of greater concentration to a region of lower concentration. Water is moving into the fresh water ameba pictured below. Note: this is the way most molecules move through membranes.
  - Active Transport - Energy in the form of ATP is used to move molecules from areas of low concentration to regions of greater concentration. To prevent the ameba below from exploding, excess water is "pumped out" by the contractile vacuole.



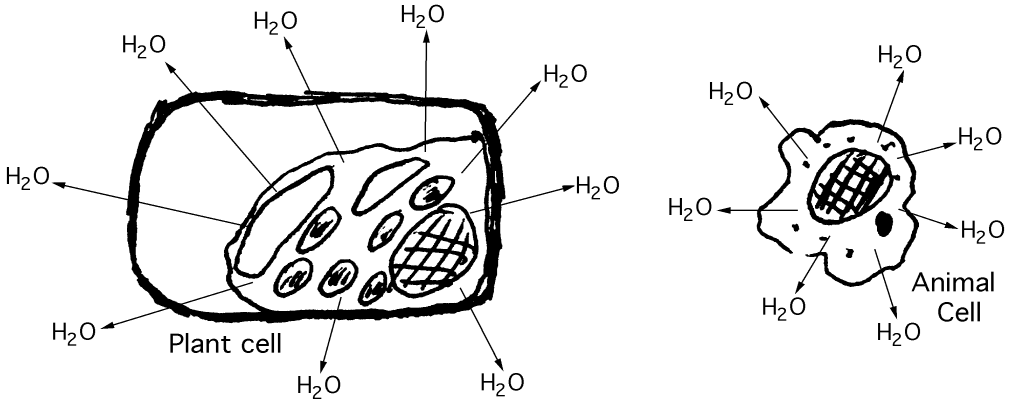
- Note: On the regents, the concentration of a substance is often represented by the number of dots or molecular formulas. The greater the number, the greater the concentration.
  - In this example, the substance represented by the dots could only move into the cell by active transport. If the substance is a small molecule, it could move out of the cell by diffusion. (If it is a large molecule, the cell membrane would prevent it from moving out of the cell by diffusion.)



  - In this example, the substances are represented by the molecular formulas. Carbon dioxide (CO_2) would move outside the cell by diffusion and oxygen (O_2) would move into the cell by diffusion.



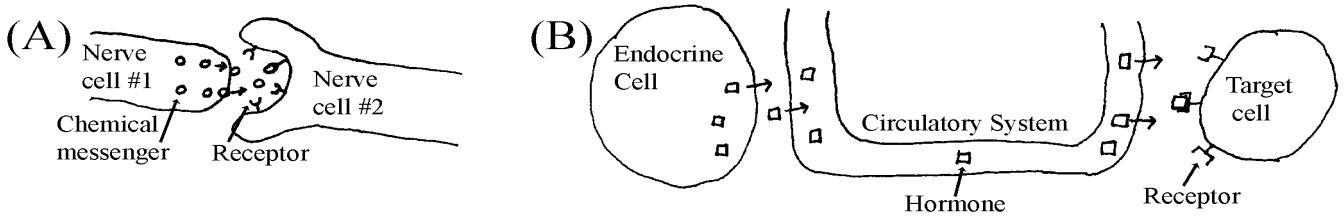
- Plasmolysis, a special case of diffusion that occurs when a living thing that does not normally live in salt water, is exposed to salt or salt water. Since there is a greater concentration of water inside the cell than outside the cell, water moves out of the cell causing it to shrink and die. (Note: The cell wall of the plant cell, a rigid structure, remains unchanged but the cell membrane pulled away as the cell shrunk.) This is the reason why you cannot drink sea water.



Salt Water Environment

- The opposite is also true. If a salt water organism is placed into fresh water, it cannot usually deal with the sudden rush of water into their cells. Consequently, its cells will begin to explode. (Plant cells don't explode because of the strong cell wall.)

B. The cell membrane has special receptor molecules that can recognize chemical messengers from other cells. Shape is very important since the chemical messenger must fit into the receptor for communication to occur. See the diagrams below.



C. The cell membrane is a barrier that separates the cell's internal and external environment. It regulates what passes into and out of the cell, however, there are limitations.

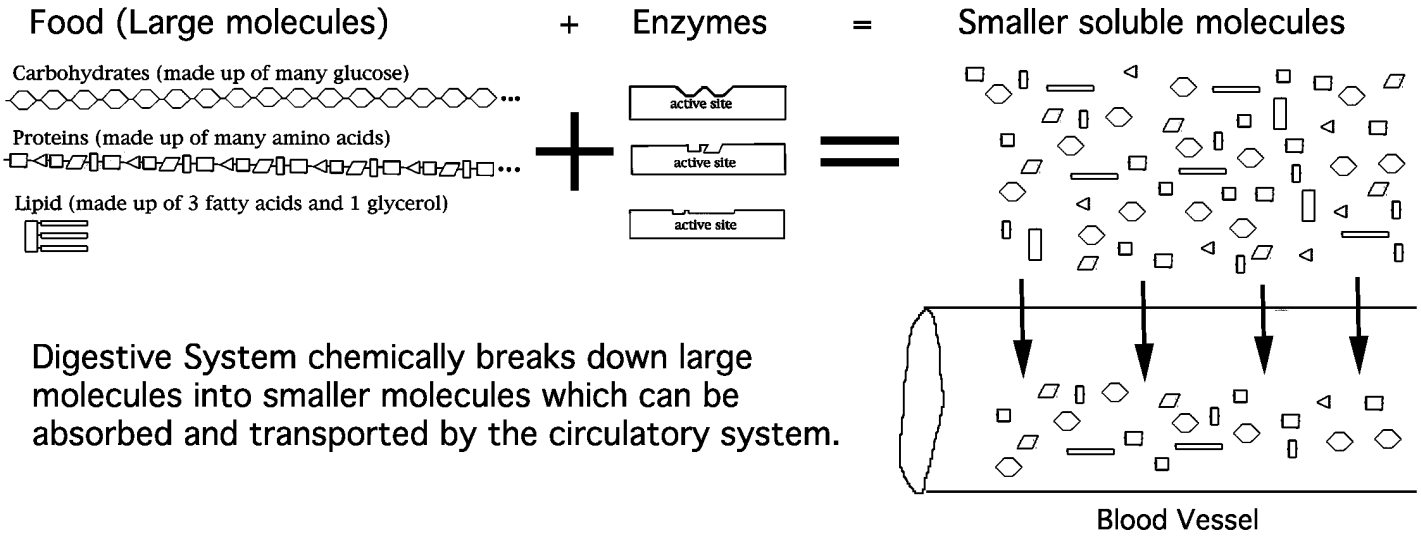
- Certain toxins or chemicals can attach to the receptors of the cell, disrupting communication between cells. (This is how some snake venom and drugs affect the nervous system.)
- Some pathogens can attach to the receptors and enter the cell, eventually leading to the destruction of the cell. (This is how HIV attacks white blood cells.)
- Certain toxins and poisons are able to pass through the membrane by simple diffusion or by dissolving their way through the membrane.

Topic 1D Human Systems

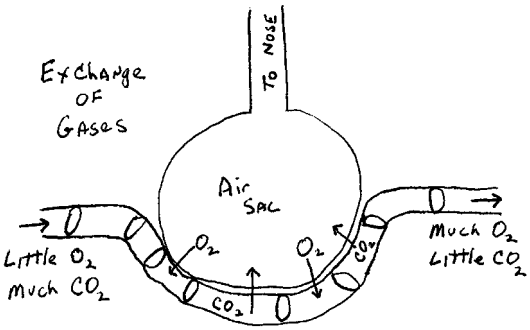
Areas Stressed On Past Regents Exams

A. Human Systems:

- Digestive System - The digestive system takes in large protein and starch molecules as well as smaller fat molecules and other substances, (ingestion), and chemically breaks them down into much smaller soluble molecules (digestion) that can pass through the intestine walls and into the blood stream.



- Circulatory System - The circulatory system uses fluid within its vast network of vessels to allow all cells of the body to transport materials to one another. It is important to understand that the purpose of the circulatory system is not "to pump blood!" It is to transport materials that are carried by the blood. The circulatory system is made up of the blood vessels, blood and the heart. Some of the materials carried by blood include:
  - Water.
  - End product of digestion including glucose and amino acids.
  - Hormones
  - Oxygen - mostly carried by the red blood cells.
  - Wastes including urea and carbon dioxide.
  - The circulatory system also carries heat from the interior body to its extremities.
- Respiratory system - Includes the nose, respiratory tubes and the lungs. The respiratory system obtains oxygen for the body and rids it of carbon dioxide. This diffusion of gases between air and the blood occurs over thin membranes in the air sacs of the lungs.



- Locomotion or movement involves the skeletal and the muscular systems under the control of the nervous system. Locomotion allows the organism to find food, shelter, a mate and to move away from danger.
- Excretion System - includes the lungs, kidneys and the sweat glands in the skin. Its function is to remove metabolic wastes from cells. Metabolic wastes include water, carbon dioxide, urea, and minerals. (Feces is a digestive waste, not a metabolic waste!)

Excretion organ	Wastes removed
Lungs	Carbon dioxide & water
Kidneys	Water, salt & urea
Skin (Sweat glands)	Water, salt & urea

- Coordination and control of the other systems is the responsibility of the nervous and endocrine systems.
  - The nervous system consists of the brain, spinal cord and a network of nerves. Nervous tissue has the ability to transmit impulses.
  - The endocrine system consists of glands that secrete hormones (chemical messengers) into the circulatory system. Some of the endocrine glands include the pancreas, testes, ovaries, pituitary, adrenal and the thyroid gland.
- Immune System is used to fight disease. White blood cells are use by the body to fight foreign bodies that get past our skin and mucus membrane barriers.
- Reproduction System includes organs that produce special cells called gametes, and organs to deliver these gametes and allow them to join together, producing new organisms. Finally the reproductive system consists of organs that allows this new organism to develop to the point that it could survive in the external environment.

B. It is important to remember that all of the systems work together to help maintain homeostasis. With the exception of the reproductive system, all other systems are necessary for the survival of the individual. Some ways these systems work together include:
   - The reproductive system is under the control of the nervous and endocrine systems. Hormones carried by the blood causes the production of gametes as well as the sexual maturing of the individual.
   - The digestive system provides the nutrients for all systems via the circulatory system.
   - The respiratory system provides the oxygen for all systems via the circulatory system.
   - No system could work properly without the coordination by the nervous system. The nervous system is necessary for sensing the internal environment and making proper adjustments that allows it to maintain homeostasis.
   - Wastes from cells are carried by the circulatory system to excretion organs where they are expelled from the body.

C. Four Malfunctions of body systems are:

System	Malfunction	Cause	Effect	Prevention
Circulatory	Heart attack	clogged blood vessels to the heart muscle	Blood stopped being pumped so body cells, no longer getting food & oxygen, die.	Eat less fat.
Respiratory	Emphysema	Lung tissue becomes rigid	Unable to fill lungs with air so unable to supply body cells with enough oxygen	Don't smoke
Digestive	Ulcer	Open sore due to bacteria.	Causes pain. If severe, bleeding and death can occur.	Less stress - (acid) (Maybe)
Any	Cancer	Heredity and/or exposure to chemicals	Nonfunctional cancer cells prevent the involved organs from functioning	Avoid chemicals

D. Even though multicellular organisms like humans are much more complex than single cell organisms like amebas, all organisms have a metabolism and maintain homeostasis. Structures within single cell organisms allow them to carry on the same processes that are the jobs of systems in multicellular organisms.

Function	Single Cell Organism	Multicellular Organism
Obtaining oxygen	Cell membrane	Respiratory System
Obtaining and processing nutrients	Food vacuoles	Digestive system
Getting rid of metabolic wastes	Cell membrane & contractile vacuole	Excretion system
Transport of substances	Cytoplasm (Cyclosis)	Circulatory system
Locomotion	Cilia or flagella	Skeletal and muscular
Production of a new organism	Nucleus	Reproductive system

Topic 2A Photosynthesis

Areas Stressed On Past Regents Exams

A. Autotrophic or producer organisms carry on the process of photosynthesis. They make food (organic molecules) from inorganic molecules using energy from light.

B. Photosynthesis uses carbon dioxide, water and light energy to produce food and oxygen. It only occurs when light is present. As the amount of light increases, photosynthesis increases as long as there is enough water and carbon dioxide present.

C. The formula for photosynthesis is:

Water + Carbon dioxide $\xrightarrow[\text{Enzymes}]{\text{Light}}$ Glucose + Oxygen + Water*

$$H_2O + CO_2 \xrightarrow[\text{Enzymes}]{\text{Light}} C_6H_{12}O_6 + O_2 + H_2O^*$$

* This water molecule is often not shown in the equation.

D. The cellular site of photosynthesis is the chloroplast.

E. The formula of glucose is $C_6H_{12}O_6$. The carbon and oxygen in glucose comes from carbon dioxide (CO_2). Water (H_2O) provides the hydrogen (H) found the glucose molecule. The oxygen (O_2) given off during the process of photosynthesis comes from water (H_2O). Most of the mass of plant tissue comes from carbon dioxide and water.

Topic 2B Respiration

Areas Stressed On Past Regents Exams

A. Respiration is a cellular process in which the energy stored in the chemical bonds of food (preformed organic molecules) is used to make ATP, the form energy must be in to be used for metabolic activities. Respiration continuously occurs in all living cells. This means that all bacteria, protozoa, fungi, animal and plant cells are always carrying on respiration.

