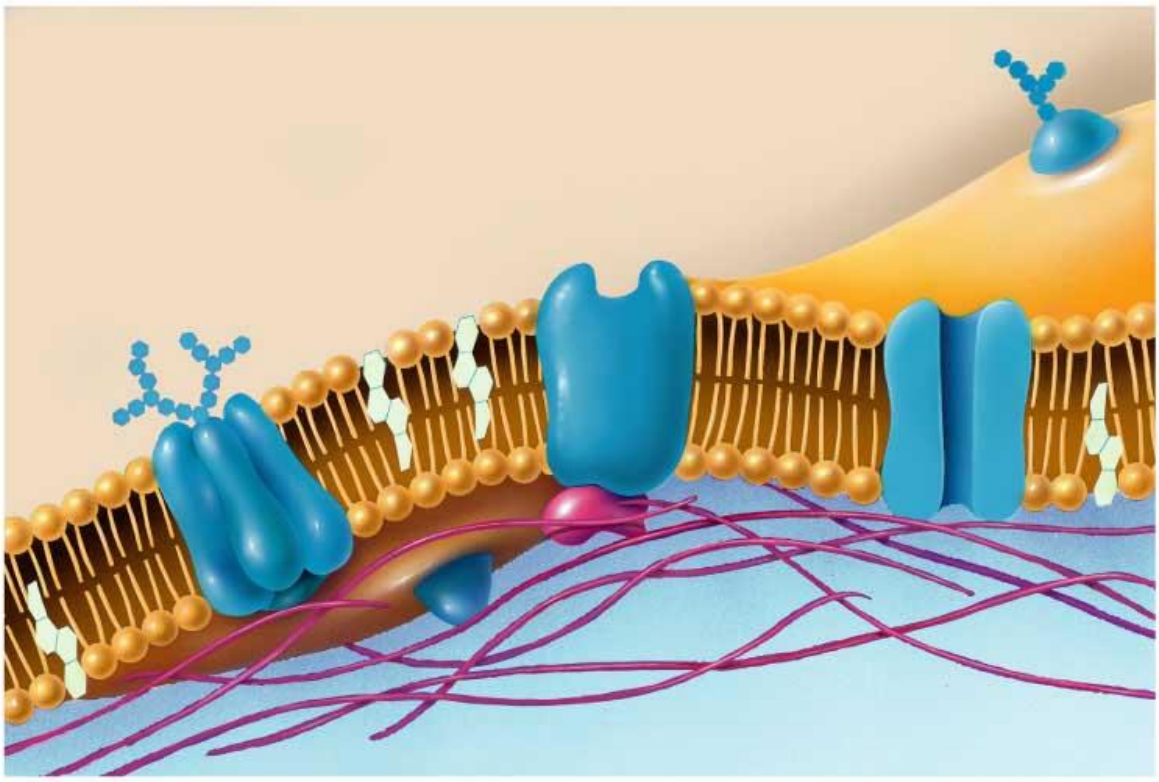
Homeostasis and Wellness

Bio30S

Mrs. Kornelsen



Learning checklist – Wellness and Homestasis

Learning increases when you have a goal to work towards. Use this checklist as guide to track how well you are grasping the material. In the center column, rate your understand of the topic from 1-5 with 1 being the lowest and 5 being the highest. Be sure to write down any questions you have about the topic in the last column so that you know what you have yet to learn.

Outcomes	Understanding	Questions
Increase awareness of personal wellness and family health history		
Develop a personal wellness plan.		
Recognize how individual wellness choices affect others. *Ex. Community, family, fetus*		
Describe how the body attempts to maintain an internal balance called homeostasis, recognizing that the conditions in which life processes can occur are limited. Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), waste management		
Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change Include: role of receptors, effectors		
Identify life processes that individual cells, as well as complex organisms, need to manage. Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, transport substances		
Explain how cell membranes regulate movement of materials into and out of cells and recognize the importance of this regulation in managing life processes and maintaining homeostasis. Include: passive transport, active transport, endo/exocystosis		
Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance		

of cell. Examples: size of molecule, concentration gradient, temperature, polarity of molecules, surface area…		
Select and use scientific equipment appropriately and safely. *Examples: microscopes, dissection equipment, prepared slides…*		
Record and organize and display data and observations using an appropriate format. Include: biological drawings		
Explain the role of energy in maintaining equilibrium in the cell. Include: role of ATP in metabolism		
Added: Describe the structure and function of proteins, lipids, and carbohydrates		

Introduction to Biology:

What is Biology?

Make your own definition:

Biology –

Examples

- ☐ Zoology –
- ☐ Botany –
- ☐ Ornithology –
- ☐ Virology –
- ☐ Entomology –
- ☐ Microbiology –
- ☐ …and many many more!

Think-Pair-Share :

So, if Biology is the *study of living things,* what are the characteristics of living things?

Characteristics of Living Things

Biologists have never agreed on a definition for life but have agreed on a list of characteristics that help us identify living things. A life form is called an organism. All organisms have the following characteristics.

- *Living things acquire energy and materials from the environment.*
  - Almost all the _____ available to life on Earth comes from the _____.
  - _____energy from the sun is captured by green plants and stored in the chemical _____of _____ molecules.
  - _____ is then available for use.
  - Once energy is obtained by another _____, it is used to fuel other life _____ (which involve chemical reactions).
  - The sum of all _____ that occur in the cells of an organism is called _____.

- *Living things are organized.*
  - Living things have various levels of _____ organization.
  - _____ are generally the smallest units that show the characteristics of life.
  - Cells are surrounded by a _____ that _____ allows _____ to flow into or out of them. More advanced cells have structures called _____ that specialize in life processes.
  - Living things are generally _____ (one cell) or _____ (many cells).
  - Humans have a high degree of organization where cells are organized into _____ and different _____ compose _____ which make up organ _____.

- *Living organisms maintain a relatively constant internal environment.*
  - Living things attempt to maintain a _____ _____ environment.
  - The _____ of a constant internal environment is called _____.
  - This is relatively easy for a bacterial cell but large organisms such as humans must have special _____ and systems to help them.

- *Living things reproduce.*
  - Living things reproduce either _____ or _____ and genetic material is passed from parents to offspring.
  - The offspring from asexual reproduction are genetically _____ to the parental cell.
  - Sexual reproduction is where two individuals combine their genetic information to form an individual with slightly _____ characteristics than either parent.

- *Living things grow and develop.*
  - _____ is recognized by an increase in size.

- In multicellular organisms, development is generally defined as an increase in the _____ of cells. But can also include the _____ of damaged tissue.
- In humans, development includes all of the_____ that take place between conception and death.
- In plants, _____ includes all of the changes that occur between the_____ and the adult form.

- *Living things respond to stimuli from their living and non-living environments.*
  - Living things live in a constant _____ with their surroundings or environment.
  - Any condition in the environment that requires an organism to adjust is called a _____.
  - A reaction to the stimulus is called a _____.
  - Organisms must be able to _____ to their environment in order to survive.
  - The distribution of all living things is determined by their_____ for a number of environmental factors.
  - Within a limited geographical area, organisms interact with their physical and biological environments to form an _____.

**Note: Non-living things may have one or more of these characteristics, but NOT all.

Assignment – Exit Slip

Using examples, explain how we, as humans, fit every requirement to being a *living thing*

Wellness and Homeostasis

A new set of designer clothes – 500 dollars. A new home theatre system – 5000 dollars. A new SUV – 50 000 dollars. Your health – priceless.

Actually, today we say that wellness is priceless. Very true, but many people don't think much about health and wellness until they are unwell or injured. We are going to begin this Biology course with thinking and talking about wellness to set the stage for study of our body systems. As we study various systems, we will revisit wellness and you will develop a personal wellness plan.

Balance - How would Philippe Petit have fared without it?

The picture to the right shows a person on a tightrope. The symbol suggests that balance is the key. Personal lifestyle choices or lack of knowledge can result in losing balance with unhappy consequences – just like losing balance on a tightrope.

In Biology, balance of body systems is called homeostasis. Homeostasis is one of the big themes in this course. We will introduce it in this module and come back to it as we study specific systems.

As we learn about our bodies and consider personal wellness, we will also consider how our own wellness (or lack if it) affects others in our family and society. Also, how are we affected by the wellness of others.

A closer look at wellness…

Physical Wellness: The physical needs of our body must be met before we can try to balance the other areas of need.

- If we are hungry, cold, or tired, it is difficult to deal with the emotional, social, intellectual or spiritual issues.
- Physical balance includes eating properly, getting adequate exercise, and sufficient rest. Only after meeting the physical demands of our body can we move on to the other areas.
- Some suggested ways to find physical balance include becoming aware of physical addictions such as alcohol, food, medications, smoking, and moving toward moderation.
- We also need to get regular physical check-ups, develop an exercise program, learn today's nutrition principles, drink water, and get sufficient sleep.

