

What You Absolutely Must Know to Pass the NYS Living Environment / Biology Regents

UNIT ONE: Science of the Living Environment

A. Terms:

1. **Observation:** What is seen or measured.
2. **Inference:** A conclusion based on observation or evidence.
3. **Hypothesis:** An untested prediction. A good hypothesis states both cause and effect (“**If-then**” statement).
4. **Theory:** A broad explanation of natural events that is supported by strong evidence.

B. Graphing

C. Controlled Experiment: Compares the results of an experiment between two (or more) groups.

1. **Experimental group:** Group being tested or receiving treatment. (ex: new drug)
2. **Control group:** “Normal” group. Should be identical to experimental group in every way except *one*: it does not receive the treatment (i.e.: no drug, or given the original drug or a *placebo*).
3. **Placebo:** A sugar pill or other “fake” treatment given to the control group so subjects do not know which group they are in.
4. **Independent Variable:** Variable that is being tested (ex: new drug). In a graph the independent variable is always plotted on the X axis.
5. **Dependent Variable:** Variable that is measured at the end of an experiment; the results (ex: does patient get better?) The dependent variable is always plotted on the Y axis.

D. Characteristics of a good experiment.

1. **Can be repeated by anyone and get the same results.**
2. **Have large sample size/many test subjects.**
3. **Are performed for longer periods of time.**

4. **Test only one variable.**
5. **Are peer reviewed** – examined by several scientists to determine its accuracy.
6. **Does not have to agree with the hypothesis.** A scientist's guess is allowed to be incorrect – and usually is.
7. **Is objective** – the experiment and conclusion are fair and **unbiased**. Fact and opinion are not mixed.

UNIT TWO: Characteristics of Living Things

A. All living things must maintain homeostasis.

1. To maintain homeostasis, organisms carry out the same basic life functions: **nutrition, excretion, transport, respiration, growth, synthesis, regulation and synthesis.** *Know these terms!*
2. All life processes make up an organism's **metabolism**.
3. Failure to maintain homeostasis causes disease and death.

B. Nutrition:

1. **Autotrophs** make their own food, while **heterotrophs** eat other organisms.
2. **Photosynthesis** is carried out by plants, alga and blue-green bacteria (autotrophs). It takes the radiant energy of the sun and puts it in the bonds of sugar molecules. Photosynthesis occurs mostly in the chloroplast of plant cells.
 - a. Plants have **stomates**, small holes in their leaves that let them exchange the gasses used in photosynthesis. **Guard cells** open and close the stomates.

C. Respiration: Organisms get energy by breaking the bonds of sugar molecules. The released energy is used to make a molecule of **ATP**, which gives all organisms their energy.

1. **Aerobic respiration** requires oxygen, and yields more ATP (energy) for a molecule of sugar than **anaerobic** (no oxygen) respiration.
2. When humans are forced to get energy from anaerobic respiration, we produce lactic acid that damages muscles (“the burn” you feel during exercise).
3. **Photosynthesis and Aerobic Respiration are opposite reactions!** They are also important in cycling oxygen, carbon, hydrogen and water through the environment.

D. Transport:

1. **Diffusion:** movement of molecules from high concentrations to low concentrations. Requires no energy (passive transport).
2. **Active Transport** requires the use of energy, usually moving molecules from a low concentration to a high concentration (against the flow of diffusion).
3. **Osmosis** is the diffusion of water into or out of the cell. If water diffuses into the cell, the cell swells (get larger) and may burst. If it loses water (being put in salt water for example) it will shrivel up.

E. Regulation: coordination and control of other life functions.

1. A **stimulus** is a change in the environment that you **respond** to.
2. A **neuron** is a nerve cell.
3. An **impulse** is the electrical signal carried by the nerves. Neurotransmitters are chemicals that help carry the impulse.
4. A **hormone** is a chemical signal secreted by different glands in the body. Examples of hormones include **insulin, adrenaline, testosterone** and **estrogen**
5. **Receptor molecules** are proteins on the surface of the cell membrane that receive signals from the nervous and endocrine system. These are needed for your cells to communicate and work together.

F. Chemistry

1. The most common elements in living things are (in order) Carbon, Hydrogen, Oxygen and Nitrogen (CHON).
2. **Organic Compounds** have Carbon AND Hydrogen (ex: $C_6H_{12}O_6$ is organic, H_2O , CO_2 , and NO_3 are not). Organic molecules are also larger than inorganic molecules.
3. **Carbohydrates** are sugars and starches. All carbohydrates are made from simple sugars (like glucose) and they supply energy.
4. **Lipids** store energy and include fats, oils and waxes. They are made from fatty acids and glycerol.
5. **Proteins** are made from **amino acids**. **Proteins** also make hormones and many body and cell structures, so *as far as your body is concerned, proteins are by far the most important of these three organic molecules.*
 - a. It is the SHAPE of proteins and how they fit together that determines what proteins can do.
 - b. Four specific jobs of proteins:

- 1) make **enzymes**
- 2) make **receptor molecules** on the cell membrane. These are used to receive chemical messages (like hormones).
- 3) make **antibodies**
- 4) make **hormones**

c. **Enzymes** are **catalysts** – they affect the rates of chemical reactions.