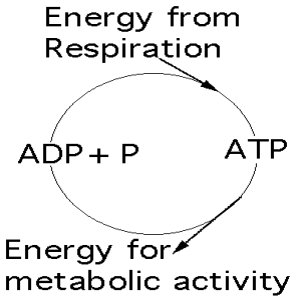
B. The cellular site of respiration is the mitochondria. Cells that need much energy, such as brain, muscle and gland cells, contain many mitochondria.

C. Respiration uses glucose and oxygen and gives off water, carbon dioxide & energy in the form of ATP. It occurs in **<u>all cells</u>** at all times. The formula for respiration is:

glucose + oxygen $\xrightarrow{\text{enzymes}}$ carbon dioxide + water + energy (ATP)

$$C_6H_{12}O_6 + O_2 \xrightarrow{\text{enzymes}} CO_2 + H_2O + ATP$$

D. When ATP provides energy for a metabolic activity such as muscle movement, it breaks down into ADP and a phosphate molecule. Note: this reaction is reversible. During the process of respiration, energy released from breaking the chemical bonds of food is used to join the ADP & phosphate molecule once again.



Comparison and summary of photosynthesis and respiration:

During the process of photosynthesis light energy is converted into chemical bond energy of food molecules. This energy is made available to organisms by the process of respiration which converts the energy of food molecules into ATP molecules. Both photosynthesis and respiration are controlled by enzymes.

A summary of photosynthesis and respiration:

$$H_2O + CO_2 + \text{light energy} \xrightarrow[\text{Enzymes}]{\text{Photosynthesis}} \text{Food} + O_2 \xrightarrow[\text{Enzymes}]{\text{Respiration}} ATP + CO_2$$

Process	Where	When	Energy from	Raw Materials	Produces	Energy to
Photosynthesis	Chloroplast	When light is present	Sun (Light)	Water Carbon dioxide	Food Oxygen	Chemical bonds of food
Respiration	Mitochondria	Always	Food	Food Oxygen	Water Carbon dioxide	Chemical bonds of ATP

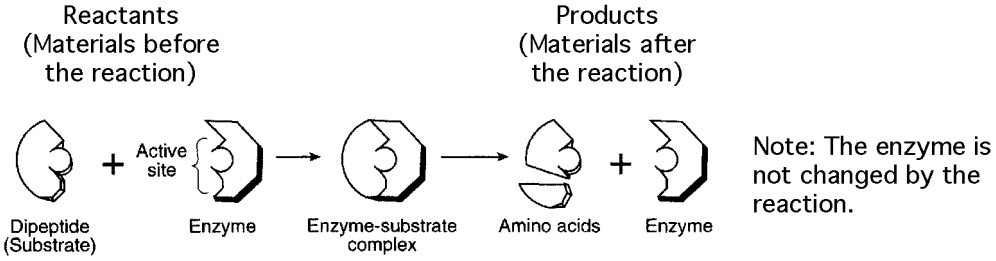
Topic 2C Enzymes

Areas Stressed On Past Regents Exams

A. Enzyme are protein molecules made up of smaller amino acid molecules. The base sequence of DNA determines the sequence of amino acids which determines the shape of the enzyme.

B. Enzymes are catalysts - they affect the rate of chemical activity without being changed by the chemical activity. The names of many enzymes end in -ase.

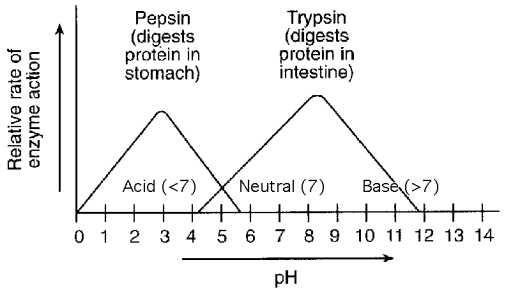
C. Most of the chemical activity of organisms, such as digestion, synthesis and respiration, is controlled by specific enzymes. Enzymes are specific because of their shape. This means that enzyme sucrase will break down sucrose but not lactose. This is because the lactose molecule will not fit into the sucrase molecule.



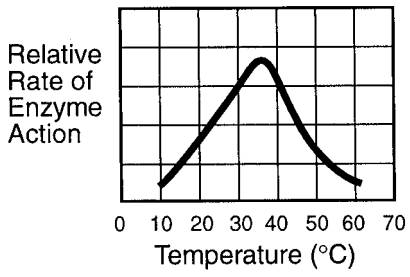
D. Enzyme shape is affected by temperature and pH. When enzymes are subjected to temperatures or pH outside their normal operating conditions, they catalyze chemical reactions slower or not at all because their shape changes.

E. Human enzymes work best at 37°C, the normal body temperature. (Note: 37°C = 98.6°F)

F. Examples of graphs representing enzymes and rates of reaction:



1. Pepsin only works in an acid environment.
2. Pepsin works best at pH of 3
3. Both Pepsin and Trypsin work at pH 5.
4. Trypsin works best at pH of 8.
5. Trypsin works over a wider range of pHs than pepsin.

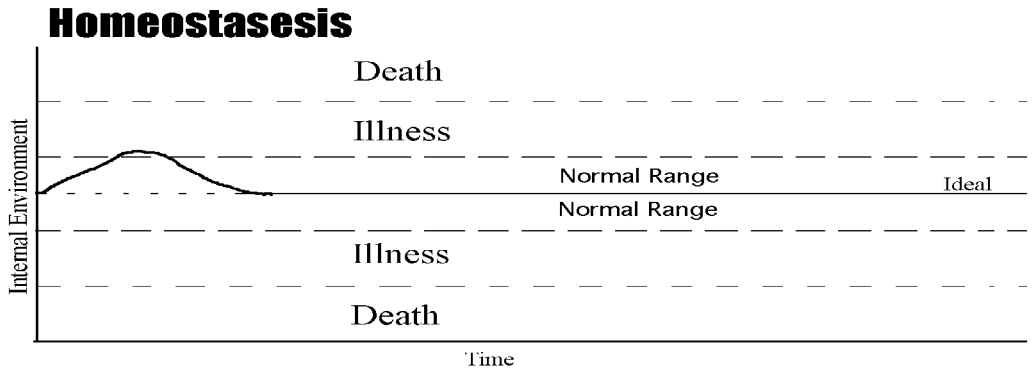


1. Probably a human enzyme because it works best around 37°C.
2. The rate increases, hits a maximum, and then decreases.

Topic 2D Homeostasis

Areas Stressed On Past Regents Exams

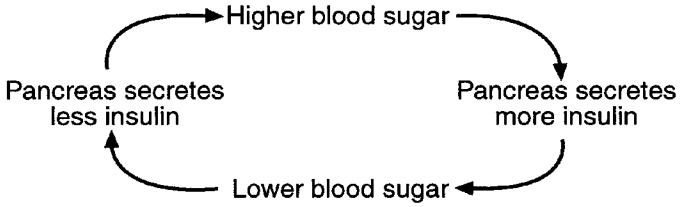
A. Organisms will react in ways that will maintain an internal environment allowing the chemical activities of life to occur regardless if the external environment changes. This process is known as homeostasis (steady state). For example, the heart and breathing rate will change due to various levels of exercise in order to keep the proper amount of oxygen and carbon dioxide in the blood. The greater the amount of exercise, the more oxygen needed and the more carbon dioxide must be excreted. Disease or physical damage to the organism can prevent the organism from maintaining homeostasis.



B. There are many different types of cells in the body. These body cells coordinate their activities with one another to maintain homeostasis by using two systems for communication:
   - The nervous system uses special nerve cells (neurons) to pass information from one part of the organism to another. Nerve cells can transmit impulses. Chemicals secreted by the nerve cells are used to bridge the gap existing between nerve cells.
   - The endocrine system is comprised of glands that secrete hormones into the blood. These hormones are carried to target cells in tissues having corresponding receptors. The target cells react to the presence of the hormones (chemical messengers).

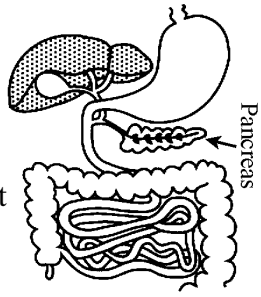
C. A feedback mechanism is cyclic process where the initial action is modified by the effects it has on the organism. Feedback mechanisms are used to help maintain homeostasis.

Example: This feedback mechanism contains arrows indicating a cyclic process.



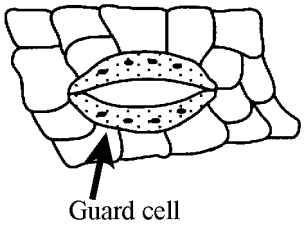
   - Negative Feedback - the effects decreases the initial action.
     - Insulin secreted by the pancreas causes a decrease in the amount of glucose in the blood and a decrease in the amount of insulin produced.
   - Positive feedback - the effects increase the initial action.
     - The head of the baby pushes against the cervix during a contraction. This stimulates the production of more hormones resulting in stronger contractions. This cycle continues until birth occurs.

D. Insulin is an important hormone that helps regulate the blood sugar level (Glucose). When extra sugar is present in the blood, the pancreas secretes insulin causing the liver and muscles to take up the extra sugar and change it into animal starch (glycogen). When the level drops towards the normal range, insulin production is shut down. Diabetes is a disease where the pancreas does not produce enough insulin to



regulate the blood sugar, Untreated diabetics have a high blood sugar level. Often the glucose molecules will spill over into the urine which can be detected by a simple urine analysis. Diabetics often control their blood sugar level by injecting insulin. If a diabetic injects too much insulin, too much glucose will be removed from the blood, causing problems ranging from unconsciousness to death.

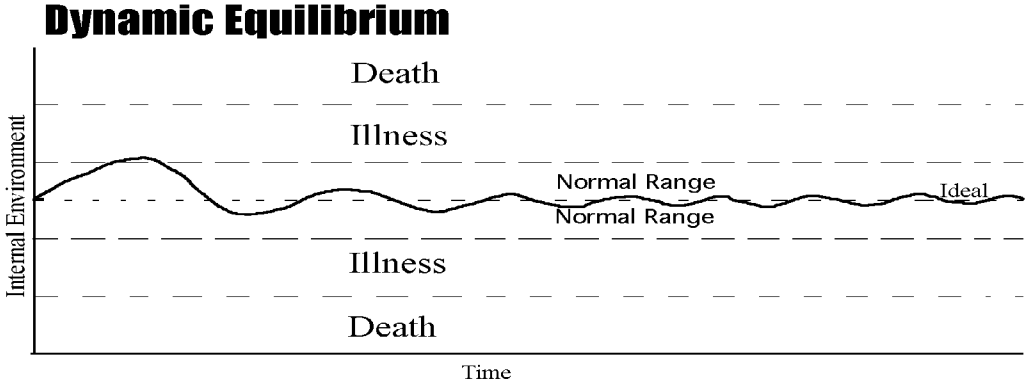
E. Guard cells regulate the size of the openings through which water vapor escapes from leaves. Carbon dioxide and oxygen will also pass through these openings. The plant's heredity and environment determine the number, location, size and function of guard cells.



F. Humans regulate the body temperature using two negative feedback loops. They are:
- If the body temperature moves above normal, a part of the brain senses the change and sends impulses over nerves causing sweat glands in the skin to start producing sweat. At the same time, the capillaries near the skin dilate, increasing the blood supply to the skin, As the water in sweat evaporates, it carries heat away, cooling the body. As the body cools to normal body temperature, the impulses to the sweat glands stop, stopping sweat production and the capillaries constrict, decreasing the blood supply to the skin.
- If the body temperature moves below normal body temperature, a part of the brain senses the change and sends impulses over nerves causing muscles to shiver. Shivering causes heat to be produced, warming the body. As the body warms to normal body temperature, the impulses to the muscles stop, stopping shivering.

G. What is normal to one organism may be abnormal to other organisms. Some fish normally live in 0°C (32°F) water while some bacteria have no problem surviving in 70°C (158°F) water, a temperature that humans (37°C) would be considered well done. Over time organisms have evolved the right structures and chemicals to maintain homeostasis and occupy and flourish in many different environments.

H. Dynamic equilibrium - It is a process similar to homeostasis in which the organism constantly makes small adjustments in order to keep its internal environment within a certain acceptable range.