Emotional Needs: Emotional needs involve our relationships with other people.

- Emotional balance includes relationships with close family and friends.
- Emotional balance also involves how we deal with the human emotions such as anger, guilt, love, fear and happiness. It is important that we find balance and try to keep a positive attitude rather than allowing negative emotions to build.
- To help achieve emotional balance, take an inventory of your relationships with other people and become aware of how you interact with them.
- If you have stressed relationships, take steps toward positive communication or reconciliation for your own sake as well as theirs. Make a list of all the things you like about yourself, acknowledge your own feelings without judging yourself. Forgive yourself of your past mistakes and forgive others of theirs.

Spirituality: Spirituality is an essential need of human nature. Our feelings, thoughts, choices, and questions are related to our spirituality.

- Some think of spirituality including all of our efforts to gain insight into the underlying, overriding forces of life. For many, it is the justification for our moral and ethical standards.
- Research studies in recent years have found that the influence of religion or spirituality appears to be highly related to a sense of well-being in elderly persons.
- Ideas for helping achieve spiritual balance might include taking time for quiet reflection, maintaining a personal journal, incorporating meditation and/or prayer into your life, becoming more aware of the world around you and the lessons it teaches, and practicing an open attitude.

Intellectual Stimulation: This involves continually finding ways to challenge our mind and continue learning.

- People need intellectual growth and stimulation to help keep balance in their lives.
- Learning is crucial in adapting to life's changes.
- Some ways to find intellectual stimulation might include attending workshops in areas of special interest, taking formal or informal classes, reading newspapers, books, and other sources of information and seeking out other people who are interested in challenging discussion and conversation.

Social Balance: Social balance includes taking time to give to others.

- It is important to contribute to one's own community and environment.
- Interdependence with others, with nature and within the family is an important aspect of living a balanced life.
- Some suggestions to add social balance to your life might include volunteering in your community, displaying a caring attitude toward others, or performing acts of kindness. Think about how you give to others and how your life makes a difference. Find an area where you can make that difference!

Family Medical History

It is useful to be aware of your family medical history for a variety of reasons, some of them include:

- People inherit half of their genetic profile from each parent
- Along with the information that determines your appearance, you inherit genes that may cause or increase your risk of certain medical conditions (except for a relatively small number genes, the identity of most disease-associated genes remain unknown)
- Family medical history can't predict your future health; with few exceptions it only provides information about risk.
- Other factors such as your diet, weight, exercise routine, other lifestyle habits, and exposure to pollutants or environmental factors – will also raise or lower your risk of developing certain diseases.
- The health and wellness of others affect us and vice versa. Think about how you and family members might be affected by an illness of a family member, the more serious the illness, the bigger the effect on us.

For more information about creating a family medical tree (family pedigree), see the following Mayo Clinic website:
http://www.mayoclinic.com/print/medical-history/HQ01707/METHOD=print#

Lifestyle Choices and Wellness/Health

We can't control our genetics and we can only partially control our environment. We can, however, control our own behaviour. We can make lifestyle decisions that help us to stay well and injury free. You will have noticed that a number of the items on the wellness checklist are based on habits of nutrition, smoking, use intoxicants, indulging in risky behaviour, and so on.

Wellness and Society

Here are some examples where the evidence suggests that a certain personal choice may have harmful and negative consequences to the individual, or those around them.

Example: Alcohol can have harmful effects on the fetus (e.g., fetal alcohol syndrome).

There are also often financial costs to society for provision of treatments.

If you fall off or crash your bicycle, there is a good chance that you will hit your head. If you are wearing a helmet, you have a better chance of not sustaining a head injury. Should there be a law to require all bicycle riders to wear a helmet?

Obesity is the cause of many medical problems. Should it be illegal to overeat or for restaurants to supersize portions? Should people be able to sue restaurants for making them fat?

Exposure to sun is associated with incidence of skin cancer. What do we say to people who power tan? What if they develop a skin cancer because of their choice?

Should society pay for treatment of injuries, diseases… that were caused by personal choice?

Wellness Checkup

Wellness is more than not being ill. Wellness is having a healthy body, mind and spirit.

Are you monitoring your wellness?

Do so by completing this checklist. Put a checkmark when the statement applies to you.

General Information

_____ I am aware of diseases that run in my family

_____ I know what type of illnesses I have had

_____ I can explain the types of diagnostic test I have had

_____ I know what type of treatment I have had

_____ I know the story of my birth

_____ I spend time with people much younger or much older than myself

_____ I have supportive family and friends

_____ I like school

_____ I am involved in extra-curricular or community activities

_____ I am a lifelong learner

_____ I can cope with stress

_____ I laugh easily

_____ I know how to relax

_____ I sleep well

_____ I like myself

_____ I consider how my actions will affect others

Nutrition and digestion

_____ I eat a variety of foods

_____ I limit my fast food intake

_____ I choose low fat items in my daily diet (e.g. low fat dressing, low fat milk, etc.)

_____ I include high fiber foods in my diet (e.g. whole wheat breads, fruit with peels)

_____ I eat at least 5 servings of fruit and vegetables a day

_____ I have at least 3 serving of milk products per day (e.g. milk, cheese, yogourt, etc.)

_____ I have at least 5 servings of grain products per day (e.g. toast, cereal, pasta, etc.)

_____ I have at least 2 servings of meat and alternatives (meat, eggs, peanut butter, etc.)

_____ I know what a single serving size is for most food item

_____ I limit my junk food intake

_____ I taste my food before I add salt

_____ I limit my salt intake

_____ I limit my sugar intake

_____ I make sure that I get enough iron and calcium in my diet

_____ I don't drink alcohol

_____ I don't go on fad diets

Transportation and respiration

_____ I maintain a healthy body weight by balancing regular physical activity and healthy eating

_____ I get 20-30 nonstop minutes of moderately intense exercise 3 or more time a week

_____ If I am unable to do 30 minutes of activity, I am still active in 10 to 15 minutes sessions throughout the day

_____ I do activities to make myself more flexible

_____ I do activities to make myself stronger

_____ I do activities to improve my cardiovascular fitness

_____ I know if my blood pressure is in a normal range

_____ When I exercise, my heart rate is in the target zone

_____ I avoid the dangers of smoking

_____ I avoid the dangers of drug

Excretion and waste management

_____ I know the signs of urinary tract infection

_____ I drink 6 to 8 glasses of non-caffeinated drinks a day (water, juice, milk, etc…)

Protection and control

_____ I stay current on necessary immunizations

_____ I do self-exams (breast and testicular)

_____ I wear seat belt in a car

_____ I only travel with sober driver

_____ I wear a helmet when riding (bicycle, motorcycle, snowmobile, etc…)

_____ I wear safety gear when participating in sports

_____ I practice abstinence

_____ I practice safe sex

_____ I wear sunscreen

_____ I follow directions for any medications that I take

_____ I go for regular physical examinations

_____ I go for eye tests

_____ I don't speed

Exit Slip: Answer the following questions and hand it in by the end of class

- What is wellness?
- What is my current level of wellness or health?
- What things do people do to promote wellness?
- What other things could I do to improve my own health?
- How do my personal choices related to my own health, affect others around me (eg: family, community)

Homeostasis

A degree of luck: How did a 13-month-old baby come back to life after being 'frozen solid'? Tim Radford

Don't try this at home, folks: the Lazarus effect is a capricious one. The 13-month-old Canadian baby who came back to life this week, after apparently freezing to death, was lucky. Erika Nordby, who somehow toddled out of the backdoor of a house in the middle of the night in sub-zero conditions - in only a nappy - was "frozen solid" when her mother Leyla found her a few hours later. But Erika had "died" at the right temperature (the air temperature was minus 24C; her body temperature had gone down to 16C). And she was a baby.

The membranes of the cells of a baby's tissue are just that much more flexible, according to Nancy Rothwell, a physiologist at the University of Manchester, and are more likely to survive the formation of ice fragments within them. "But the big thing is being exactly the right temperature, and that was absolutely luck," she says.

Freezing is very, very dangerous: lower the temperature and the blood starts to clot, which can lead to kidney damage (babies once again are much more likely recover). But some other things go your way. Oxygen requirements fall dramatically off as body temperature falls. So lower the temperature in a controlled way - they do it on the operating table every day - and there can be virtually no circulation, and virtually no heartbeat for a period, yet the brain will survive.

People with severe head injuries who have fallen into snow and frozen a bit have survived when others at room temperature have died. This has been so noticeable that doctors have tried chilling head injury victims to enhance their survival. Once again, when it works, it tends to work for the young; the older ones get kidney and cardiovascular problems. But the ones who survive this are more likely to recover from brain injury. At a lower temperature, the oxygen requirement falls 10-fold.