- 1) **lock and key model** – one type of enzyme fits one type of molecule. Change its shape and the enzyme will no longer work.
- 2) **very high temperatures** cause proteins and enzymes to lose their shape so that they no longer work properly. This is why high fevers are dangerous.

6. **pH:** The pH scale measure the strengths of **acids** and **bases**. A low pH (0-6.9) is a acid, a high pH (7.1-14) is a base, and 7 is neutral (water).

G. Cells- Cells are the basic unit of life. All living things (except viruses) are made of cells.

1. You must know the cell theory (all living things are made of cells).
2. You must know the differences between plant and animal cells.
3. You must know the following organelles: *cell membrane*, cell wall, nucleus, chloroplast, cytoplasm, ribosome, vacuole, mitochondria
4. **The cell membrane** is made of lipids and proteins. It shows selective permeability – that is only some molecules can pass through it (typically small molecules like water and oxygen). Large molecules (like starch or protein) need to be moved by active transport.
 - a. NOTE: Students often assume cells have a cell wall OR a cell membrane. ALL cells have a cell membrane, including those with cell walls (plants, fungi, some bacteria and protists). The cell wall is mostly for protection; the cell membrane is needed to control movement into and out of the cell. The animal kingdom is the only kingdom that completely lacks cell walls.

H. Classification-

1. Organisms are classified mostly by evolutionary history. Those with common ancestors are grouped together.
2. **Kingdoms** are large groups of related organisms (fungi, bacteria, protists, animals, plants).
3. A **species** is able to successfully reproduce amongst its members.

4. A scientific name is made up of an organism's *Genus* and *species*.

UNIT TWO: Maintaining Homeostasis in the Human Body:

A. Organization:

1. Cells are **specialized** into tissues.
 - a. **Tissues** are groups of cells specialized to do certain jobs. Examples of tissues include muscle tissue and nerve tissue.
 - b. **Specialization** or **differentiation** occurs because only some genes in the nucleus of a cell are "turned on". Almost every cells has a complete set of genes, but on those needed for the cells particular job are active. So while a red blood cell has all the genetic information needed to make nerves cells, bone cells and skin cells, all those genes are turned off, and only the red blood cell genes are turned on.
2. **Tissues** work together to form **organs** (heart, lungs, kidney).
3. **Organs** work together in **organ systems** (digestive system, nervous system, etc).

B. Digestive System:

1. **Food is broken down so that it is small enough to enter the body tissues/cells.**
2. The digestive system is a one way passage through the body that includes the **mouth, stomach and intestines.**
3. Food is moved through the digestive system by muscular contractions (peristalsis).
4. Food is broken down mechanically and chemically.
5. Undigested food is eliminated as solid waste. *This is not excretion.*

C. Transport/Circulatory System.

1. Moves material (water, nutrients, hormones, wastes) through the body.
2. **Red blood cells** carry oxygen. **White blood cells** fight disease.
3. **Plasma** is the fluid of the blood. It transports everything *except oxygen*.
4. **Platelets** clot the blood.

D. Immune System:

1. The job of the immune system is to protect the body against **pathogens**.

- a. Types of pathogens include viruses, bacteria, and parasites.
2. **White Blood Cells** are the main components of the immune system. Different w.b.c's have different roles.
3. **Antigens** cause an immune response. **Antibodies** are proteins made by white blood cells to attack antigens. *Each antibody attacks a specific antigen as determined by its shape.* (see page 2 for proteins).
4. Be able to explain why your body's immune system rejects organ transplants.
5. Blood type O is a universal donor; type AB is the universal acceptor.
6. A **vaccine** is an injection of a dead or weakened pathogen. This causes the body to make antibodies against that pathogen.
 - a. Vaccines only prevent diseases. They are not cures.
7. **Antibiotics** are drugs used to stop infections by **bacteria**. Antibiotics will not work against viruses.

E. Respiratory System:

1. Physical respiration (breathing) provides oxygen needed for chemical respiration (which releases energy from sugar).
2. The **diaphragm** is the muscle that allows breathing to occur.
3. You breathe faster when CO₂ builds up in the blood (not when you need oxygen).
4. The **alveoli** are very important because it is here that the oxygen enters the blood and CO₂ leaves. The alveoli look like microscopic sacs surrounded by capillaries.