Topic 2E Disease

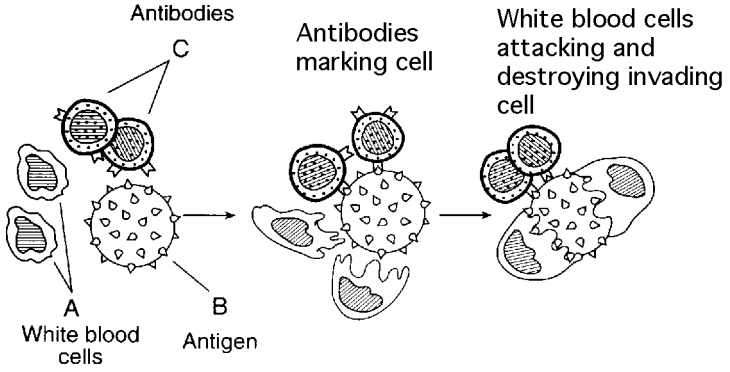
Areas Stressed On Past Regents Exams

A disease is any condition which prevents the normal functioning of the organism. Types of diseases include:

Disease	Characteristics	Examples
Cancer	Uncontrolled division of mutated cells which can lead to a tumor. Most of the time the body is able to recognize these cancerous cells and destroy them before they can harm the body.	Lung cancer Skin cancer Breast cancer Prostate cancer
Inherited disorders	These diseases are passed in the genetic information from the parents. These diseases cannot be cured, but often can be controlled by diet and drugs.	Cystic fibrosis Down's syndrome Sickle cell anemia
Toxins (Poisons)	The amount absorbed and the toxicity determine the effects.	Alcohol Nicotine Lead
Organ malfunctions	Occurs when the organ stops functioning as it should. Could be the result of other forms of disease.	Heart attack Kidney failure Diabetes
Poor Nutrition	The body does not get enough nutrients including protein, carbohydrates, fats, mineral and/or vitamins.	Anemia (Iron) Scurvy (Vitamin C) Kwashiorkor (Protein)
High risk activities	The chance of contracting one of these diseases can be reduced by a change in one's behavior	AIDS Lung Cancer Skin Cancer Heart attack
Pathogens (microbes that can cause disease)	**Viruses** - They can only reproduce in a living cell. They are very small consisting of a nucleic acid and a protein coat	Chicken pox HIV or AIDS Flues and colds
	Bacteria - One celled organisms which are often treated by giving antibiotics.	Strep throat Staph infection Syphilis
	Fungi - organisms that are related to yeast & mushrooms.	Athletes foot Ringworm Jock itch
	Protozoans - One celled organisms that can live in and harm the body. Antibiotics can sometimes be used to treat these diseases.	Amebic dysentery Malaria
Multicellular Parasites	**Parasites** are organisms that survive by living and feeding on other organisms	Leeches Tapeworms Hookworms

A. The immune system is used to fight disease. When the body detects invading pathogens or foreign bodies, white blood cell (WBC) production increases. White blood cells fight infections by:
   - engulfing and destroying pathogens.
   - producing antibodies in response to the antigens on the surface of the invading pathogens.
   - identifying invaders (foreign bodies or pathogens) for destruction.

B. An immune response occurs when the body makes antibodies to fight the invading foreign bodies.
   - Antibodies are "Y" shaped molecules which are specific because of the shape of the antibody must match the shape of the antigen if it is to attach to the antigen on the surface of the foreign body or pathogen.



   - Antibodies are produced by white blood cells
   - Antibodies are produced in response to invasion of foreign bodies such as pathogens.
   - Antibodies produced for one disease will not work on other diseases because the shape of the antibodies will not match the shape of the antigens on the surface of other pathogens.

C. Vaccinations consists of weakened or dead pathogens, or the surface parts of pathogens, all which have antigens. When given to an organism, the organism will make antibodies to attack the antigens. Once the body learns how to make the antibodies to fight the antigen given, it can not get that particular disease, Vaccines are very important in controlling the disease and preventing its spread.

D. AIDS is a viral disease (caused by the HIV virus) that attacks the immune system, making the body more susceptible to other infections (disease). People can avoid AIDS by not injecting any illegal drugs into their veins and by having sex only with the person that they are married.

E. When a person gets a transplanted organ, immunosuppressant drugs are given to stop the immune system from rejecting the organ. This occurs because the antigens on the transplanted organ cells are different than the antigens on the body's own cells and are recognized as being foreign. When the person gets the immunosuppressant drugs, he/she is more susceptible to disease due to the weakened immune system.

F. An allergic reaction occurs when the immune attacks harmless substances. Histamines are produced causing localize swelling and discomfort.

G. Scientists have developed many tests to determine if a disease is present. Early diagnosis and treatment may limit the damage caused by the disease.

Topic 3A Heredity and Genes

Areas Stressed On Past Regents Exams

A. The genetic material is located in the nucleus of cells. Genes are made up of DNA and are located on chromosomes. Each species cells have a constant number of chromosomes in the nucleus of their cells (exception - sex cells have 1/2 normal chromosome number). eg. Man has 46 chromosomes in each body cell and 23 chromosomes in each gamete.

B. Size relationships (becoming smaller):
Nucleus ⟶ Chromosomes ⟶ Genes
   a. The nucleus contains chromosomes.
   b. Each normal human body cell contains 46 chromosomes.
   c. Genes are located on specific sections of chromosomes. Each gene is made up of DNA that will control a specific trait such as hair color. Each chromosome has hundreds of genes.

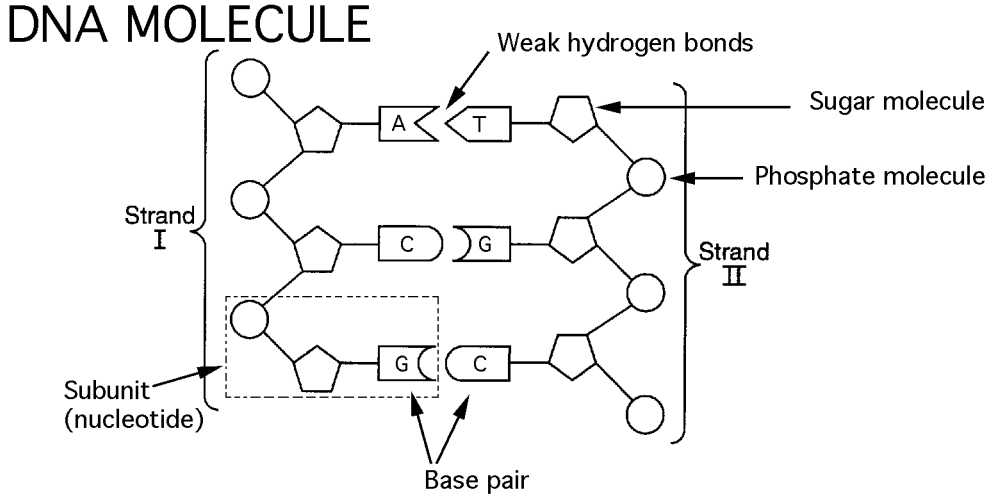
C. Sexual reproducing organisms usually have considerable different combinations of genes. This is why sexually reproducing species usually have a great variety of expressed traits.

D. Most traits are controlled by two genes, one from the mother and one from the father. Sometimes one gene (dominant gene) can prevent the expression of another gene (recessive gene). The recessive gene will only be expressed when both parents pass it to the offspring. Important Note: Some traits, such as eye color and skin color, are controlled by multiple genes.

Topic 3B DNA & Protein Synthesis

Areas Stressed On Past Regents Exams

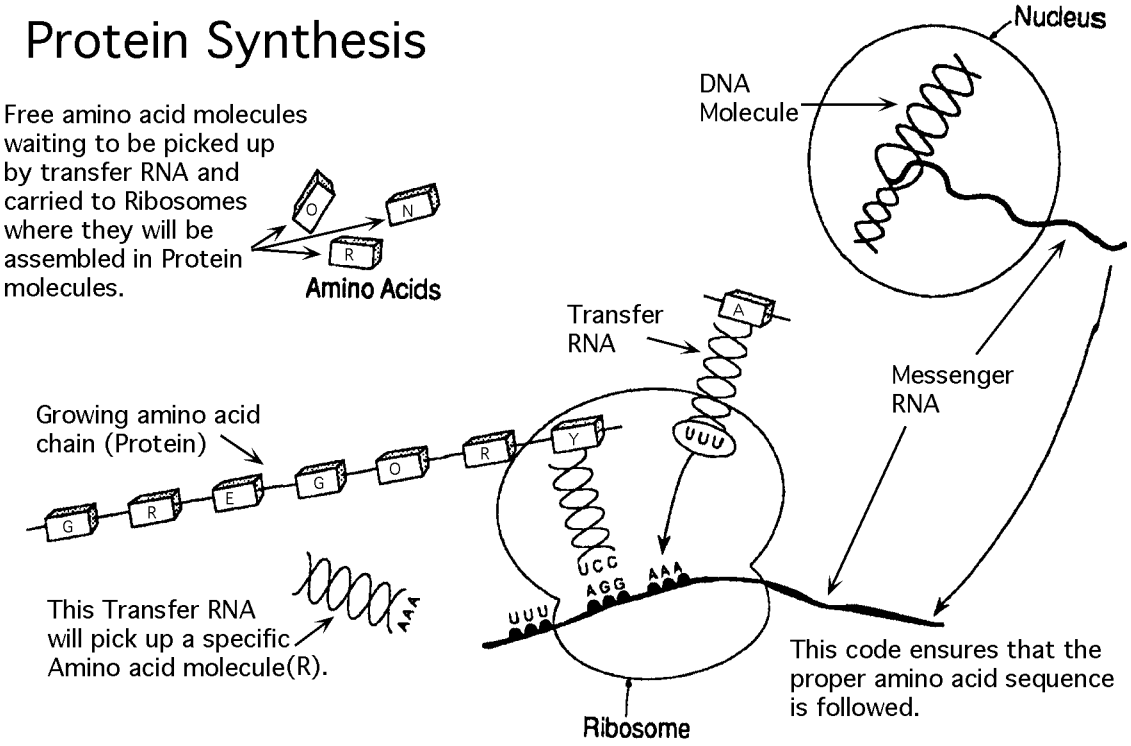
A. DNA is a very important molecule. It is composed of two strands in the shape of a double helix. Each strand of DNA is made up of repeating subunits (nucleotides). Each subunit is made up of a phosphate, sugar, and one of 4 bases A, T, C or G. Base A pairs with T while base C pairs with base G.



B. The actual sequence of the bases (ATCG) in a DNA strand is the genetic code. No two humans have the identical genetic code, unless they are identical twins.

C. The two DNA strands are held together by weak hydrogen bonds. These bonds can break, exposing the base and allowing it to act as a template (patten). This allows two important processes.
   a. The replication of the DNA which is necessary every time when the cell divides so the new cells will have the exact copy of the DNA (or each chromosome) as the old cell.
   b. The manufacture of messenger molecules (Messenger RNA), a single strand copy of DNA that is used to carry the code out of the nucleus to the ribosome in the cytoplasm. This code is used to

control the manufacture of proteins in ribosomes. Each three sequential bases of the messenger molecule forms a codon (triplet) which determines the amino acid inserted into the growing protein molecule. The proteins are used for structure and for controlling rates of chemical reactions (enzymes) This is how DNA can control the chemical reactions within the cell. (See the protein synthesis diagram on the next page.)



D. Most members of a species have considerable genetic variation. Genes with different base sequences allows for the expression of different traits or characteristics (the different genes cause the production of different proteins which cause the different traits). This is the reason why some members of a species are more resistant or susceptible to poison, antibiotics, or certain diseases than other members of the species.

E. Cells of the same organism contain the same genetic information (DNA) but can produce different types of cells that function differently and produce different proteins. This can occur because different portions of the cell's DNA are used in different types of cells.

Topic 3C Mutations and Gene Expression

Areas Stressed On Past Regents Exams

A. An organism appearance is determined by both its DNA and its environment. Organism with the same DNA can appear different because of environmental factors such as temperature, pH, food, sunlight, etc. can effect the expression of genes.

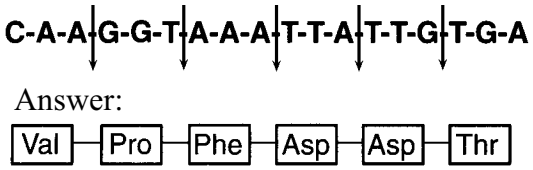
B. Any change in the species DNA is considered to be a mutation. A simple gene mutation such as a change in the base sequence would have much less effect than major mutation like the addition or subtraction of a chromosome. Only mutations that occur in the formation of the reproductive cells (gametes — egg or sperm) of the organism can be passed onto the offspring, affecting future generations. Common gene mutations include:

- Deletion - A base pair is missing
- Addition - An extra base pair is inserted
- Substitution - A base pair is substituted
- Inversion - Several base pairs are turned around and now out of sequence.

C. Mutations occur randomly. However their numbers are increased when cells are exposed to mutagenic agents such as ultra violet light, x-rays, radiation, and certain chemicals.

D. When a base sequence is changed, different amino acids may be substituted in the growing protein chain, changing the shape and possible function of the protein.

E. In order to determine the proper amino acid sequence, you must first separate the bases into groups of three. Look in the table to determine which amino acid codes for each group of 3 bases.
Example: For the following DNA code:



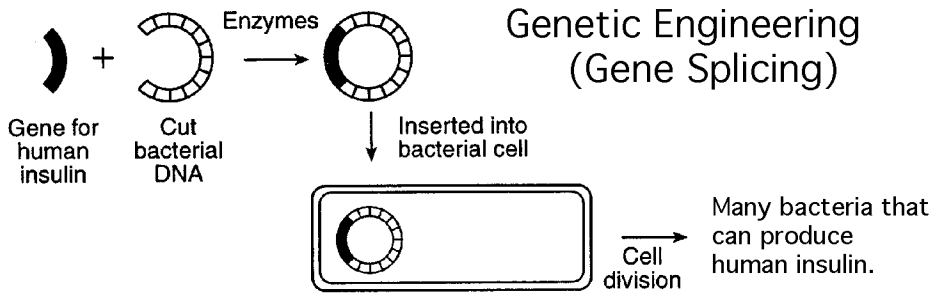
Amino Acid	Abbreviation	DNA Code
Phenylalanine	Phe	AAA, AAG
Tryptophan	Try	ACC
Serine	Ser	AGA, AGG, AGT, AGC, TCA, TCG
Valine	Val	CAA, CAG, CAT, CAC
Proline	Pro	GGA, GGG, GGT, GGC
Glutamine	Glu	GTT, GTC
Threonine	Thr	TGA, TGG, TGT, TGC
Asparagine	Asp	TTA, TTG

Topic 3D Genetic Engineering

Areas Stressed On Past Regents Exams

A. Selective breeding has occurred for thousands of years (Dog breeding). Selective breeding occurs when humans choose which traits are desirable and therefore which organisms should reproduce.