First the fingers and toes go numb, and then the limbs, because the body reacts to keep the vital organs warm: this is the core temperature at the heart of human survival. Oxygen consumption falls, blood thickens, fluids retreat to the centre, the kidneys work overtime: people who are cold become conscious of a need to urinate.

At 31^{o}C (well below normal body temperature) hallucinations begin. Nazi doctors experimenting with cold water baths at Dachau established death at a core temperature of about 25C. But there have been dramatic tales of children surviving at far lower temperatures. In 1994, a two-year old girl in Saskatchewan was found with her limbs frozen solid, her core temperature at 14C.

She lived.

The same principle keeps hibernating polar bears alive through the long Arctic night. "They lower their body temperature, the heart rate goes down to say, two a minute, and they manage to survive because they have such low requirements," says Prof Rothwell. The mammalian machinery that keeps bears going as a matter of evolutionary course could also occasionally work its magic for humans caught in the snow.

"Most enzyme activities in the body double with every 10C change. So if you drop by 10C you have halved all chemical reaction, and if you drop 10C more you halve again. Probably if they were around 5C or 8C core, they could survive. There is a lot of luck involved, being at the right temperature, after cooling at the right rate, and then rewarming at the right rate - and the risk was in the rewarming. But it can happen, and it has happened. They were clinically dead, of course, by the criteria we used, but not obviously really dead because they could function again."

In her 1998 televised Royal Institution lectures, Prof Rothwell lowered a PhD student into freezing water to make a point about physiology. She also pointed to Canadian frogs that did, literally, freeze.

"They were frozen solid in the ice, and then they gradually thawed and just woke up. A key thing with the ability to cool - animals or people - is the fluidity of their membranes, so that you don't get fracture. It seems likely that animals that survive very low temperatures - ice fish and so on - have very high levels of polyunsaturated fats in their membrane. They also have antifreeze type things in their blood."

And, she points out, the refrigerator and the ice bucket are now routinely called in to keep life going. "Hearts for transplant are transported in ice, and other organs," she says.

Great interactive activity on homeostasis:

- *http://www.teachersdomain.org/resource/tdc02.sci.life.reg.bodycontrol/*

Questions:

1. What role did luck play in the survival of the 13-month old baby and 2 year-old?

2. Why wouldn't an adult with a body temperature lowered to 14-16C be likely to survive?

3. What are the practical applications of the knowledge of the effects of reduced core body temperature?

Word Splash:

Draw a line between the words you think are connected to each other. In a phrase, explain their connection

Internal balance

Death

Fluctuation

Normal range

Body systems

Body temperature

Interaction

Blood pressure

Negative feedback

Body systems

Blood pH

Thermoregulation

Waste management

Osmoregulation

Changes in environment

Glucose concentrations

Homeostasis

Introduction

At any given time our body is working to maintain its internal physiological environment in a stable state, or a constant internal balance. The example that comes readily to most people's minds is our relatively constant body temperature. Think about the adjustments your body must make to maintain this constant body temperature during an everyday activity such as walking to school on a brisk winter morning in Manitoba.

A Cold Walk

Before leaving the house you put on your winter outerwear – boots, mitts, hat, scarf and parka. The increased amount of clothing traps body heat and you begin to sweat as your body tries to cool down. As you leave the house and enter the cold winter air your exposed cheeks feel cold. Near the end of the walk you notice your toes and fingers beginning to feel numb. You're late so you run the rest of the way to school. When you arrive you're glad to find the run has warmed up your fingers and toes, however, as you walk through the hallway to your locker you find yourself beginning to sweat again. You remove your winter outer wear at your locker and head to class. A few minutes later you find yourself becoming cold and you begin to shiver as your body tries to warm up.

This example shows how your body works to maintain one specific aspect of its internal environment - a body temperature of approximately 37 degrees Celsius. In fact, if your body fluctuates too much from this temperature, it could lead to death. Homeostasis is the ability of the body to maintain its internal environment within acceptable ranges despite the changing external environment.

In addition to a body temperature of about 37 degrees Celsius, you may be familiar with some other body constants. These include a blood pressure of about 160/106 Kpa , a blood pH near 7.4, blood glucose concentrations at about 100mg/mL. While these "normals" do vary, there is a very limited range within which the body can function and death can result if these normal ranges are exceeded.

In order to function properly, homeostatic mechanisms must allow the body to:

- regulate respiratory gases
- maintain water and salt balance
- regulate energy and nutrient supply
- maintain constant body temperature
- protect against pathogens
- make repairs when injured

Homeostasis depends on the action and interaction of a number of body systems to maintain a range of conditions within which the body can best operate. Because the external environment is constantly changing and homeostatic reactions respond to the change and bring the body back to a given set point, it is often referred to as a dynamic equilibrium. A dynamic equilibrium is a condition that remains stable within fluctuating limits. Many homeostatic reactions begin with the body's sensing of changes in the external environment.

Negative Feedback Mechanisms

Negative feedback systems are an important mechanism used to maintain homeostasis, or dynamic equilibrium. There are many examples of negative feedback systems around us. In your home you set the thermostat to the "normal" temperature you would like your house to stay at. If the temperature drops below this temperature a sensor notes this change and causes the furnace to come back on until the house has heated up to the set temperature. A negative feedback mechanism in your body also makes adjustments to bring things back to within an acceptable range.

Feedback mechanisms have three main components: a sensor, and coordinating centre and an effector. The sensor is responsible for detecting variation in the set point and will send messages to the coordinating centre that will then send a message to a specific effector to rectify any variation from a set point.

Temperature set to 20^{o} C (NORMAL CONDITION)

Internal house temperature drops to 17^{o} C (CHANGE

The thermometer on the thermostat detects drop in temperature (SENSOR)

Thermostat turns on furnace (COORDINATING CENTRE)

Furnace starts and begins to warm house (EFFECTOR)

Temperature returns to 20^{o} C (NORMAL CONDITION)

The coordination and regulation of homeostasis through negative feedback mechanism in the body is most often achieved by a combination of nervous and hormonal mechanisms.

Homeostatic Systems

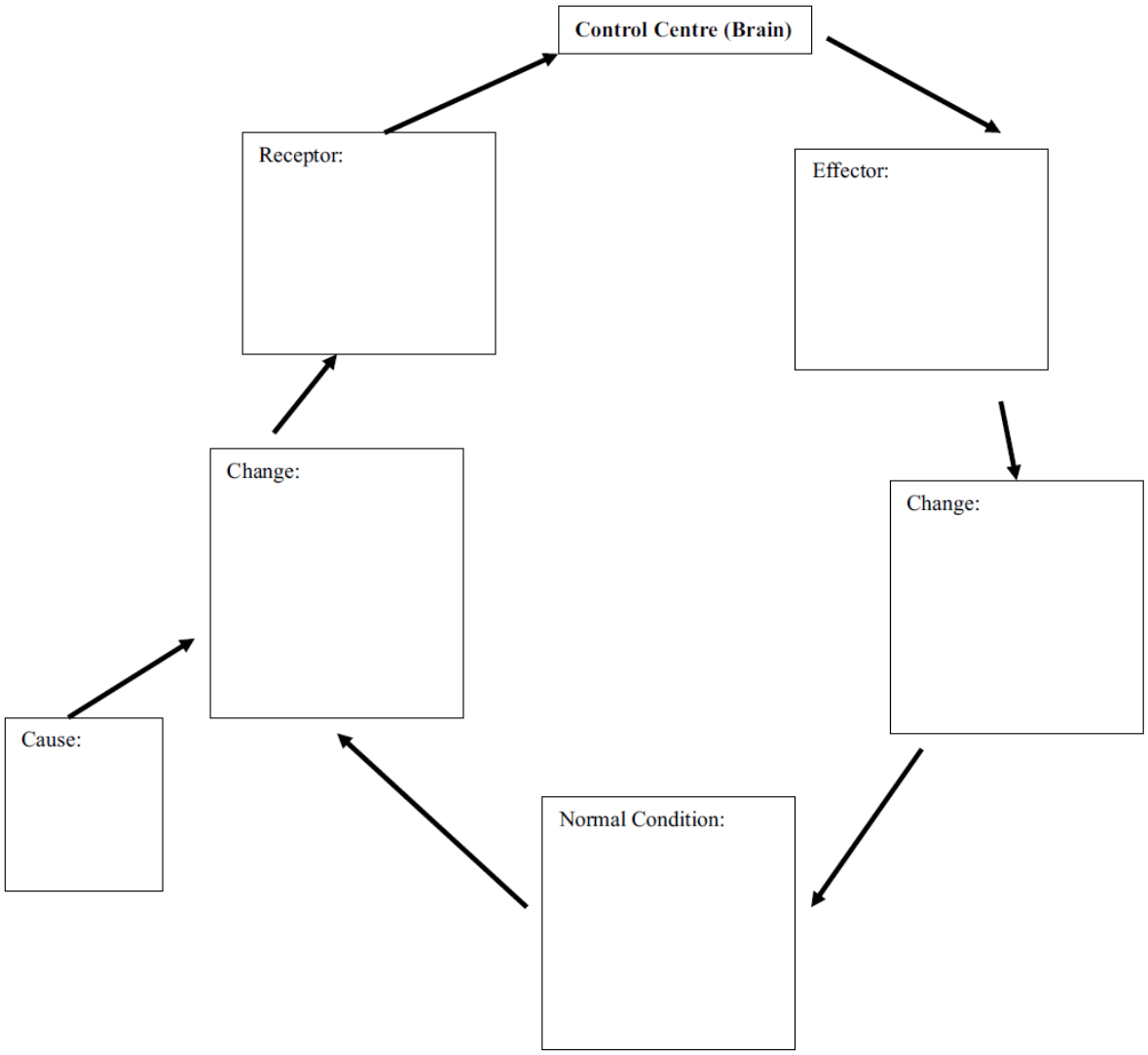
Three important homeostatic systems in the human body that depend upon negative feedback mechanisms to maintain equilibrium are: thermoregulation (the maintenance of body temperature), osmoregulation (water balance) and waste management.