Excretory System:

5. Removes metabolic waste from your body.
6. Your body excretes **salt, water, urea and CO₂**.
7. **Lungs** excrete CO₂ and water and the skin excretes sweat.
8. The **kidneys** filter waste from blood and reabsorb nutrients.
9. The **liver** filters toxins and dead red blood cells from the blood.

F. Skeletal Muscle System

1. Know the function of bones, bone marrow, cartilage, tendons and ligaments.

2. Muscles only pull and must work in pairs.

G. The Nervous System

1. The nervous system regulates your body along with the endocrine system.
2. Know the three parts of the **brain** and what they do (cerebrum, cerebellum, medulla).
3. The **spinal cord** controls reflexes and brings impulses from the nerves to the brain.

Endocrine System:

4. Regulates body along with nervous system. Slower but with longer lasting effects.
5. The **pancreas** makes **insulin** and glucagon which control blood sugar.
6. Adrenal glands make **adrenaline** when the body is under stress.
7. **Testosterone** (male), **estrogen** and **progesterone** (female) are the sex hormones.
8. Hormone levels are controlled by **negative feedback**.

H. Interaction between Systems:

1. Be able to explain how different systems of the body work together to maintain homeostasis.

Ex:

Nutrients from the digestive system are transported to cells by the circulatory system.

Wastes from respiration are removed by the excretory system.

The nervous and endocrine systems work together to control the body.

I. Diseases and Disorders:

1. Be familiar with different diseases and disorders, what causes them, and how they may affect the body. Don't fret about memorizing all of them. Typically the exam will ask you to name a disease and how it disrupts homeostasis.
2. Diseases and disorders include: Heart attack, stroke, cancer, Down's syndrome, diabetes, cystic fibrosis, sickle cell anemia, diarrhea, ulcers, AIDS, goiter, scurvy, rabies, meningitis, pneumonia, asthma, bronchitis, appendicitis, cold, flu
3. Causes of diseases (**Pathogens**):
 - a. viruses (AIDS, cold, flu, chicken pox)

- b. bacteria (strep throat, food poisoning, syphilis)
- c. fungus (athlete's foot, ringworm)
- d. parasites (tapeworm, leeches)
- e. genetic disorders (Down's Syndrome, sickle cell, cystic fibrosis)
- f. environmental toxins (lead poisoning, radiation)
- g. poor nutrition (Scurvy, goiter)
- h. organ malfunction (heart attack, diabetes)
- i. high risk behavior (smoking, drug use, exposure to sun)

UNIT THREE: Reproduction

A. Asexual reproduction:

- 1. Advantages: faster, easier
- 2. Disadvantage: no variety. Offspring are the same as parent.

B. Sexual reproduction:

- 1. Advantage: variety
- 2. Disadvantage: more time, effort and risk.

C. Mitosis

- 1. Asexual
- 2. One division => two identical, diploid ($2n$) cells.
- 3. Chromosome number in the daughter cells is **the same** as in the parent cell.
- 4. Large organisms use mitosis for growth and healing. Simple organisms use it to reproduce.

D. Meiosis

- 1. Sexual reproduction
- 2. One cell divides *twice* to make four DIFFERENT cells.
- 3. All 4 cells are haploid (n) meaning they have half the number of chromosomes found in the parent cell.

4. Makes **gametes** (sex cells). In humans 4 sperm cells or 1 egg and three polar bodies are produced each time meiosis occurs.

5. Separates pairs of **homologous chromosomes** so that offspring get one chromosome of each pair from a different parent.

E. Fertilization occurs in the **fallopian tube**. A fertilized egg is called a **zygote** and has a normal number of chromosomes ($2n$).

F. The fetus develops in the **uterus**. Cells divide without becoming larger (cleavage). After a few days, cells begin to **differentiate** – that is they start to form different types of cells (nerve, skin, bone, etc). At this stage the embryo is very vulnerable to alcohol, drugs, etc because the important organs and systems are just starting to develop.

1. See page 7 for more on differentiation.

UNIT FOUR: Genetics:

A. Humans have 46 chromosomes, or 23 homologous pairs.

B. Chromosome pairs carry alleles for the same trait. We all have two alleles for each gene - 1 from each parent, 1 on each member of the homologous pair.

C. While genes determine our traits, **the environment can affect expression of genes.**

D. Each chromosome has hundreds or thousands of genes. Each gene codes for a particular protein (**1 gene=1 protein**).

E. DNA is made of 4 bases: **ATCG**. A three letter **codon** represents a specific amino acid. These amino acids are assembled into proteins.

F. Base pairs: A-T, C-G (in RNA, A-U and C-G)

G. RNA carries the genetic code to ribosomes. The ribosomes then synthesize **protein** (see page 2 for more about proteins).

H. Changes to DNA are called **mutations**. They can only be passed on if they occur in reproductive cells (sperm or egg).