B. Gene splicing is a type of genetic engineering which allows the insertion of foreign DNA into the DNA of a cell. This foreign DNA could be from a completely different species. This is how scientists are able to grow bacteria that produce human hormones like insulin and human growth hormone (HGH), and grow special crops that might be resistant to drought or insects. Genetic diseases may also be cured by replacing missing or defective genes. Only the cells with the altered DNA and the offspring of theses cells are affected.

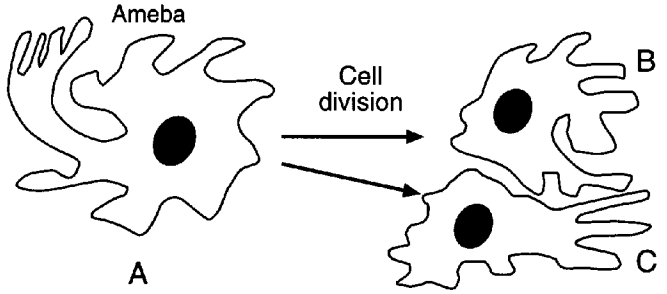


Topic 4A Sexual, Asexual & Cloning

Areas Stressed On Past Regents Exams

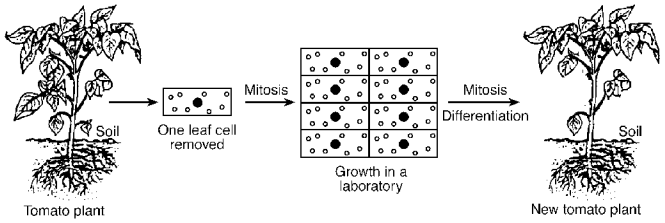
A. Organisms can produce other organisms of the same species through reproduction and development.

B. Asexual reproduction involves one parent. Offspring are produced that have identical DNA as that parent. Examples of asexual reproduction include binary fission in amebas and paramecium, budding in yeast, regeneration in starfish and vegetative propagation such as cuttings in plants.



C. Sexual reproduction involves two parents. The DNA of the offspring produced have different combinations of DNA from both the parents. This produces variations within the species. Mammals, birds, reptiles, amphibians, fish, insects, worms and flowering plants (most plants) all reproduce sexually.

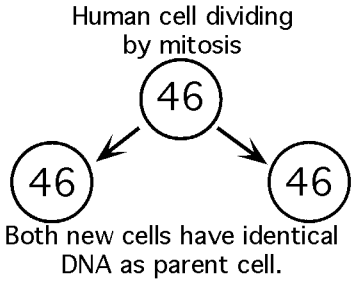
D. Cloning is a form of asexual reproduction that is used to make genetically identical organisms. DNA from one nucleus of a body cell is transferred to an egg whose DNA has been destroyed. The organism produced will be identical to the organism that donated the DNA. Note: large numbers of plants can be made in a short time by producing many small plants directly from the cells of a single plant. All of these plants are identical since the DNA used is from one plant.



Topic 4B Mitosis, Meiosis & Gametes

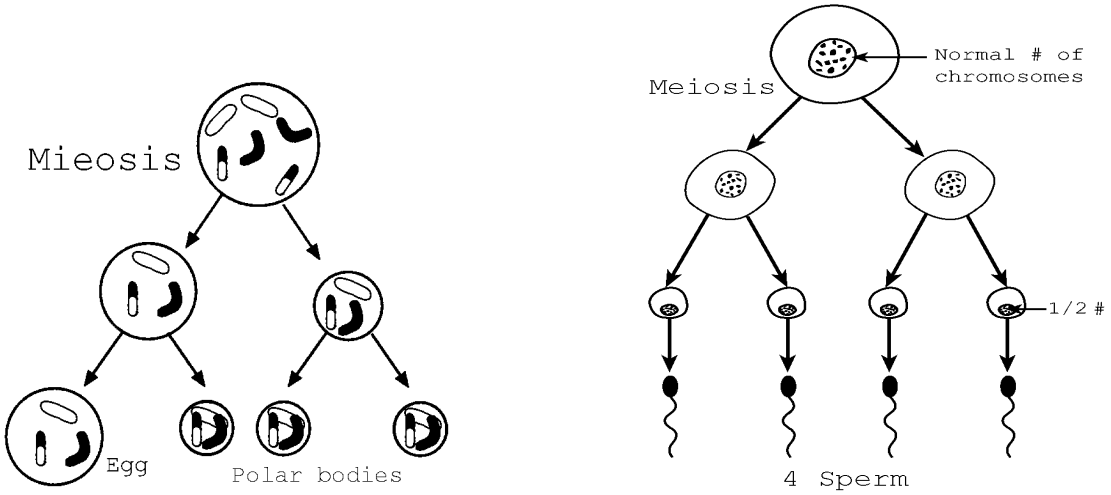
Areas Stressed On Past Regents Exams

A. During the process of mitosis, the DNA (chromosomes) of the original nucleus replicates, producing two nuclei containing identical DNA (chromosomes) as the original nucleus. This process is used for growth, tissue repair and asexual reproduction. Cancer is uncontrolled mitosis.

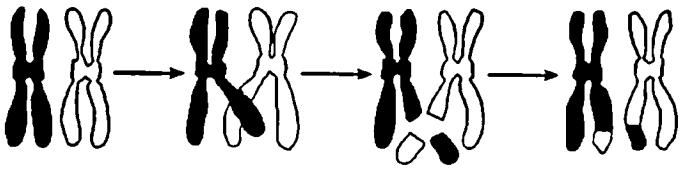


B. Gametes are produced by a reduction division called meiosis. Four motile sperm are produced from each primary sex cell in the testes while one large egg is produced from each primary sex cell in the ovary. The gametes produced will contain 1/2 the normal number of chromosomes found in body cells.
During meiosis, one chromosome from each pair of chromosomes is randomly selected for each gamete,

producing gametes that contain different DNA, which produces variations in offspring. That is why offspring from the same parents but different pregnancies may have similar characteristics, but will never be identical.



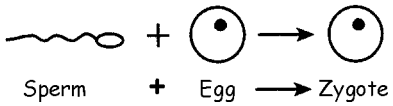
C. Often there is a further mixing of the genetic material by a process known as crossing-over. Sections of chromosomes are exchanged between the pairs of chromosomes.



Topic 4C Fertilization and Early Development

Areas Stressed On Past Regents Exams

A. Sexual reproduction involves the fusion of gametes (sperm and eggs) called fertilization which restores the normal chromosome number of the species. It produces organisms that are genetically different from each other. Most plants and animals reproduce by sexual reproduction because it promotes variation, a characteristic necessary for a species to survive a changing environment.

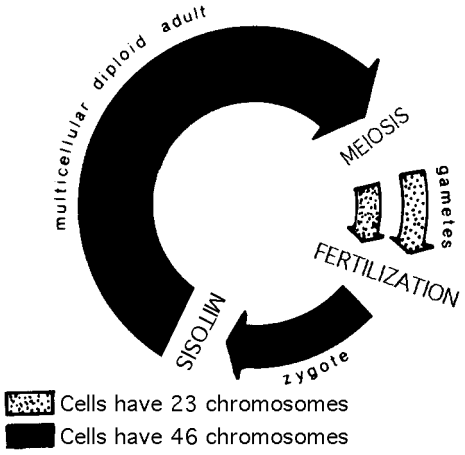


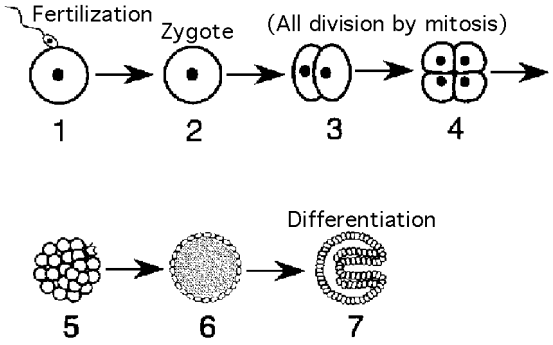
B. If an organism reproduces sexually, only the DNA present in cells that are involved in producing gametes can be passed on to the offspring. That is why mutations or changes in the DNA that are passed to offspring must first occur in gametes. Mutations are important because they produce variations.

C. Sperm, the male gamete, has a flagella (tail) that allows it to swim to the female gamete, the egg. Organisms, such as fish and amphibians, that have access to water often will produce eggs which are externally fertilized and develop in the water. Land animals usually carry on internal fertilization. Fluids and nutrients provided by accessory glands aids in the movement of sperm to the egg. The fertilized eggs may develop internally like mammals or externally like birds.

D. During sexual reproduction of humans, the nucleus from the male sperm combines with the nucleus of the egg, restoring the normal 46 chromosome number. This process, called fertilization, occurs in the upper 1/3 of the oviduct. The first cell of the new organism is called a zygote. The zygote begins to divide by mitosis, until a ball of similar cells is produced. These cells start to change or differentiate, forming the different

tissues necessary to form the various organ systems. This is possible, even though all the cells have the same DNA, because each type of cell uses a different portion of their genetic makeup.





Topic 4D Reproductive Anatomy

Areas Stressed On Past Regents Exams

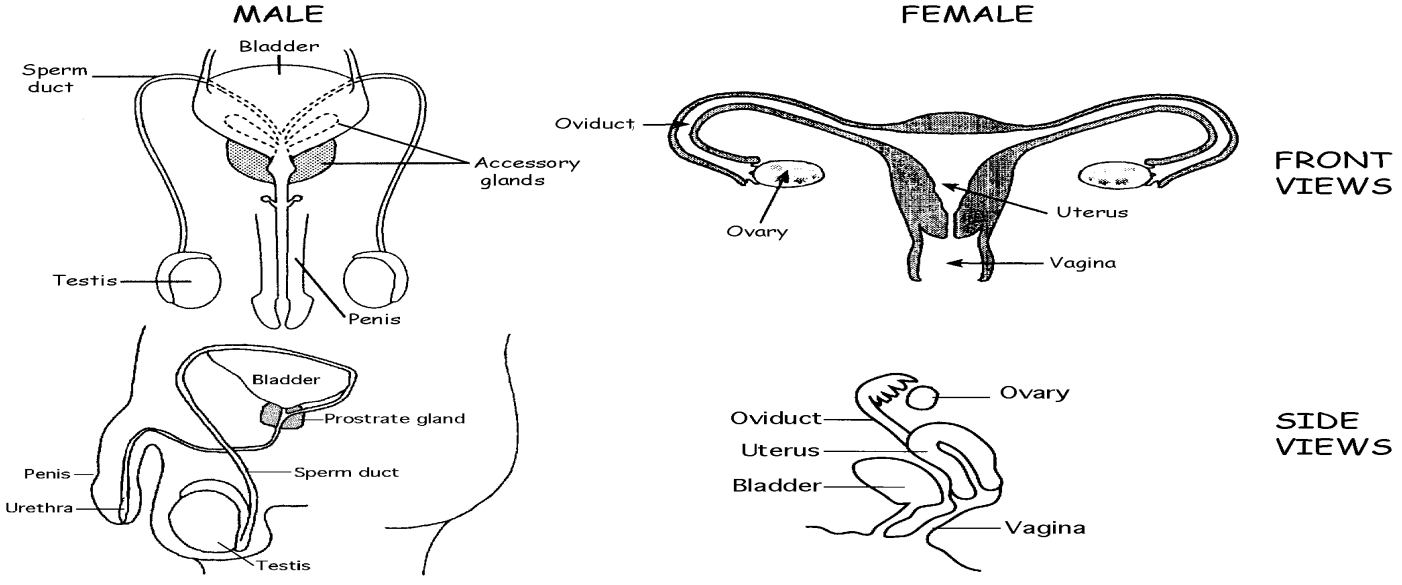
A. The human menstrual cycle is controlled by the hormones estrogen and progesterone produced by the ovaries and hormones produced by the pituitary. Each month, the number of blood vessels in the inner layer of the uterus increases in case an egg becomes fertilized. If the egg fails to becomes fertilized, the inner layer of the uterus breaks down and menstruation occurs.

B. Male gametes, sperm, are produced in the testes while the female gametes, eggs, are produced in the ovaries. Estrogen produced in the ovaries and testosterone produced in the testes are sex hormones that are responsible for the production of the gametes and also the development of the secondary sexual characteristics of humans.

C. There is a continuous duct that carries sperm and other fluids from the testes and other accessory organs to the outside. Many animals, that carry on internal fertilization, have a penis, a structure that is used to deliver the sperm and fluids into the females body.

D. The baby (embryo and fetus) develops in the uterus of mammals. The placenta allows the exchange of materials between the mother and the developing baby.

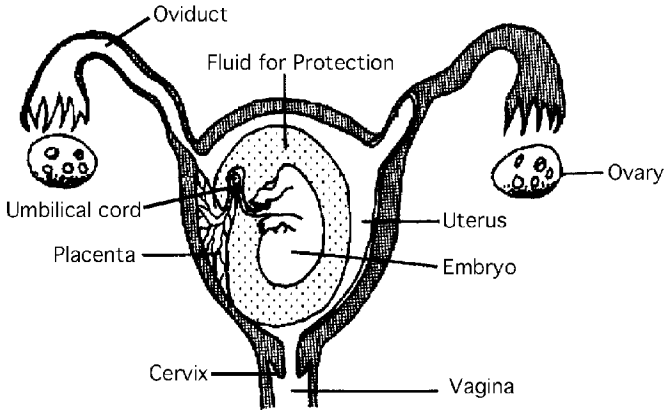
E. Most human reproductive questions are accompanied with a human anatomy diagram



Topic 4E Fetal Development and Reproductive Technology

Areas Stressed On Past Regents Exams

A. Animal breeders will sometimes collect and freeze sperm to be used later. This process of artificial insemination allows the breeder to use the sperm of animals with desired characteristics without actually transporting the animal to the site for breeding.