Thermoregulation is the ability to maintain a constant body temperature. The constant body temperature for humans is 37 degrees Celsius, although there are individual variations. Humans are able to maintain a constant body temperature despite changes in the external environmental temperature (endotherm). The hypothalamus, a part of the human brain, is the coordinating centre for body's temperature regulation. When there is a change in the external temperature the hypothalamus will release hormones that target specific effectors such as sweat glands.

Osmoregulation is the ability to maintain a constant water balance. For the body to maintain water balance, humans must consume fluids daily. A drop in fluid intake by as little as 1 % of your body mass will cause thirst, a decrease of 5 % will result in extreme pain and collapse, while a decrease of 10 % often results in death. The hypothalamus is the coordinating centre for water balance and can detect changes in the fluid concentrations of the blood. When the fluid concentration of the blood decreases (dehydration) then the hypothalamus will trigger the release of a hormone to increase water absorption.

Waste management, or the ability of the body to rid itself of harmful wastes, is essential for the maintenance of homeostasis. One example of a harmful waste product is the ammonia produced during the breakdown of proteins. Ammonia is extremely toxic to the body. The liver is most important organ involved in the elimination of ammonia. Various organs, such as the kidneys, lungs, skin and stomach, as well as the liver, are involved in the elimination of various other waste products.

Negative Feedback Mechanisms



Homeostasis questions:

1. Define "dynamic equilibrium."

2. Describe what a sensor, coordinating center, and effector are.

3. What is the hypothalamus a coordinating centre for?

4. Why is osmoregulation so important?

5. Give three examples of organs that are involved in the elimination of wastes.

Discovery Channel (2002) – Survival in Ice with Dr. Gordon Giesbrecht

Questions:

1. What body temperature is clinical hypothermia?
2. What body temperature is mild hypothermia?
3. What body temperature is moderate hypothermia?
4. What body temperature is severe hypothermia
5. What was Dr. Gordon Giesbrecht's and John's first priority when getting out of the water and why?
6. Do you think that this YouTube video is reliable? What evidence can you use to support your claim?
7. What are two tips that you can take with you after watching this video?

http://youtube.com/watch?v=DyBVWrqvkEg

Perspiration and Cooling

This task can be used with middle-level or high school students. The equipment used is simple, and available in almost any science classroom. Perspiration, or sweating, is the loss of fluid through normal skin in humans. Fluid loss occurs from sweat glands secreting, or by diffusion through other skin structures. However, we seldom think of this process in terms of its implications for the temperature equilibrium of our bodies. Since science is perceived to be useful and relevant when we use its concepts and principles to explain phe and observations that personally affe this task challenges students to use concepts to explain a phenomena they perience daily—making the task aut and relevant.

This task requires students to dem strate competence with several skills: co lecting data, graphing data, and formulating conclusions. The scoring guide is based on these skills with spe criteria that relate to this activity.

Perspiration and Cooling
Student Task Sheet

Task: Collect and analyze data on perspiration.

Materials per student:

- 2 test tubes
- eye dropper
- newspaper strips, width the length of the test tubes
- hot water in Styrofoam cups
- paper towels
- room temperature water
- 4 rubber bands
- timer or clock
- test tube rack
- thermometer
- funnel

Background:

When you get hot you perspire, and this is your body's way of maintaining normal temperature. But how effective is perspiration in maintaining your body temperature?

Directions:

1. Examine the apparatus at this station.
2. Place the test tube rack on a paper towel. Prepare your test tubes by wrapping each one with a strip of newspaper. Use two rubber bands to hold the paper on the test tubes.
3. Quickly fill both test tubes with hot water. Take care not to spill any water on the newspaper.
4. Place one thermometer in each test tube. Record the starting temperature for each test tube on a data table. In the next step, one (1) test tube becomes the "wet" test tube and one (1) remains dry.
5. Use the eye dropper to quickly wet the newspaper of one (1) of the test tubes with room-temperature water. The newspaper on the test tube should be completely saturated with water.
6. Measure the water temperature in each test tube at intervals of one minute for the next 12 minutes, and record your measurements in a data table you construct.
7. Construct a line graph of your data, and answer questions 8–13.
8. From your data table, what is the temperature of the water in both the wet and dry tubes at 6 minutes?
9. From your graph, what is the temperature of the water in both tubes at 9.5 minutes?
10. Use your graph to predict what the temperature would be in the dry tube after 15 minutes. Using complete sentences, suggest an explanation for your prediction.
11. Using complete sentences, describe and compare the cooling patterns of the two test tubes.
12. Using complete sentences, explain what causes the differences in water temperature between the water in the two tubes.
13. Using complete sentences, describe what comparison you can make between the effect of perspiration on the skin of the human body, and the newspaper on the wet test tube. Relate your answer to body temperature control.

Cell Theory:

Assignment: Microscope lab handout (to be handed out)

Modern Cell Theory (Virchow)

- "Every animal appears as the sum of vital units, each of which bears in itself the complete characteristics of life"
- **The three principles of modern cell theory are:**
  1) **_____ - Every living organism is made up of 1 or more cells**
  2) **_____ - The smallest living organisms are single cells, and cells are the functional units of multicellular organisms**
  3) **_____**

General Features of all Cells

1.

i) It isolates the cell's contents from the external environment
ii) It regulates the flow of materials into and out of the cell (acquiring nutrients and expelling wastes)
iii) It allows interaction with other cells

2.

1) Each cell stores a genetic blueprint for the entire organism in the form of DNA (deoxyribonucleic acid)
2) In eukaryotic cells (plants, animals, fungi, protists) the DNA is stored in a separate membrane bound structure called the nucleus
3) In prokaryotic cells (Bacteria and Archaea) the DNA is not separated from the rest of the cell by membranes

3.

- The fluid portion contains water, salts, and assorted organic molecules; it is a thick soup of proteins, lipids, carbohydrates, salts, sugars, amino acids, and nucleotides
- Most metabolic functions occur in the cytoplasm

4.

- To maintain their incredible complexity, all cells must continually acquire and expend energy

5.

- Most cells are small (from 1 to 100 micrometers- millions of a meter)
- Because of the size, the discovery of the cell did not happen until after the invention of the microscope
- Large organisms consist of many small cells because it gives them a much larger surface area through which nutrients can be absorbed and wastes can be excreted (surface area:volume ratio problem)

How do cells get around the Surface Area to Volume problem?

http://www.hillstrath.on.ca/moffatt/bio3a/cellbio/sa-vsoln.htm

Activity:

Work in pairs to estimate the number of cells in your little finger. There are 1000 µm in a millimeter. Assume your finger is a cylinder ($V = 3r^2h$) and that the average size of one of your body cells is 1000 μm^3

Basic Features of Cells Questions

1) Why are cells generally small in size?

2) Cells having a nucleus are referred to as _____ cells and those lacking a true nucleus are called _____ cells.

3) Which does NOT agree with part of the cell theory?
   a. Insects are composed of cells.
   b. Paramecia come from Paramecia.
   c. Bacteria are the smallest possible organisms
   d. Minerals are important for good health.
   e. Spontaneous generation can not occur.

4) The DNA in a prokaryotic cell is contained in the _____ region of the cytoplasm.