I. All cells in the body contain the same genes. Only some of these genes are turned on (that is, your eye cells contain the instructions on how to make bones, but only the genes to make new eye cells are actually turned on). We do not yet know exactly why this happens.

J. Selective breeding produces animals and plants with desired traits (disease resistance, larger fruit, more meat or milk, specific colors).

K. Genetic engineering or **gene splicing** inserts genes of one organism into the genes of another. Enzymes are used to cut and copy the DNA segments. Bacteria are often used

because they have no nucleus protecting their DNA and they reproduce very quickly, allowing large amounts of medicine (insulin) to be made.

a. The example of gene splicing you **MUST** know:

The gene to make human insulin was inserted into bacteria. These bacteria can now make insulin that is exactly the same as human insulin. This insulin is used by diabetics. This is safer than the cow and sheep insulin that were used in the past.

L. New technologies (**karyotyping, DNA fingerprinting**) are making it easier to diagnose and treat genetic disease, though we cannot yet cure them.

M. Genetic research has posed many **ethical** problems (ie right and wrong) that science alone cannot answer.

Unit 5: Evolution

A. Basically states that modern species evolved from earlier, different species and share a **common ancestor**.

B. Charles Darwin proposed that **natural selection** is the mechanism that causes species to change. The basic steps in natural selection are:

1. Overproduction of offspring.
2. Competition for limited resources.
3. Survival and reproduction OR death.

C. Organisms that are **better adapted to their environment and able to reproduce successfully are considered “fit”**. Unfit organisms die, and their traits are eventually removed from the gene pool.

NOTE: Evolutionary fitness has nothing to do with physical fitness. Stronger is not always better.

D. Evolution is usually driven by a change in the environment.

E. To evolve, variations must exist in a species **BEFORE** the environment changes. They do not get a trait just because it is needed.

F. Variations exist primarily as the result of sexual reproduction and mutation.

G. Species with more variation are better able to survive environmental changes.

H. Gradualism is a theory that says change occurs slowly. **Punctuated equilibrium** is a theory that says evolution happens in quick spurts.

I. Creation of new species usually requires **geographic isolation** which eventually results in **reproductive isolation**.

J. Evidence in support of evolution comes from the fields of geology (fossil record and radioactive dating), genetics, biochemistry, anatomy and embryology (among others).

UNIT 6: Ecology: *This is the most important part of the test!!!*

A. Understand how organisms interact with their environment (food webs, nutrient cycles).

B. Energy is needed to keep an ecosystem going. The energy comes from the sun and is made usable by **producers** (plants and other **autotrophs**)

C. Energy is passed on to other organisms in the form of food. Since all organisms must use energy for their own needs, most energy is lost before it can be passed to the next step in the food chain. As a result, organisms high on the food chain have less energy available to them and must have smaller populations.

D. Environmental factors (air, water, light, temperature, pH, food, predators etc) determine which organisms can live in an ecosystem and how large the population can get.

1. The maximum size of a population is called the **carrying capacity**.

E. There are many roles in an ecosystem (**niche**), but **competition** between species usually results in only one species occupying a niche at any one time. Often, organisms with similar needs will divide resources to reduce competition (ex: birds eat insects during the day, bats eat them at night).

F. Know the basic processes of **ecological succession**.

G. Human action (development, industrialization, pollution, farming, over hunting, overgrazing, clear cutting, introduction of foreign species, soil erosion) often has negative consequences for the ecosystem (and humans too).

H. The negative effects humans have had on the environment are all mostly due to the increasing human population.

I. **Biodiversity** refers to the variety of life on earth. As habitats are lost and species become extinct, biodiversity is reduced. This is bad because 1) ecosystems with low diversity take longer to recover from environmental changes and 2) we use organisms for many things such as food and medicine; by reducing biodiversity we are losing potentially valuable resources.

J. **Actions being taken by humans to reduce or repair damage to the environment include:**

1. Recycling wastes
2. Conserving available resources

3. Using cleaner resources (ex: solar over fossil fuels)
4. protection of habitats and endangered species
5. use of biological controls instead of pesticides and herbicides
6. Farming native plants (ex: cocoa in the rainforest)
7. Planting trees to replace those cut down.
8. Rotating crops or planting cover crops to reduce soil loss.

K. Know the following terms: **producer, consumer, omnivore, herbivore, carnivore, predator, parasite, habitat, niche, population, community, ecosystem, biosphere, pollution, renewable resource**

L. For each of the following ecological problems, you should be able to identify the *specific* cause, their negative effects on the environment, and a way that people are trying to fix the problem:

1. acid rain
2. loss of habitat (ex: deforestation)
3. loss of diversity
4. global warming
5. loss of ozone layer
6. introduced species
7. industrialization