B. The placenta is and organ that is attached to the inner layer of the uterus. It is the site of exchange of materials through a membrane that keeps the mother's blood and baby's (embryo - fetus) blood separate. Oxygen and food normally moves from the mothers blood through the membrane into the baby's blood. Wastes, such as urea and carbon dioxide moves from the baby's blood through the membrane into the mother's blood. If toxic a chemical such as alcohol is present in the mother's blood, it could move across the membrane into the baby's blood, causing harm to the developing embryo or fetus, especially during early pregnancy when the organ systems are forming.That is why pregnant women should avoid chemicals, tobacco, over the counter and illegal drugs, and alcohol.

C. Two techniques used to determine the developing baby's health are:
- Sonograms - Sound waves are used to produce a computerized image of the developing fetus. Doctors are able to determine the number of fetuses, the sex of each and check their physical development.
- Amniocentesis - Some of the amniotic fluid (surround the fetus) is collected by a needle that penetrates the mother's uterus. The developing cells are analyzed for genetic diseases such as Down's syndrome and Sickle cell anemia.

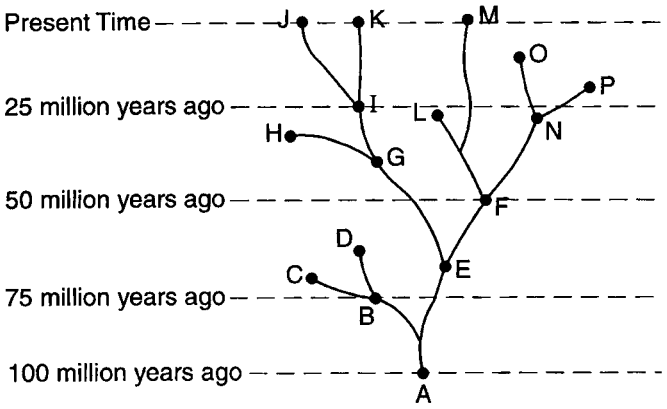
Topic 5A Fossil Record, Time Lines & Cladograms

Areas Stressed On Past Regents Exams

A. Two different species may have similar evolutionary histories or common ancestors if:
- Much of their DNA is identical.
- They have similar proteins.
- They contain similar structures.
- The have similar embryonic development.

B. Fossils found in sedimentary rock can help determine past environments and the history of life. Fossils in the lower layers are older than the fossils in the upper layers. This fossil history supports the theory of Evolution.
- Early life was simpler than the more complex life of today. Single cell organisms (unicellular) appeared about 3 billion years ago. Multicellular organisms appeared about 1 billion years ago and became increasingly more complex.
- Present day species developed from earlier species.
- Two or more species have similar structures because they have the same ancestors.
- Different species did not evolve at the same rate. (Different species have different adaptations that function in a changing environment.)
  - The key for survival is for members of a species to have adaptations that function in a changing environment.
- The great majority of all the different species that have inhabited this earth have become extinct due to environmental change.

C. You must understand phylogenic trees - See notes.



Notes:
- Species J, K and M are presently alive. All others are extinct.
- Species A is the common ancestor to all others.
- Species I is a common ancestor to species J and K.
- Species E is a common ancestor to all the living species.

Topic 5B Natural Selection

Areas Stressed On Past Regents Exams

A. A niche is the function or roll of a species within an ecosystem. Competition occurs when two species occupy the same niche. The species that is best adapted to the niche will increase in numbers eventually forcing the other species to move to another niche or to become extinct.

B. Genes that control traits or adaptations that aids a species to survive tend to increase in frequency because the surviving members of a population are more likely to pass these genes to their offspring. These traits have a high adaptive value. (Note: The words adaptation, variation, characteristic and trait can often be used interchangeably with one another.)

C. The mechanics of Evolution include:
- Overproduction - more offspring are produced than can be supported by the environment.
- Limited resources causes a struggle for existence (competition.)
- Organisms are different because of genetic diversity due to mutations and genetic shuffling during meiosis.
- Natural selection (selection of the fittest by nature - those best adapted).
  - Over time the proportion of the species with the advantageous characteristics increases.

D. Natural selection occurs when nature (the environment) acts as the selecting agent, determining which traits or adaptations are beneficial or necessary for survival. The organisms that survive are those that are "most fit" or "best adapted". This is opposite to selective breeding where man decides which traits or adaptations must be present if reproduction is to occur.

Topic 5C Source of Variations

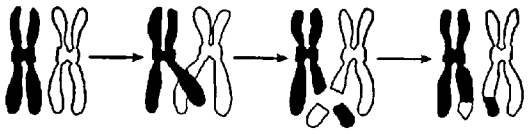
Areas Stressed On Past Regents Exams

A. Sources of inheritable variations include:

1. Mutagenic agents such as cosmic rays, x rays, ultraviolet rays, radiation from radioactive substances, and certain chemicals can cause changes in the DNA known as mutations. These changes in the DNA can give rise to new traits or adaptations. If theses changes occur in cells that form gametes (sperm and eggs), these new traits or adaptations can be passed on to the offspring.
2. A shuffling of the genetic material occurs when sexually reproducing organisms form gametes by the following two methods:
   - The random separation of each pair of chromosomes, producing gametes with different chromosome combinations, and therefore different portions of the original DNA.

Number of pairs of chromosomes	Number of different gametes that can be produced
2	4
4	16
12	4,096
23 (Human)	8,388,610

   - Crossing over between a pair of double stranded chromosomes where the chromosomes exchange similar sections, mixing up the genetic information.

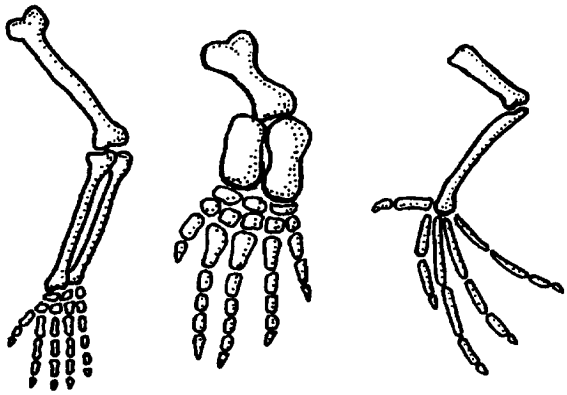


B. Note: Offspring of sexual reproducing organisms are similar to each other because they share much common DNA, but they are different (unless identical twins) because they do not receive the same DNA from their parents.

Topic 5D Significance of Variations

Areas Stressed On Past Regents Exams

A. Genetic variations can cause:
   - Structural changes that can accumulate over thousands of years altering the function of the structure.
     - The similarities between these structures indicate that these organisms have a common ancestor.
     - The differences indicate that the structures have evolved to function in different environments.
   - Behavioral changes including:
     - Rituals a species might go through before mating,
     - The way the species makes a web or nest,
     - The way a species takes care of their young.
   - Functional changes (without structural changes) including
     - Production of new toxins for protection
     - Production of new digestive enzymes



B. Variation within a species (Genetic biodiversity) is very important if the species is to survive in a changing environment. The greater the variation, the greater the chances of adaptations are present that will allow them to survive a changing environment.

- Many scientists believe the Florida panther and African cheetah will become extinct because they lack genetic diversity.

Topic 5E Patterns of Change

Areas Stressed On Past Regents Exams

A. Evolution is most likely to progress quickest when there is great genetic diversity (Members of a population have many different adaptations) along with much environmental change. If the environment changes, different traits or adaptations may give certain members of the population an advantage. When these organisms reproduce, they will pass along the genes that cause these different traits or adaptations, changing the population.

B. Sexually reproducing organisms with many variations usually have the greatest chance of surviving a change in the environment.

C. New species are formed when the original population is separated into two groups by some type of natural barrier such as a body of water or mountain range. Since these groups are no longer interbreeding, they are not sharing new variations that arise by mutation. Eventually, these organisms will be so different, they would be different species. This process is accelerated in a changing environment.

D. Organisms with a short reproductive cycle have demonstrated that they can rapidly evolve.
   - Because members of their population are genetically different (They have variations.), some mosquitoes are more resistant to insecticides (poisons that kill insects) than others. When sprayed with insecticides, the resistant insects survive and pass on their beneficial genes (DNA) to their offspring. Therefore the offspring are resistant to the insecticide. The next time the insecticide is used, less mosquitos would be killed.
   - Because members of their population are genetically different, some bacteria are more resistant to antibiotics (drugs that helps the body kill bacteria) than others. When individual-A is given an antibiotic for a bacterial infection, the resistant bacteria survive longest and pass on their beneficial genes (DNA) to their offspring. If an individual-A does not continue to take the antibiotic for the prescribe time, these most resistant bacteria could survive long enough to be passed to individual-B. The same antibiotic would not be as effective if given to individual-B, because the bacteria would be resistant to that antibiotic.

Topic 6A Organisms and Their Environment

Areas Stressed On Past Regents Exams

A. Terminology you need to know:
   - **Producer** (**Autotroph**) organisms make food by photosynthesis, Algae and plants are common producers.
   - **Consumers** (**Heterotroph**) eat other organisms (food or preformed organic material).
   - **Decomposers** break down organic matter (body remains & wastes) releasing minerals back into the environment where they can be reused by organisms (recycled).
   - A **Population** includes all members of one species that live in a defined area.
   - A **Community** includes all living things in a defined area.
   - An **Ecosystem** includes the community (**biotic**) and physical (nonliving or **abiotic**) factors.
   - The **Biosphere** includes everywhere living things exist on Earth.

B. The physical factors (abiotic resources) limit the types of organisms that could populate a given area. Some physical factors include soil type, available water, temperature range, pH and the amount of sunlight. Two cases where there is a lot of available sunlight but it may not reach the autotroph:
   - Forest floor - Filtered out by the tree leaves above the forest floor.
   - Deep Ocean - Filtered out by the water above. (The deep ocean is cold and dark!)

C. The number of organisms of a single species that a given environment can support is called the carrying capacity. It is determined by the available abiotic factors and biotic factors (interactions of other living organisms).

D. Competition among members of a population will increase if their numbers increase, and/or if their space or food supply decreases.

Topic 6B Population Interactions

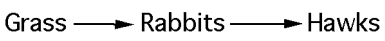
Areas Stressed On Past Regents Exams

A. Terminology you need to know:
   - A **parasite** is an organism that lives off of and harms another organism called the host.
   - A **herbivore** feeds off of plants.
   - A **carnivore** feeds on other animals.
   - A **scavenger** feeds on animals it did not kill.
   - A **niche** is the organism's function (its roll) in the ecosystem. Competition occurs only when organisms have the same niche.
   - A **habitat** is the area where the organism lives.
   - **Producer** (**Autotroph**) organisms make food by photosynthesis, Algae and plants are common producers.
   - **Consumers** (**Heterotroph**) eat other organisms (food or preformed organic material).
   - **Decomposers** break down organic matter (body remains & wastes) releasing minerals back into the environment where they can be reused by organisms (recycled).

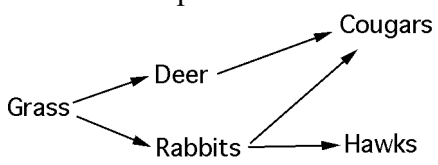
B. Stable ecosystems need:
   - a constant supply of energy (sunlight) for producer organisms
   - biodiversity for efficient transfer (fi)of this energy (food web)
   - decomposers for recycling the minerals such as nitrogen

C. Food webs and food chains are used to represent the flow of energy through the ecosystem. When a population number rapidly changes in a food web or food chain, it will have both short term and long term effects. For example consider the food web below, if we removed cougars from this web, the short term effect would be an increase in the number of deer and rabbits, and less grass since it will be eaten by these two herbivores. However the long term effect is a little less clear. There would be much greater competition between the deer and rabbits for the grass. Since the deer no longer have a predator feeding on them, restricting their population, it is probable that the deer population will grow to a point where the grass will run out causing a major drop in the number of deer, rabbits and hawks.

Food chain example:



Food web example:

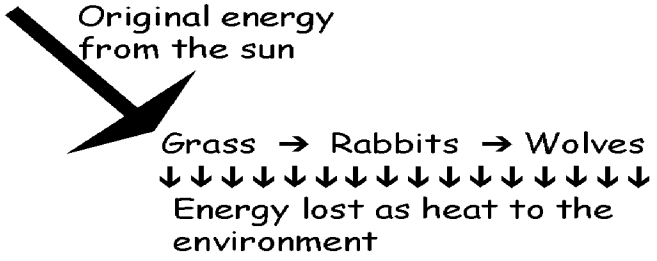


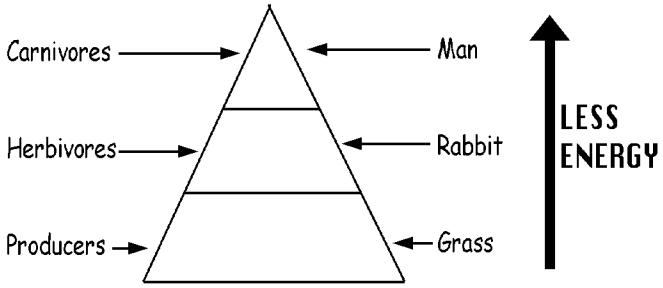
Topic 6C Energy Flow Through Ecosystem

Areas Stressed On Past Regents Exams

A. A constant supply of energy is necessary because organisms used energy for their metabolic processes. This energy is lost to the environment in the form of heat. Therefore as energy is transferred from one organism to the next in a food chain, there is less energy available. The total energy can be represented by a food pyramid. The bottom of the pyramid has the greatest volume representing the greatest energy.