5) Why do you think a cell membrane is important?

Cell Structure Introduction

In preparation for learning more about the cell, define the following words and label them on cell. You will need to use a separate piece of paper so you have enough room to define the words. Note: Most words are on both the plant and animal cell, but some are only on one or the other.

Structures:

Nucleus:

Centrioles:

Nucleolus:

Mitochondrion:

Nuclear membrane:

Ribosome:

Cytoplasm:

Rough/ Smooth endoplasmic reticulum:

Golgi body/apparatus:

Lysosome:

Chloroplast:

Cell wall:

Vacuole:

Plasma membrane:

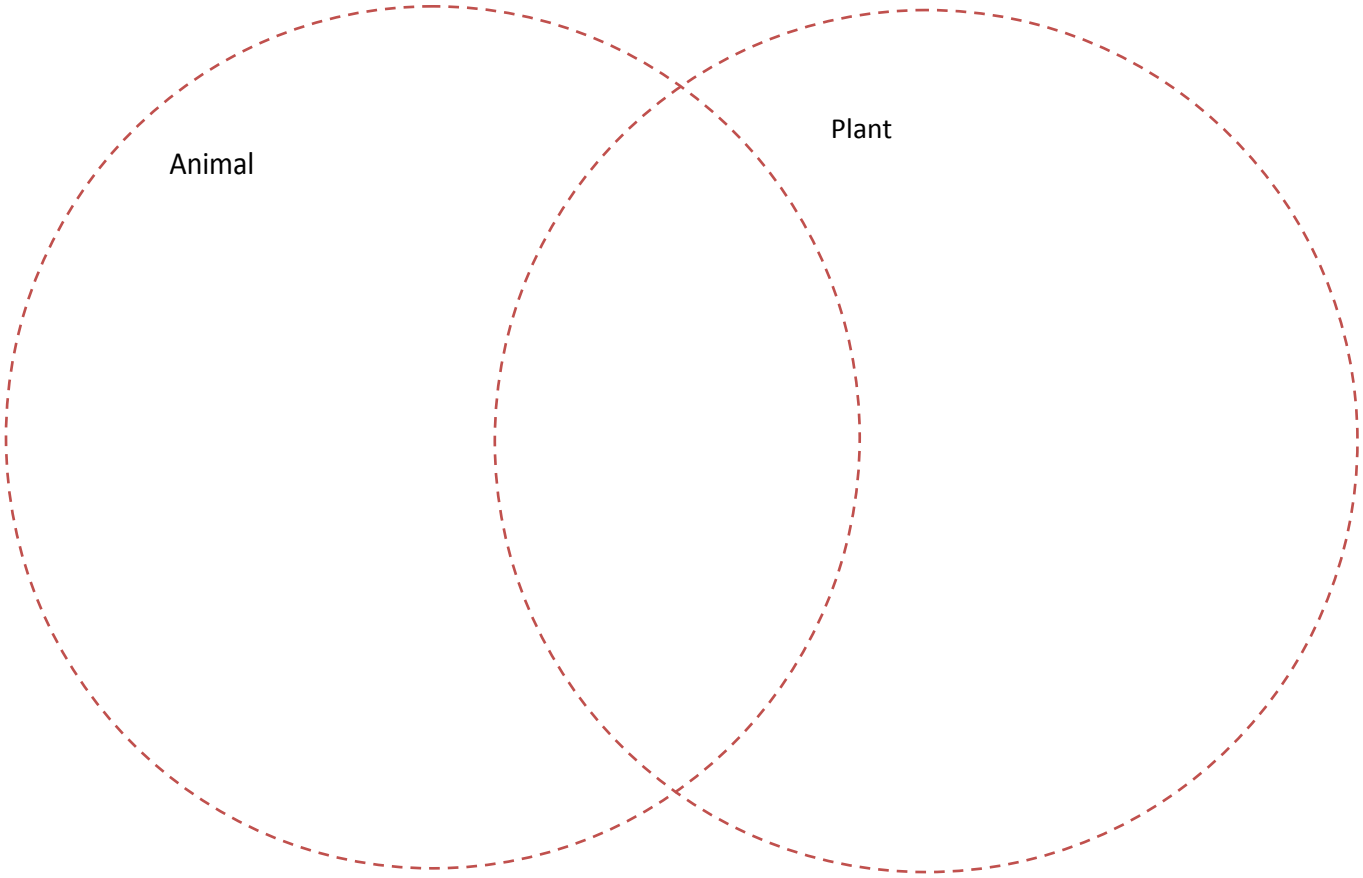
Central vacuole:

Animal Cell

Plant Cell

VENN Diagram:

Which organelles are common to both plant and animal cells, and which are unique to each? Write the names of the organelles of animal cells in the *animal* circle and the organelles of plant cells in the *plant* circle. Write the organelles that occur in both cells in the space where the two circles overlap.



Organelle Bank (use these words in the Venn diagram):

Nucleus, Mitochondria, ribosomes, endoplasmic reticulum, centrioles, Golgi, lysosomes, cell wall, chloroplasts, plastids, central vacuole.

Biomolecules:

Biomolecules are large organic compounds used by all living organisms. All biomolecules contain carbon, hydrogen, and oxygen. They may also contain nitrogen, phosphorus, sulfur, or iron.

It is important to learn about the building blocks of the matter that makes up our body in order to fully understand our body's processes. Learning this material well now will help you in the rest of the course.

The 4 main types of biomolecules include:

i) _____

ii) _____

iii) _____

iv) _____

Great Website to practice Biochemistry:
http://www.wiley.com/legacy/college/boyer/0470003790/animations/animations.htm

Carbohydrates:

- All are composed of carbon, hydrogen, and oxygen in a ratio of 1:2:1
- Used as an energy source in living organisms
- The formula of glucose is normally given as C6H12O6, which is the same for all six-carbon monosaccharides.
- Fructose and galactose differ from glucose in the internal arrangement of the molecule.

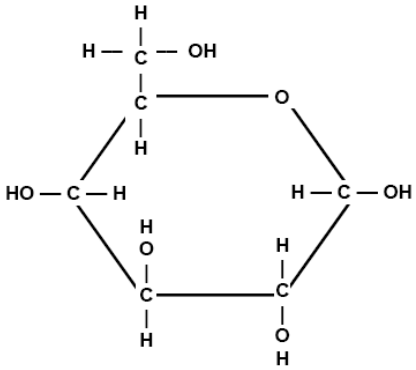
Three types:

1. **Monosaccharides – simple sugars**

i) Glucose _____

ii) Fructose _____

iii) Galactose _____



GLUCOSE - The structural diagram of **glucose.** Glucose differs from fructose and galactose only in the arrangement of the elements

2. Disaccharides – compound sugars

i) _____ $C_{12}H_{22}O_{11}$

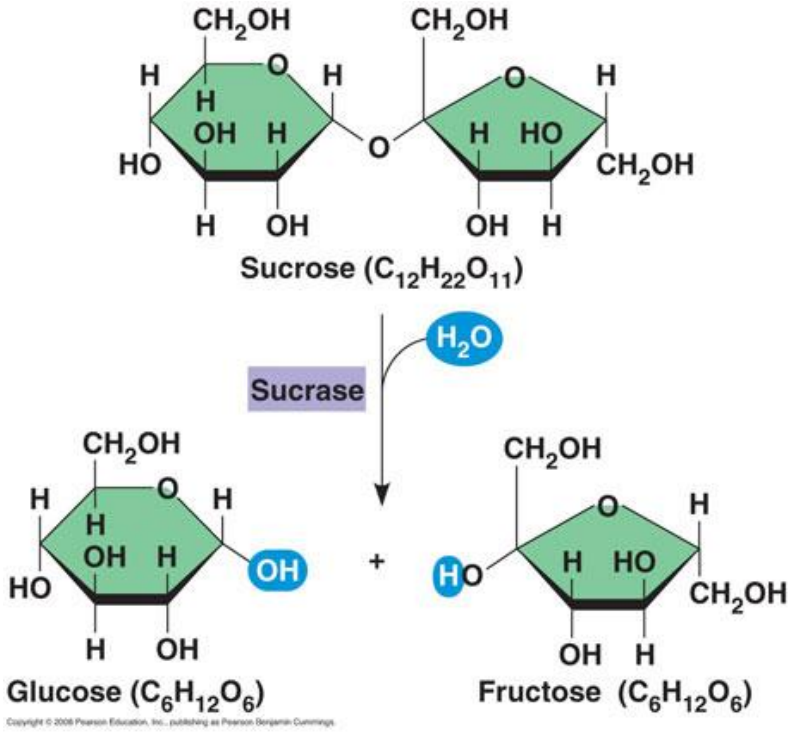
- Produced by starch digestion present in malt. Composed of two molecules of _____

ii) _____ _____

- Table sugar, produced in sugar cane and beets. Composed of _____ and _____

iii) _____ _____

- Milk sugar, composed of _____ and _____



Sucrose - composed of glucose and fructose. With the addition of water and in the presence of an enzyme, it can be broken down into its original monosaccharides. This is called **hydrolysis.** We will learn more about this in digestion

*Note:

All monosaccharides have the formula **$C_6H_{12}O_6$**

All disaccharides have the formula **$C_{12}H_{22}O_{11}$**

- These molecules are known as structural isomers. They have the same molecular formula but different structural formula

3. Polysaccharides – Complex Sugars

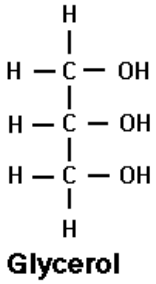
_____, _____, and _____ are examples of complex carbohydrates. These occur when many monosaccharides are bonded together.