Therefore:





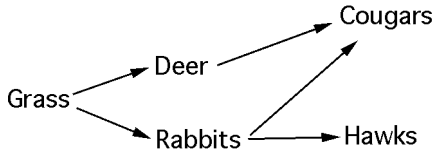
B. There is a limited amount of resources available for living things. Therefore, materials must be recycled. Materials are passed from one organism to another and to and from the environment. Decomposers are important in releasing the minerals from animal wastes and the remains of dead organisms so they can be reused. (Note: energy can never be recycled.)

C. All food chains begin with producer organisms and end with decomposers (These bacteria and fungi may not be pictured but they are always understood.). The arrows (fi)represent the flow of energy. In the case of the following food chain, — Sunflower fi Chicken fi Fox —, the arrows indicate that energy is passing from the sunflower to the chicken and then to the fox. In other words, the fox consumes the chicken which consumes the sunflower.

D. Food webs represent energy (food) relationships in the ecosystem more accurately than food chains because it shows all of the alternate pathways of energy flow.

Food chain example:

Food web example:



Topic 6D Biodiversity

Areas Stressed On Past Regents Exams

A. Stable ecosystems need:
- a constant supply of energy (sunlight) for producer organisms
- biodiversity for efficient transfer (fi)of this energy (food web)
- decomposers for recycling the minerals such as nitrogen

B. The greater the genetic diversity (variations) within a species, the greater the chance that a species can survive a change in the environment.

C. Biodiversity is the number of different species in a given area. Great biodiversity advantages include:
- A more stable the community because if one species dies out, there are others to take its place.
- The greater the number of plants, the greater the chance of finding chemicals that might help scientists to make drugs to fight disease or to produce other products that could help society.

- Diseases and insects spread slower because the different species act as barriers between members of the species under attack.

D. Little biodiversity (a one crop farm) disadvantages:
   - Diseases spread quicker because similar plants are right next to one another.
   - Pest problems increase because of the concentration of food. They can hop from plant to plant.
   - Rapid lost of mineral content of soil, decreasing subsequent crop yield unless the minerals are replaced by using fertilizers.

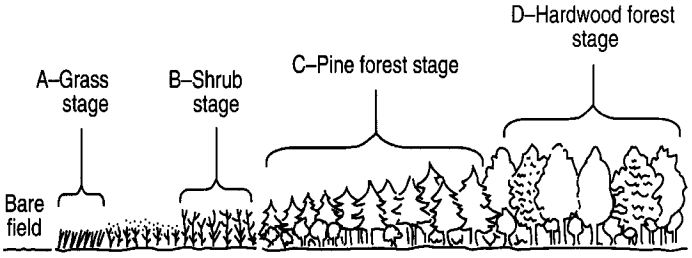
Topic 6E Succession

Areas Stressed On Past Regents Exams

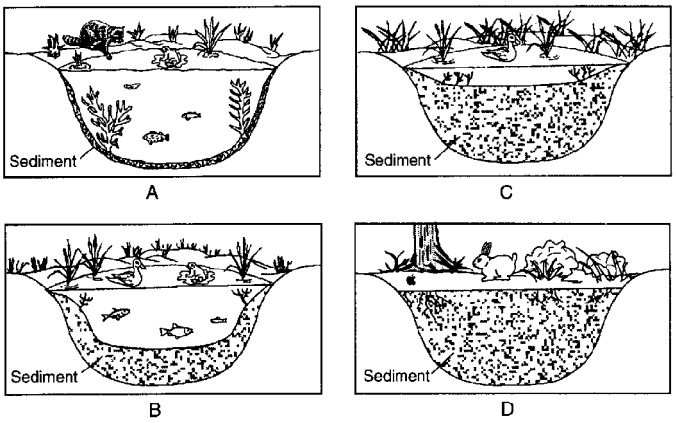
A. Ecological succession is an orderly process where one community modifies an environment making it more suitable for a different community until a climax community is reached. Once the climax community is reached, it will remain stable unless there is a major environmental change such as logging, forest fire, or severe weather. The damaged community will eventually return to its climax state.

New York State Examples:

1. Bare field to hardwood forest:



2. Aquatic to terrestrial:



7 Topic A Our Environment

Areas Stressed On Past Regents Exams

A. Two types of resources that can benefit man are:
   1. Renewable - Can be replenished within a lifetime. Examples include:
      - Wood and wood products such as paper - Forests can be cut down and regrown.
      - Surface water such as water from rivers - Rivers are supplied by precipitation.
      - Wind (windmills), light (solar cells) and water (hydroelectric) when producing power.
      - Animals - As long as you don't over-harvest or destroy their habitat, they will reproduce, producing more.
   2. Nonrenewable - Once it is used, it is gone.
      - Fossil fuels - Natural gas, oil and coal - When it runs out - it will be gone.
      - Deep ground water - It takes hundreds of years to replace.
      - Minerals - Aluminum, iron, magnesium, and calcium.

B. In order to reduce solid wastes and to conserve (save) our resources, we should:
   - Reducing their use - Car-pooling or taking mass transit reduces gasoline use.
   - Reuse the product over again and again - Plastic bags can be brought back to the store and reused to carry groceries.
   - Recycle it so it can be made into another produce - Cans, bottles and paper should be recycled in New York City because its good for the environment and its the law!

C. There are natural processes that normally occur to maintain the ecosystem.
   - Decomposition is very important so minerals and other molecules trapped in once living organisms can be released into the environment so it can be reused. Decomposition is carried on by bacteria of decay and fungi. (This is nature's way of recycling!)
     - When farmers remove their crops and when homeowners cut their grass and remove the clippings, they prevent this natural replenishment of minerals to the soil. In order to keep the soil productive, fertilizers or a substitute organic (once living) material must be used.
     - Some people will keep a compost pile where they throw all organic materials such as grass clippings, leaves and food scraps. When the materials breakdown, they use it in their gardens as natural fertilizer. These people help reduce the amount of solid wastes in landfills.

D. Bio-remediation is method humans use to restore an ecosystem damaged by oil, or some other human activity, by speeding up natural processes. With this method, naturally occurring bacteria are encouraged to reproduce and consume the oil, changing it into harmless water and carbon dioxide. This type of clean up is preferred to the "dig and dump" method which just pollutes a different site.

Topic 7B Humans and the Environment

Areas Stressed On Past Regents Exams

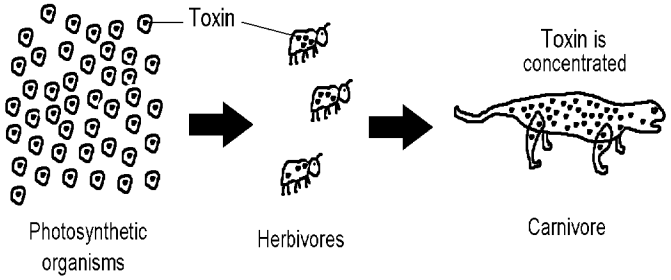
A. The increasing human population is contributing to many of the ecological problems of the world because humans have a great ability to alter the environment. As the population grows, there will be an:
   - increase use of nonrenewable resources (minerals, oil, coal & natural gas).
     - Once these are used, they will be gone forever.
   - increase use of renewable resources (Lumber, animals & plants).
   - increase use of land to build homes, shopping centers, and other facilities used by humans.
     - In order to get more land, farms are being converted into homes, forests are being cleared, and wetlands are being filled. Entire habitats are being destroyed.
   - increase amount of land, air, water and thermal pollution.
     - The burning of fossil fuels for heat, transportation and cooking will produce greater amounts of pollutants including carbon dioxide, the gas many scientists believe is responsible for global warming and gases containing sulfur and nitrogen, which are responsible for acid rain.
     - The more humans, the more garbage produced and the more places will be needed for its disposal.
     - More human wastes and chemicals produced by human activity will find their way into the environment.

B. It is important to distinguished between human activities and natural processes. Human activities are caused by humans while natural processes are caused by nature. Examples include:
     - Some natural processes - weather, movement of energy through a food web, succession and evolution.
     - Some human activities - Burning fossil fuels, industry polluting a river, government forcing industry to clean polluted areas of a river, recycling glass and metal, and damming a river to produce hydroelectric power.

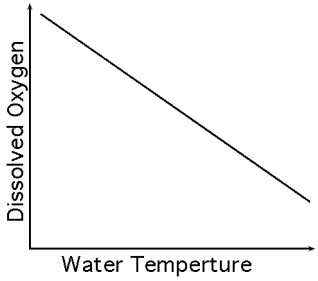
Topic 7C Impact of Technology

Areas Stressed On Past Regents Exams

A. Industrialization and technology are the causes of many environmental problems.
- Industries often require great amounts of natural resources including:
  - Large amounts of electricity - Fossil fuels are often burned by power plants to supply the necessary electricity.
  - Large amounts of water for cooling and/or for the manufacturing process.
  - Chemicals for the manufacturing process.
  - Large amounts of valuable land near water, roads and/or rails.
- Industries contribute to:
  - Acid rain that is caused by burning fossil fuels which increase the amount of sulfur and nitrogen compounds in the atmosphere. These compounds can travel great distances before they are dissolve in water, producing rain with a low pH. Acid ran can directly damage plants and algae. It can also change the pH of the water and soil where it falls, preventing the growth of many species of animals and plants that would normally grow in the area.
  - Release of chemicals and other pollutants into the environment. These chemicals will often be released in water, causing water pollution. They can be concentrated into some organisms by natural processes.



  - When pollutants are not excreted, they are concentrated as they move through food chains. Photosynthetic organisms absorb a small amount which is concentrated by herbivores and further concentrated by carnivores, making them unfit to eat.
  - Thermal pollution by dumping large amounts of heated water into bodies of water. Some organisms suffocate (die from lack of oxygen) because heated water cannot carry as much dissolve oxygen (O_2) as cool water.



  - Global warming by producing carbon dioxide, a greenhouse gas. (See topic 7E.)
  - Loss of biodiversity by habitat destruction through pollution, and utilization of land for the factories. (See topic 7D)

B. Farms and farming can cause environmental problems.
- Farms will often use pesticides.
  - Pesticides often cause more problems than they solve. Pesticides kill indiscriminately, killing the predator as well as the pest and can become pollutants which can harm unintended organisms down the food chain. Furthermore, often pesticide resistant pests will continue to multiply,

rendering the pesticide ineffective.

- Farms will often use fertilizers.
  - When fertilizers remain in the soil, they help plants grow. However, when fertilizers are washed out of soil by heavy rains and into bodies of water such as lakes and rivers, they encourage excessive algae growth (Algae blooms). This excessive growth of algae is harmful in two ways:
    1. It can block the sunlight from reaching plants that would normally grow on the bottom of these bodies of water.
    2. Although this algae can produce oxygen when sunlight is present, at night it needs oxygen. At night the algae can use all available oxygen in the water causing the fish to suffocate.
- Farm animals produce wastes.
  - When wastes remain in the soil, it can enrich the soil and help plants grow. However, when wastes are washed into bodies of water such as lakes and rivers, they encourage excessive bacteria (Bacterial bloom) and algae growth (Algae blooms). The increased amount of bacteria even further depletes the amount of available oxygen for animals.

C. Nuclear power has both disadvantages and benefits.
- Disadvantages:
  - Produces a great amount of thermal pollution.
  - No place yet to store the radioactive wastes produced by the plants.
  - They might be targets for terrorists.
- Advantages:
  - Do not produce greenhouse gases.
  - Do not use fossil fuels.
  - Can be economical - European model.
  - Many years of fuel can be made available.

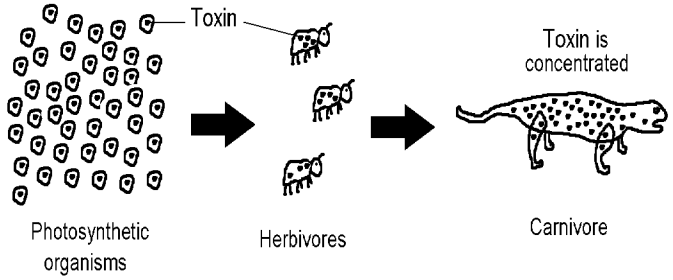
D. Government will often pass laws to regulate industry. This is necessary because often people will make decisions solely on economic reasons and not what is best for the environment or society. However excessive regulation can slow growth of the economy, causing jobs to move to other sections of the country or to other parts of the world.

Topic 7D Loss of Diversity

Areas Stressed On Past Regents Exams

A. Biodiversity is lost due to:
- Direct harvesting - removing organism from its habitat.
  - Often it involves an endangered (of becoming extinct) species.
  - Sometimes an organism is removed as a benefit to another organism. This strategy may backfire such as in the case where wolves and mountain lions were removed so more deer could be produce. The deer population, no longer checked by natural predation, increased in some areas to the point that they did not have enough food supply. This caused the deer to consume many plants that they would not normally eat. By the time the deer ran out of food and their number drastically drop, many species of plants and animals that normally fed on these plants were gone.
    - Note: The population of deer in New york State is suppose to be kept in check by hunters. Unfortunately, this is not happening. There are more deer in New York State today than when Henry Hudson sailed the *Half Moon* up the Hudson river in 1609 looking for a Northwest route to the Orient. Deer are involved in numerous car accidents, help spread Lyme disease and eat lawns, garden plants and farm crops.

- Clear-cutting forest for lumber, farmland or for buildings and roads. this activity destroys the habitats of organisms and disrupt their food supply.
  - The clear cutting or burning of the rain forest is not only decreasing biodiversity, but it is also lessening our chances to study and identify many species of plants that may have chemicals that could produce products that would benefit man, such as medicine.
- Importation of species to new ecosystems where they out-compete the native populations because they have no predators in their new area.
- Use of pesticides which often cause more problems than they solve. Pesticides kill indiscriminately, killing the predator as well as the pest and can become pollutants which can harm unintended organisms down the food chain. Furthermore, often pesticide resistant pests will continue to multiply, rendering the pesticide ineffective.
- Pollution which outright kills or prevents or lowers the rate of reproduction of the species.
  - Pollutants are often concentrated by food chains. Photosynthetic organisms absorb a small amount which is concentrated by herbivores and further concentrated by carnivores. At some point, it becomes toxic to the organism.



B. Humans are attempting to restore the natural ecological balance by:
- Species preservation - protecting or by raising and releasing endangered species.
- Increasing the use of biological controls rather than using pesticides (pest poisons) and herbicides (plant poisons) which can indiscriminately harm other good organisms.
  - Sometimes biological controls are used to reduce the populations of an imported species by introducing other imported species that feed on the original imported species. Occasionally this strategy backfires when the second imported species feeds on native organisms rather than the original imported species.
  - Other biological controls include:
    - Using sex hormones to trap pests.
    - Releasing males sterilized by radiation.
    - Introducing pest resistant plant species.
    - Increasing the natural predators such as ladybugs, praying mantises, and certain types of fish that prey on mosquitos lava which live in the water.
- Through genetic engineering and selective breeding, scientists are increasing the yield of farms by introducing new varieties of plants that produce more food. If you can grow more per acre, less natural land would have to be converted to farmland.
- Replacing forests by planting new trees whenever foresters harvest a tree for wood products.

Topic 7E Global Atmospheric Changes

Areas Stressed On Past Regents Exams

A. There appear to be two major global (world-wide) atmospheric changes occurring today. They are:
- Global warming — Some scientists say it is caused by burning fossil fuels which gives off carbon dioxide (CO_2), a greenhouse gas. The warming of the earth will cause climate changes that will disrupt weather patterns and destroy habitats, resulting in decreased biodiversity. Also, global warming may

melt the ice caps causing widespread flooding of low-lying costal areas such as New York City and most of Long Island which would further destroy habitats and decrease biodiversity. Global warming can be reversed by reducing the amount of atmospheric carbon dioxide levels. This can be accomplished by burning less fossil fuels and by planting more plants. Plants use carbon dioxide to make food by photosynthesis.
Note: Many third world countries are cutting and burning down their forests to make use of their land.

- Ozone depletion — It appears that large holes are opening in the ozone shield that protects the earth from ultraviolet radiation. Ultraviolet radiation can kill some plants and cause mutations such as skin cancer in humans. Scientists believe that CFCs (chlorofluorocarbons) used as refrigeration gases and spray can propellant are responsible for converting ozone (O_3) into atmospheric oxygen (O_2). Although CFCs are banned in United States today, there are still many refrigerators and air conditioners that have this refrigerant in their systems. Communities are attempting to collect this refrigerant when these units are disposed of, preventing the CFCs from entering the atmosphere.
  Note: China, India and Korea are still manufacturing and using CFCs.

Topic 7F Dealing with Environmental Problems

Areas Stressed On Past Regents Exams

A. We study ecology to gain an understanding of the interrelationships of the many different organisms of the world with each other and to their nonliving environment. It is the hope of many that we can prevent disruptions of (or ever restore) existing wildlife habitats so future generations can enjoy the vast diversity that exists on our planet.

B. When enacting new laws or considering new projects concerning the environment, government has the responsibility to balance the benefits and disadvantages to its people living today and those who will live in the future. Examples:

- Should a law be passed to restrict the release of a substance into the environment that might temporarily be toxic such as the release of acid by paper mills.

Benefits	Disadvantages
1. Prevent the destruction of organisms near where the substance is released. 2. Keeps the environment clean and safe for all.	1. It will cost more to find an alternate method of disposal. The company might not want the additional cost and close the plant, knowing that it can build a new plant in a third world country and save much money. Several thousand Americans will be out of work.

You call it - Should the law be passed?

- Should oil companies be allowed to drill in Alaska?

Benefits	Disadvantages
1. Oil produced will increase world supply, reducing imports and lowering prices for gasoline and heating oil for all Americans.	1. If there is an oil spill, it may temporarily disrupt a small area of the permanently snow covered national wildlife reserves.

You call it - Should the oil drilling be allowed?

- Should a law be passed to require Mid-America states of Ohio, Indiana and Illinois to install scrubbers on their coal-fired power plants, reducing the sulfur and nitrogen compounds leaving their smokestacks?

Benefits	Disadvantages
1. There would be less acid rain and air pollution in the Eastern states. 2. Over time, many of the lakes and streams will once again become populated with life. 3. Keeps the environment clean and safe for all.	1. Mid-Americans will have to pay more for their electricity. 2. Manufactures might not want to pay extra money for electricity and move to another state or maybe even out of the country. Thousands may lose their jobs. 3. If manufactures stay, they will need to raise the prices of their goods sold to all Americans.

You call it - Should the law be passed?

- Should a law be passed preventing snowmobiles in Yellowstone and other national parks?

Benefits	Disadvantages
1. Animals active during the winter will not be disturbed by the presence of humans. 2. The parks can save money by employing less Park rangers during the winter months.	1. People will not be able to enjoy winter activities in a very unique places since these places are only accessible by snowmobiles.

You call it - Should the law be passed?

C. In the future, Americans are going to be asked to vote on environmental policies that will affect the use of land and waterways. This is why it is important that citizens understand ecological concepts to make intelligent choices.

Topic 8A The Scientific Method

Areas Stressed On Past Regents Exams

A. Science is a step by step method of seeking the truth. When scientists believe they found the truth, they will develop theories. A theory is a scientific explanation that is supported by much experimental data. Because the universe is so complex, and scientists are gaining new knowledge every day, some scientific research that was accepted as "right" has now been proven wrong. Even theories are sometimes disproved. Good scientists must always be ready to accept the truth when new evidence is presented and confirmed.

B. Scientists consider most well designed experiments as a benefit to the body of science, even when the hypothesis is disproved by the experiment. New knowledge is gained and questions leading to new investigations often occurs.

C. Just because it may be possible through science, it does not mean that it should be done. There are often moral judgements or ethical problems that need to be considered before undergoing scientific exploration.

Topic 8B Designing an Experiment

Areas Stressed On Past Regents Exams

A. Steps of a Scientific Study
- A. Always starts with a problem
- B. Collect information from internet, books, and journals about the problem.
- C. Hypothesis - The proposed solution to the problem. It should relate the independent variable to the dependent variable.
  - An "if.....then....." or *I think that* "....." statement.
  - Example: If the temperature decreases, then the thickness of the ice on the lake will increase. OR The colder the temperature, the thicker the ice on the lake.
- D. Experiment - Used to test the hypothesis. Data is produced by observation and then the data is usually organized into tables and graphs so it can be more easily analyzed. (Note: When designing the experiment, the scientists must consider safety and the ethical treatment of any organisms being tested,)
- E. Conclusion - Based on the data produced in the experiment. The hypothesis will either be proven right or wrong.
  - Models can sometimes be used to explain the results
  - Even if the hypothesis is proven wrong, scientific knowledge is increased which may lead to further questions and experimentation.
- F. Peer review - Other scientists check the method or may even repeat the study and check to see if they are able to duplicate the results. This step is important for the conclusion to be accepted as a theory. A theory is a body of knowledge that is accepted by most scientists.

B. The significance (meaningfulness - how valid) of an experiment is increased by:
- A greater number of subjects (things being tested) or trials involved in the experiment.
  - 500 - very significant; 100 - significant; 10 - not too significant; 1 - insignificant
- The greater the difference in the results of the control group and the experimental group. If the results from the control group and the experimental group are close, the experiment failed to produce a significant difference.
- The greater the number of species tested if it a generalized study across a wide number of species such as for animals or plants. (Note: there are many types or species of animals and plants.) However, because of the genetic difference of each species, the conclusion is only valid for those species actually tested.

C. Every good scientific study always has at least two groups, the control group and the experimental group.
- The experimental group is the one being tested. It gets the drug or "treatment".
- The control group is the exact duplication of the experimental group with the exception that it is lacking the one factor being tested. Instead of being "tested," the control group is given a placebo (sugar pill) or some other inactive substance such as water.
  - It is important that all the conditions in both groups are the same except the one condition that is being tested.
    - If plants are being tested, some of the conditions that should be the same are size, type, health of plant, light, water, humidity, temperature, growth container, soil type and amount of fertilizer or minerals.
    - If animals are being tested, some of the conditions that should be the same are age, sex, size, health, diet and living conditions.
- The results of the experimental group is compared with the control group to determine the effect (or effectiveness) of whatever is being tested.

D. Every experiment has two variables, the independent and dependent variables. A variable is something that changes or varies.
   - The independent variable is controlled by the scientist in order to produce the data from the experiment that is needed to arrive at a conclusion. An experiment should have one independent variable. The independent variable is placed into the left column of a data table and is plotted on the x-axis (horizontal axis). In order to find the independent variable, you should ask the question: "What is the scientist changing in the experiment in order to prove the hypothesis."
     - (Note: The independent variable is usually not a test tube or group number. It would be how each group or substance in the test tubes is different.)
   - The dependent variable is the variable that you measure as a result of the experiment. It is the data produced by the study. There can be more than one dependent variable in an experiment. The dependent variable is placed into the right column of a table and is plotted on the y-axis (vertical axis).

E. The experiment must be designed to give data that can prove or disprove the hypothesis. Examples include:
   - Testing drugs that will be used on humans — Rats & mice are often used first to test drugs that will be later used on humans because rats, mice and humans are mammals and they often react similarly to many drugs. Rats and mice are inexpensive, and easy to experiment on. However, the effects of the drug are only valid for rats and mice. That is why before any drug is approved by the FDA, it must be used in experiments on humans. The results of the group taking the drug (experimental group) are compared with the results of the group taking the placebo (control group) to determine the effectiveness of the drug.
   - Something that affects plant growth — Plant growth can be indicated by measuring the size and/or number of leaves, surface area of leaves, height of plant or weight of plant.

Topic 8C Organizing Data

Areas Stressed On Past Regents Exams

A. Data tables are used to organize data from an experiment.

- Its title should state the relationship between the independent and dependent variables.
- The right most column heading should be the dependent variable along with its units of measurement followed by data corresponding to the independent variable. Sometimes, data tables have more than one dependent variable.
- The column left of the dependent variable(s) heading should be the independent variable along with its units of measurement followed by the data listed in increasing numerical order.

Examples of tables:

Table 1: The Effect of Temperature on Digestion

Tube	Temperature (C.°)	Amount of digestion after 48 hours
1	4	0.0 mm
2	8	2.5 mm
3	21	4.0 mm
4	37	7.5 mm
5	100	0.0 mm

↑ Label ↑ Independent variable ↑ Dependent variable

Table 2: The Effect of Temperature on Fish Respiration

Group	Number of Fish	Temperature (°C)	Average Rate of Movement of Gill Covers per Minute
1	5	10	15
2	6	15	25
3	4	18	30
4	7	20	38
5	6	23	60
6	4	25	57
7	4	27	25

↑ Label ↑ Independent variable ↑ Dependent variable

Table 3: The Effect of Temperature on Oxygen Content of Water

Temperature (°C)	Freshwater Oxygen Content (ppm)	Seawater Oxygen Content (ppm)
1	14.24	11.15
10	11.29	9.00
15	10.10	8.09
20	9.11	7.36
25	8.27	6.75
30	7.56	6.19

↑ Independent variable ↑ Dependent variable 1 ↑ Dependent variable 2

The number of fish column in Table 2 is a variable, but is not what being changed to test the hypothesis. It is significant because it gives the number of test subjects.

Three questions you should be able to answer!

1. What is the independent variable?
2. What is the dependent variable?
3. What is the relationship between these two variables?

Topic 8D Graphing

Areas Stressed On Past Regents Exams

A. Data is graphed to visualize the relationship between the independent and dependant variables.
Graph Example: One milliliter of a solution containing an even distribution of two species of bacteria was spread on the surface of a nutrient medium in each of five culture dishes. The nutrient medium in each dish was the same, except for pH. The dishes were then incubated at 37°C for 24 hours. The number of bacterial colonies in each dish was then counted, and the results are represented in the data table below.