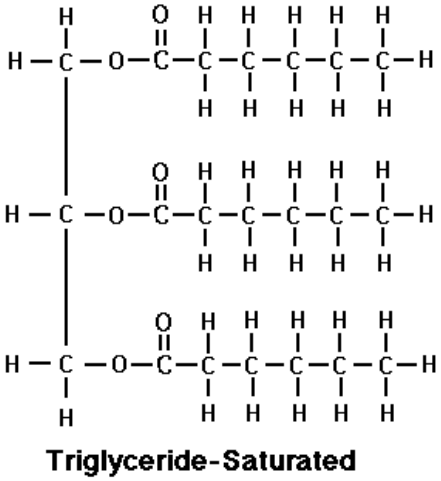
Lipids:

Lipids (_____) are made up of the following:

i) _____

ii) _____





Because three fatty acids are attached to one glycerol, a lipid is sometimes referred to as a **triglyceride**

Function of Lipids:

- Insulation from cold
- Protection of internal organs from injury
- Energy as a food source
- Structural (waxes)
- Dissolves fat soluble vitamins

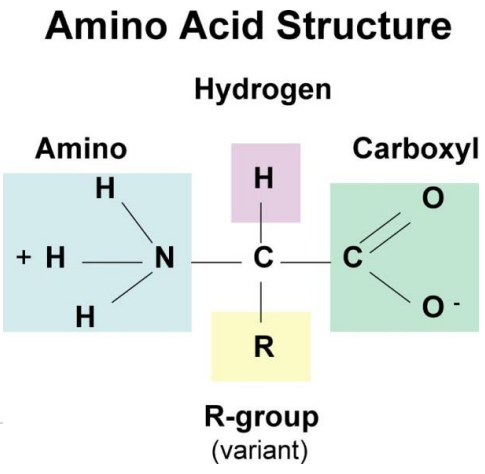
Unsaturated Fats vs. Saturated Fats:

We've all heard of the difference between "good" fats and "bad" fats. How exactly do they differ?

Saturated fats (animal)	**Unsaturated Fats (vegetable)**

Proteins:

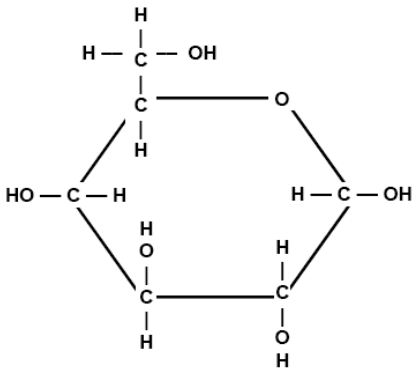
- Examples include meat, cheese, legumes, egg whites, enzymes, and hormones
- Proteins are composed of chains of **amino acids.**
- There are 20 different amino acids. Our body is able to synthesize 10 of these. The remainder must come from our diet.
- Proteins such as hormones and enzymes carry out specific functions
- Other proteins such as those in muscle, bone, nail, and connective tissue carry out structural functions



Biomolecules Questions:

Carbohydrates

1. What elements must be contained within all biological organic compounds?
2. What is the general formula for a monosaccharide?
3. What is the general formula of a disaccharide?
4. Name and give 3 examples of a monosaccharide.
5. Name and give 3 examples of a disaccharide
6. What are polysaccharides? Name three
7. Give the molecular formula for each of the following:



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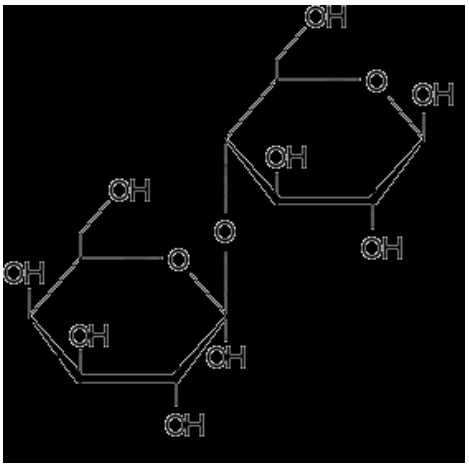


_____

Lipids:

8. List three roles that lipids play in living systems
9. Give two major sources of fats in our diet
10. Fats are made of three _____ and one _____
11. Explain the difference between saturated and unsaturated fats?

Proteins:

12. Name two functions of proteins.
13. What are the building blocks of proteins?
14. Why do we need to eat protein?

Cell Homeostasis – The Cell Membrane

Activity: With a partner, discuss the following questions. The answers are not necessarily in your notes. THINK ABOUT IT!!!

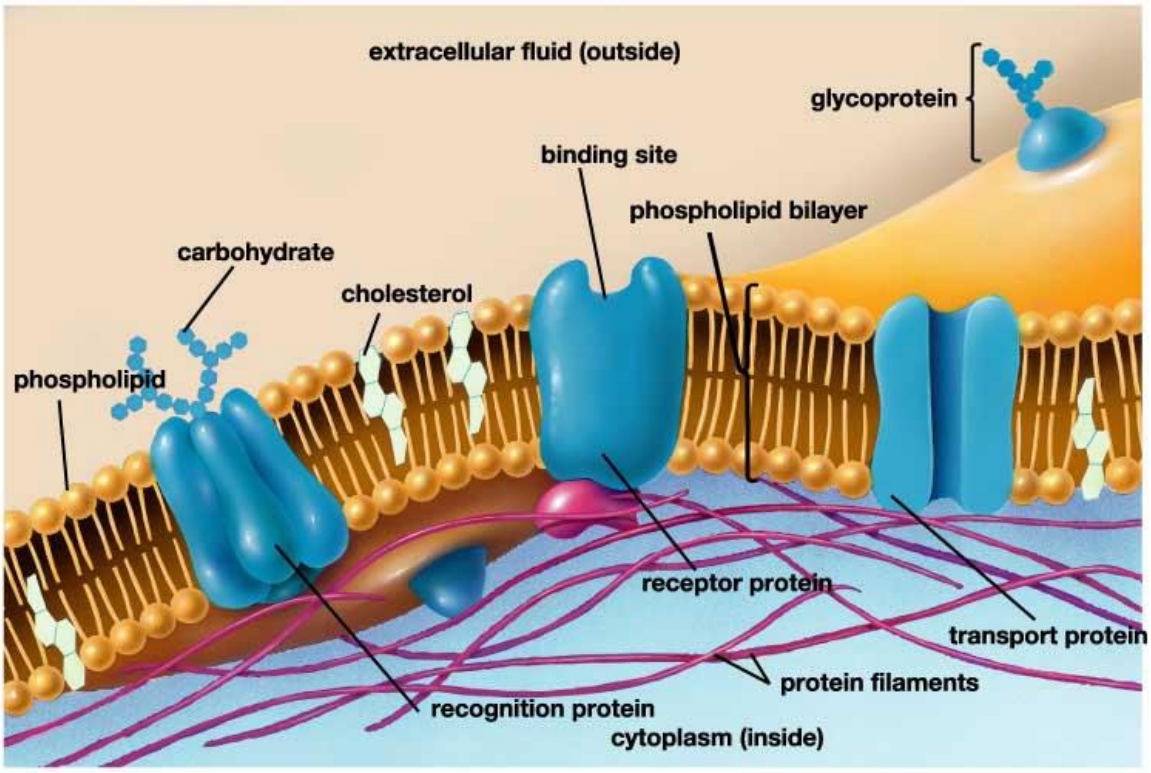
1. Explain how each method of transport contributes to homeostasis of the cell.
2. Draw each method of transport.
3. Why are you thirsty after having eaten a bag of chips?
4. Why does grass die in the spring after the snow melts?
5. Why do your fingers and toes wrinkle up after a bath or after swimming?
6. Why is your thirst not as satisfied with coffee or coke as with water?
7. Why do we sweat, on a cellular level?
8. How does a grape become a raisin? What happens?