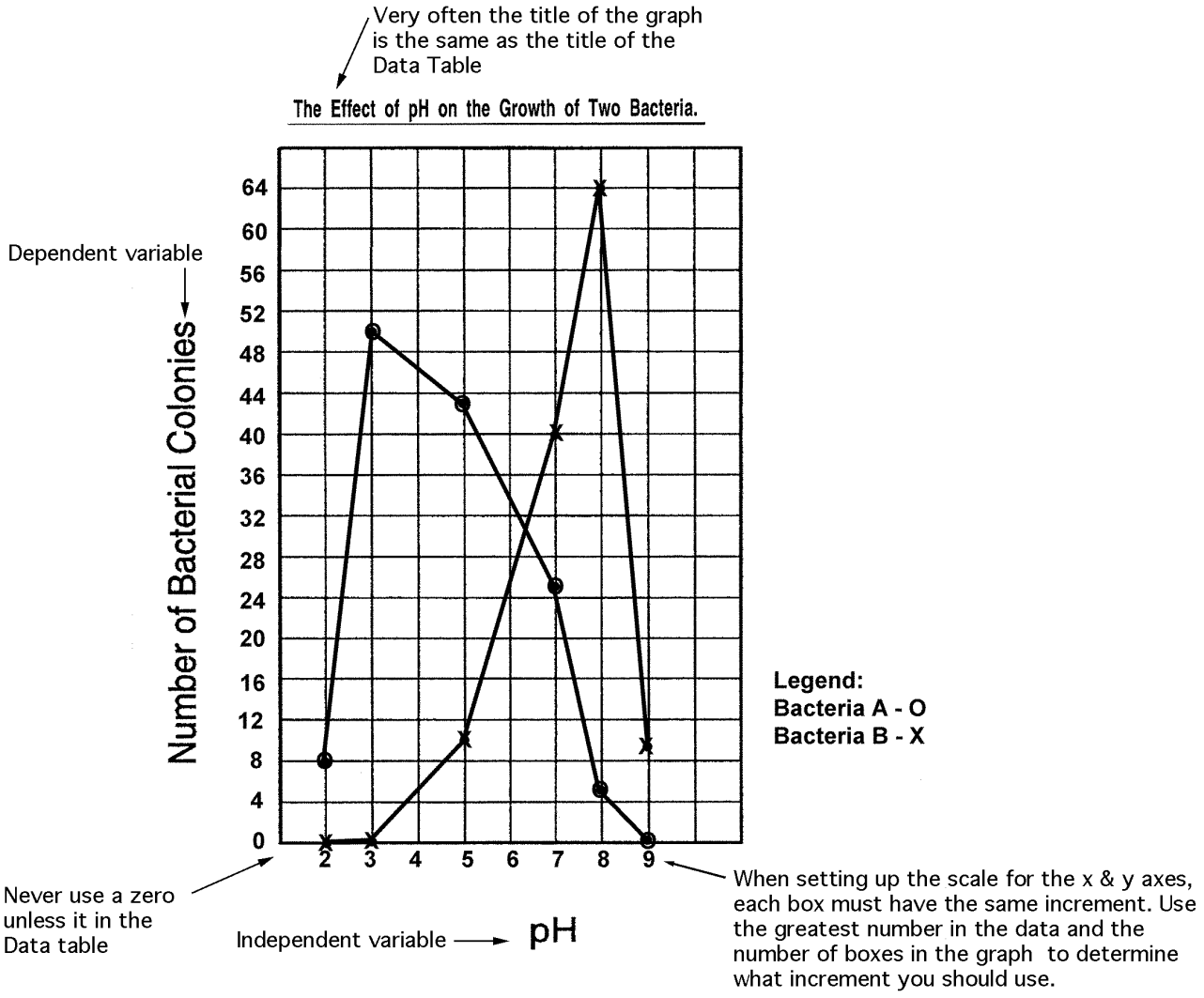
Independent variable →

Table 1: The Effect of pH on the Growth of Two Bacteria.

pH of nutrient medium	Number of Bacteria A colonies on nutrient medium	Number of Bacteria B colonies on nutrient medium
2	8	0
3	50	0
5	43	10
7	25	40
8	5	64
9	0	9

← Dependent variables

Very often the title of the graph is the same as the title of the Data Table



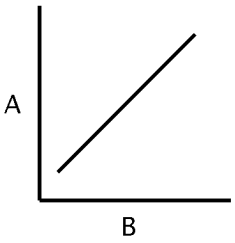
Topic 8E Interpreting Results

Areas Stressed On Past Regents Exams

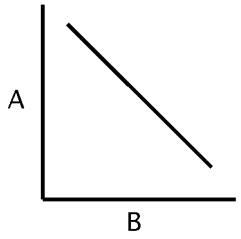
A. In order to fully understand a scientific study, one must view the entire scientific study. Often unscrupulous people can manipulate the data to their advantage. Scientific studies of humans are difficult because it is nearly impossible to account for all the variables. Good scientific research is usually not based on testimonials from individuals.

B. Graphs and tables can show the relationship between the independent and dependent variables. Examples of graph relationships include:

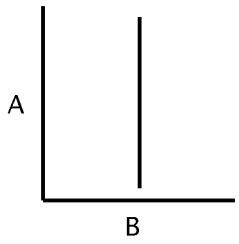
- Direct relationship
  - Graph will have a positive slope.
  - As B increases, A increases.

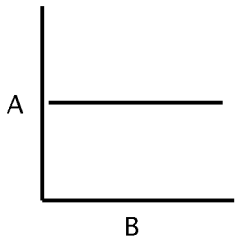


- Inverse relationship
  - Graph will have a negative slope.
  - As B increases, A decreases.



- The following two graphs show no relationships.





C. Conclusions must be based on the actual data produced by the experiment. If an experiment is valid, it could be repeated with the same results. (The data in the experiments would be so similar, scientists would arrive at the same conclusions.)

D. Every scientific study (experiment, test) can be improved ("Made better," "Made more reliable," " Made more valid," "Have more confidence in," "Greater significance" etc.) by repeating the experiment or increasing the number of test subjects and, if it is a generalized study. increasing the number of species tested.

Topic 9 Laboratory Skills

Areas Stressed On Past Regents Exams

A. There are certain lab procedures everyone must know. They are:

- Safety glasses must be worn anytime chemicals and/or instruments are used during the lab. Safety glasses must also be worn anytime a substance is heated during the lab.
- When heating substances in test tubes, **NEVER**:
  - heat with a stopper on — the stopper could pop off or the test tube explode!
  - point the test tube at anyone — the contents can boil out burning the individual.
- If anything gets into your eye, you must use the water station immediately to rinse your eye. After rinsing the eye, you should inform your teacher.
- Keep your hair away from open flame — it ignites easily.
- Keep loose clothing away from machinery — it could get caught in the machinery, causing serious bodily injury.

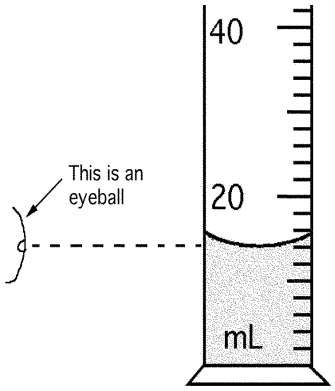
B. There are certain basic microscopic procedures everyone must know. They are:
- When preparing a wet mount, always use a coverslip to protect the objective lens.
- Compound microscopes eyepiece image is inverse and upside down. Therefore, the slide must moves in the opposite direction as being observed through the eyepiece. (An easy way to determine the actual orientation of a specimen drawn from the image viewed through the eyepiece lens is by simply rotating the drawing 180°. Example, if you draw a 6 you are actually looking at a 9 that is on the slide.)
- Always use low power to start searching for your specimen because lower power has the greatest field of view. Once the specimen is located, the specimen should be centered before switching to high power because high power has a much smaller field of view.
- The diaphragm must be readjusted every time there is a change in power because there is a reduction in the amount of light as view through the eyepiece when you increase the power,
- Stains are used to make it easier to see cell components, especially the nucleus, when viewing under the microscope. Two stains you must know are iodine (Lugol's solution) and Methylene blue
- Focusing allows you to sharpen an image. Only use the fine adjustment when focusing under high power. Both the course and fine adjustment can be used when focusing under low power.

C. Table: Instrument and size:

Can't see	Electron Microscope	Compound Microscope	Dissecting Microscope	Naked eye
Atoms molecular structure	Ribosomes Mitochondria	Protists and cells Chloroplast, Nucleus and vacuoles Cell wall	Insets Dissections	Gross structure

D. When measuring the amount of liquid in a graduated cylinder you must:
- Determine the scale used for measurement. (What is the value of each line?)
- Hold the graduated cylinder straight.
- Read at the bottom of the meniscus.

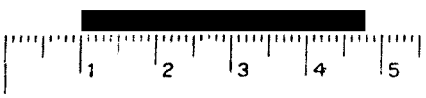
You should be able to determine that 14 ml of fluid is in the graduated cylinder to the right.



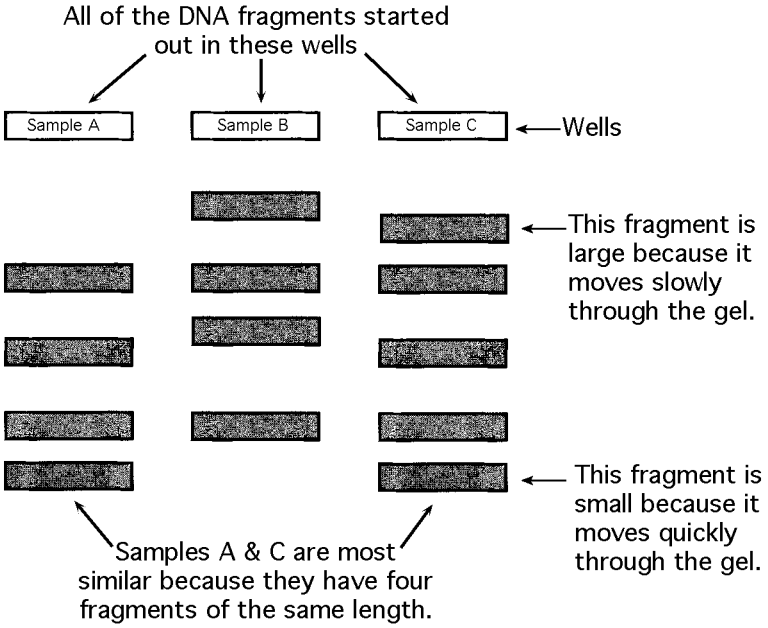
E. When measuring the length of an object you must use the correct units. Some units you may use are:
- Centimeter (cm) - smaller than 1/2 inch. This line "▬▬" is 1 centimeter long.
- Millimeter (mm) - 1/10 of a centimeter. This line "▬" is 1 millimeter long.
  - Note: There are 10 millimeters in one centimeters.
- Micrometer (µm) - 1/1000 of a millimeter. This line "|" is the thinnest one I can make on my computer and printer, is about 80 times thicker than 1 micrometer.
  - Note: there are 1000 micrometers in one millimeter. 1 µm is a very small measurement.

If the object to be measured starts at 1 cm, you must subtract this amount from measurement you take from the ruler. See right.

You should be able to determine that this block is 3.8 centimeters long!



F. Scientists can separate and/or identify molecules by:
- Chromatography - can separate different substances because their molecules flow through a medium, usually paper, at different rates. They flow at different rates because some molecules stick (adhere) to the paper more than other molecules. The rate of flow depends on the solvent used and the type of paper. The molecules can be identified by comparing the test samples with known substances. Chromatography is often used to separate pigments.
- Electrophoresis - a technique where larger molecules are separated due to their size and charge. An electric charge pulls the collection of molecules through a gel. The smaller molecules move faster and separate from the larger molecules. Gel electrophoresis is often used to separate DNA fragments and protein molecules.



G. The pH scale is used to indicate how acidic or basic is a substance. You must know:
- A pH of 7 indicates a neutral substance.
- A pH greater than 7 indicates a basic substance. The greater the number the stronger the base.
- A pH less than 7 indicates an acidic substance. The lower the number, the stronger the acid.

Bromthymol blue is a pH indicator that is blue in a basic solution, green in a neutral solution and yellow in an acid solution. When carbon dioxide dissolves in water some of it combines with the water molecule and forms a weak acid. When bromthymol blue is added to this solution, it would turn yellow. If plants were add to this solution and it was placed into sunlight, the solution would eventually turn green because the carbon dioxide would be removed from the water and the solution would become neutral.

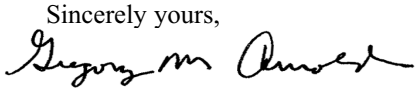
Dear student,

The Living Environment Regents Examination is one of the most important examinations your are going to take in High School. Students who fail this examination usually do not graduate. This is because it is one of the 5 required examinations necessary to meet graduation requirements. In order to do well on this examination students usually have to study 25 to 40 hours. That seems like a lot of time, but remember that the exam covers the entire years work.

Students in human biology who are absent from this very important examination usually fail because this examination counts as a final examination and is averaged into your final grade for the year. So make sure that leave your house on the day of the examination early enough to get to school on time.

I would wish you "good luck", but unfortunately, there is nothing lucky about passing a Regents examination. One must be prepared by conscientiously studying for the exam. Therefore, I wish that you will be able to walk into the Living Environment exam confident that your are going to pass because you are well prepared for this exam!

Sincerely yours,



Gregory Arnold
AP Science

The Entire Regents schedule:

EXAMINATION SCHEDULE: JANUARY 2007

Students must verify with their schools the exact times that they are to report for their State examinations.

JANUARY 23 TUESDAY	JANUARY 24 WEDNESDAY	JANUARY 25 THURSDAY	JANUARY 26 FRIDAY
9:15 a.m.	**9:15 a.m.**	**9:15 a.m.**	**9:15 a.m.**
RE in Global History & Geography RCT in Writing	Comprehensive French* Comprehensive Spanish Physical Setting/Earth Science RCT in U.S. History & Gov't.*	RE in U.S. History & Government RCT in Reading	Living Environment Mathematics B RCT in Global Studies*
1:15 p.m.	**1:15 p.m.**	**1:15 p.m.**	**Uniform Admission Deadlines** Morning Examinations – 10:00 a.m. Afternoon Examinations – 2:00 p.m.
Comprehensive English: Session One RCT in Mathematics*	Comprehensive English: Session Two RCT in Science*	Mathematics A Physical Setting/Chemistry Physical Setting/Physics	