All living cells have a plasma membrane that encloses their contents. The plasma membrane has two functions;

1. Forms a boundary between the cell's internal environment and its external environment. It also holds the cell contents together and keeps unwanted substances from entering.
2. Controls the flow of substances into and out of the cell. It is said to be **selectively permeable**, allowing only certain substances such as nutrients and other essential molecules to enter the cell and allowing waste materials to leave the cell. Small molecules, such as oxygen, carbon dioxide, and water are able to pass freely across the membrane by diffusion, but the passage of larger molecules, such as amino acids and sugars, are carefully regulated.

Electron microscope examinations of cell membranes have led to the development of the **fluid-mosaic model**. The fluid mosaic model of the cell membrane has two layers of phospholipid (fatty substances) molecules in

which protein and cholesterol molecules are embedded. This is often referred to as a **phospholipid bilayer.**



Plasma Membrane

Each of the protein molecules is folded into a compact globule and inserted with the others at random intervals into the membrane. Some of the protein molecules extend completely through the membrane. Others are located in either the outer surface or the inner layer of the membrane.

There are different types of membrane proteins that can be found imbedded in the cell membrane. They are channel proteins, carrier proteins and receptor proteins. The functions of these proteins are described in their names. **Channel** proteins allow particular molecules to cross the membrane by providing a channel for it to pass through. (think of the square and round pegs thru a board game for small children -- square pegs can't go through round holes.) **Carrier** proteins selectively interact with specific molecules so that they can cross the membrane. For example, a glucose carrier protein will only allow glucose through, not other molecules. **Receptor** proteins have a shape that allows a specific molecule to bind to it. The binding of the molecule (e.g. hormone) usually changes the shape of the protein and to bring about some response in the cell. They function like a padlock. When a certain molecule (key) comes in contact with the portion on the exterior of the cell membrane, information about the environment is transferred into the cell, which triggers a response by the cell. Some receptor proteins have carbohydrates attached to them and are referred to as **glycoproteins**. These proteins also act as ID tags which give each cell its identity.

Cholesterol molecules are also embedded in the cell membrane. They function to prevent the phospholipid molecules from "sticking" together, allowing fluidity of the membrane so that molecules can pass through. We typically associate cholesterol with hardening of the arteries and other cardiovascular disease. However, we can see that cholesterol also plays an important function in the body.

Phospholipid bilayers are formed because they have **hydrophilic heads** (like water) and **hydrophobic tails** ("afraid of" water).

Cell Membrane Questions:

1) How do cell membranes contribute to homeostasis (very important!)?

2) What is a phospholipid

3) How does the phospholipid bilayer form?

4) Explain the functions of channel proteins, receptor proteins and glycoproteins.

5) What is the function of cholesterol in your cell membrane?

6) What are the two functions of cell membranes?

7) Why is the cell membrane referred to as a fluid mosaic?

- Do build a membrane activity

Transport Across Membranes

Important definitions:

Fluid: is any substance that can move or change shape in response to external forces without breaking apart (liquids and gases are fluids).

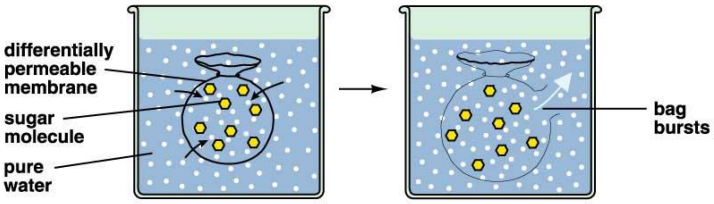
Concentration: the number of molecules in any given unit of volume

Gradient: the physical difference in properties, such as temperature, pressure, electrical charge or concentration of a particular substance between two adjoining regions.

Methods of Transport

1. Passive Transport - movement of substances across a membrane, going down a concentration gradient. Does NOT require the cell to expend energy.

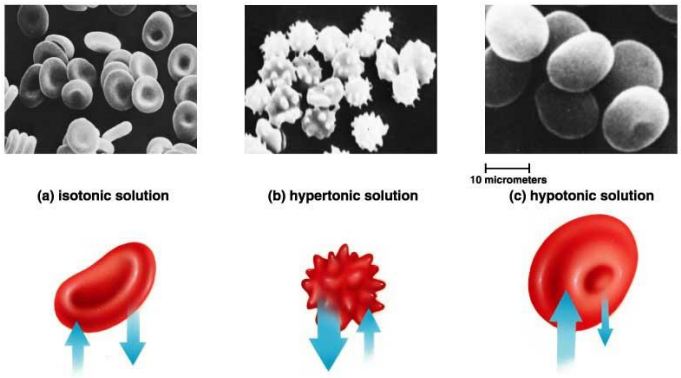
- **Simple diffusion:** diffusion of water, dissolved gases, or lipid-soluble molecules through the phospholipid bilayer of a membrane.
- **Facilitated diffusion:** Diffusion of (usually water-soluble molecules) through a channel or carrier protein.
- **Osmosis:** Diffusion of water across a selectively permeable membrane that is, a membrane that is more permeable to water than dissolved molecules.



i. *Isotonic*: a solution which has the same concentration of dissolved particles as the cytoplasm of a cell.

ii. *Hypertonic*: a solution that has a higher concentration of dissolved particles than the cytoplasm of a cell.

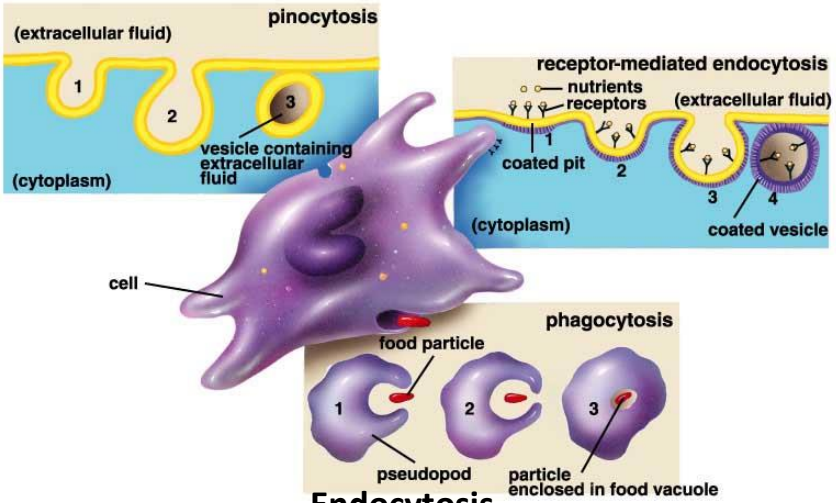
iii. *Hypotonic*: a solution that has a lower concentration of dissolved particles than the cytoplasm of a cell.



2. Energy-requiring Transport - movement of substances into or out of a cell using cellular energy. (Movement of molecules against the concentration gradient)

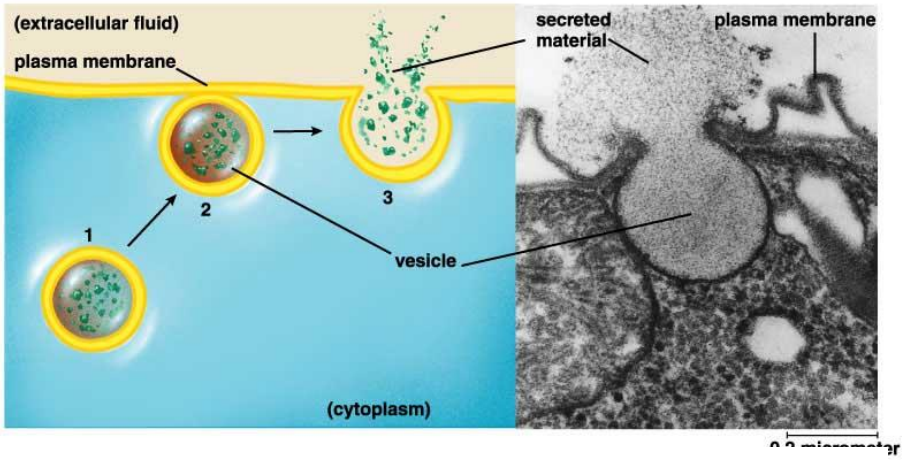
- **Active Transport:** Movement of individual small molecules or ions through membrane-spanning proteins, using cellular energy, usually adenosine triphosphate, ATP, (ATP receptor inside the cell).
- **Endocytosis:** Movement of large particles, including large molecules or entire microorganisms, into a cell by engulfing extracellular materials, as plasma membrane forms membrane-bound sacs that enter the cytoplasm.

    i. *Pinocytosis*: the process of engulfing liquid food material and bringing it inside the cell
    ii. *Phagocytosis*: resembles pinocytosis, but in this case forms larges vesicles and some form of solid food is taken into the cell. (ex. White blood cells protect us from disease by phagocytizing bacteria that enter our bodies)



Endocytosis

- **Exocytosis:** Movement of materials out of a cell by enclosing the material in a membranous sac that moves to the cell surface, fuses with the plasma membrane, and opens outside, allowing contents to diffuse away.



Exocytosis

Lab: *Do the osmosis lab (Handout)*

Transport across Membranes questions:

1) Make a concept map containing the following words:
   - Active transport
   - Passive transport
   - Endocytosis
   - Pinocytosis
   - Phagocytosis
   - Osmosis
   - Facilitated diffusion
   - Diffusion
   - Exocytosis
   - High concentration to low concentration

2) Why do the heads of the phospholipids point out and the tails point to each other?
   a. The tails are nonpolar and form hydrogen bonds with each other.
   b. The tails are repelled by the aqueous environment.
   c. The heads are attracted to the water inside and outside
   d. a and c.
   e. b and c.

3) Within the fluid mosaic of a plasma membrane, what is the role of transport and channel proteins?
   a. They prevent passage of amino acids.
   b. They allow movement of salts and sugars through the plasma membrane.
   c. They may set off cellular changes such as cell division or hormone secretion.
   d. They are cell-surface attachment sites.
   e. They identify the cell

4) When substances move through a plasma membrane and down gradients of concentration this is called:
   a. Active transport
   b. Passive transport
   c. Pinocytosis
   d. Exocytosis
   e. Entropy

5) For diffusion to occur, there must be:
   a. a membrane
   b. a gradient
   c. water
   d. ATP
   e. all of these

6) Molecules which permeate a plasma membrane by facilitated diffusion:
   a. Require an expenditure of energy
   b. Require the aid of transport proteins
   c. Move from an area of low concentration to an area of high concentration
   d. Do so much more quickly than those crossing by simple diffusion
   e. All of these

7) In reference to diffusion, "passive" really means:
   a. without a membrane
   b. in the air
   c. no gradient
   d. very slowly
   e. no energy required

8) If red blood cells are taken from the body and placed in a hypertonic solution, what happens to the cells?
   a. The cells swell and burst because water moves into the cells.
   b. The cells shrivel up because water leaves the cells.
   c. The cells remain unchanged due to equal solute concentration inside and outside the cells.
   d. The cells remain unchanged due to equal water concentrations inside and outside the cells.
   e. They become white blood cells.

9) Active transport requires:
   a. Transport proteins
   b. ATP
   c. A membrane
   d. A gradient
   e. All of these

10) What is active transport?
   a. Diffusion of molecules within a cell.
   b. Movement of molecules into or out of a cell against a concentration gradient.
   c. Movement of molecules into or out of a cell down a concentration gradient.
   d. The movement of molecules into or out of a cell using special proteins and not requiring an expenditure of energy.
   e. Rapid movement of molecules in a solution.

11) Solutions that cause water to enter cells by osmosis are termed:
   a. Hypertonic
   b. Isotonic
   c. Hypotonic
   d. Permeable
   e. Hydrophilic

12) The blood plasma of a human becomes _____ to their red blood cells if they drinks saltwater.
   a. hyposmotic
   b. isotonic
   c. hypotonic
   d. hypertonic
   e. hydroponic

13) The process whereby white blood cells engulf bacteria is termed:
   a. Adhesion
   b. Exocytosis
   c. Pinocytosis
   d. Phagocytosis
   e. Ingestion

14) When a red blood cell is placed in an isotonic solution, which of the following will occur?
   a. The cell will shrivel.
   b. The cell will swell and burst.
   c. The cell will shrivel, and then return to normal.
   d. The cell will swell and then return to normal.
   e. Nothing.

Energy…. ATP

Energy = the ability to do _____

The energy living organisms use is called _____ **energy**.

- Examples:
  - energy plants use to _____
  - energy animals use for _____ or maintaining a constant body temperature.
- Free energy becomes available in an organism when energy _____in one form _____ to another form during chemical reactions.
- Organisms store energy in the organic molecules. This energy is known as _____energy.

_____ cells require a _____ source of energy to do 3 kinds of work, without a constant source of energy, living systems would not survive.

- _____ - includes _____ and breaking down large complex molecules such _____.
- _____ - involves the movement and _____of materials or nutrients for building complex molecules or growth of the cell.
- _____ - involves movement such as _____ contractions.

Energy Storage in Living Organisms

_____ energy can be used in living organisms, it is _____into a form which the organism can _____.

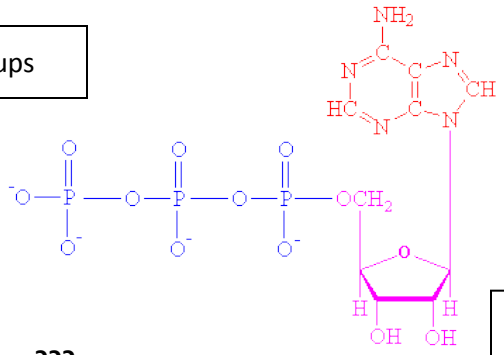
The special carrier of energy is the molecule _____ _____, or ATP.

The ATP molecule is composed of three components (see diagram below).

1. At the centre is a sugar molecule, _____ (the same sugar that forms the basis of DNA).
2. Attached to one side of this is a base (a group consisting of carbon and nitrogen atoms); in this case the base is _____. Note: Adenine and Ribose together form Adenosine.
3. Attached to the other side of the sugar is a string of _____ groups. These phosphates are the key to the activity of ATP

Phosphate groups

Adenine



Ribose

How does ATP provide energy???

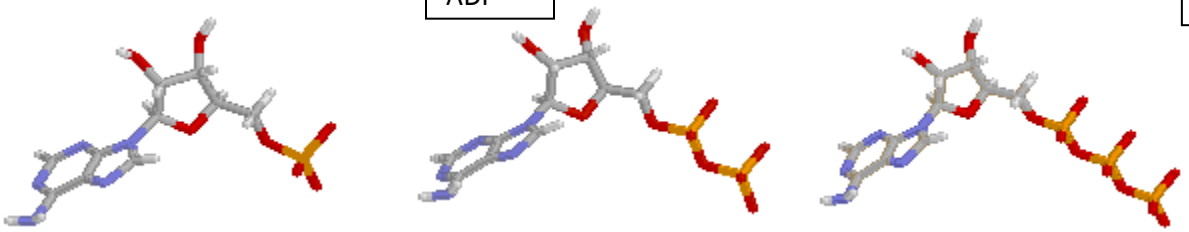
ATP works by _____ the _____ phosphate group (energy is stored in the _____ between the phosphate groups) when instructed to do so. This reaction, loss of a phosphate group, releases energy.

As energy is required, the ATP loses _____ phosphate group, releasing energy to _____ a process such as contracting a muscle. Once the cell has used the energy required, ATP can be _____ by providing an energy source (food).

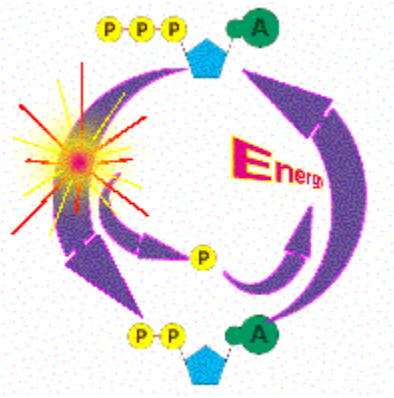
The reaction product is _____**(ADP).** Even more energy can be extracted by _____ a second phosphate group to produce _____ **(AMP).**

ADP

AMP



When the organism is _____ and energy is not immediately needed, the reverse reaction takes place and the phosphate group is _____ to the molecule using energy obtained from _____.



Thus the ATP molecule acts as a "_____battery" molecule, storing energy when it is not needed, but able to _____ it instantly when the organism requires it.

Exit Slip – Do an exit slip on the assigned question

ATP (cut and paste) **Activity**

P
P
P
P
P

Homeostasis and Cell Theory Review

Wellness/Introduction to Biology:

- What is wellness? What can you do to monitor your wellness? Why is learning about wellness important?
- Why is your family history important to learn about?
- What are the five aspects of wellness? (Physical wellness, emotional needs, spirituality, intellectual stimulation, social balance)
- Know and understand the characteristics of living things.

Biomolecules:

- Know what the basic building blocks of lipids, proteins, and carbohydrates are.
- Know the structure and function of lipids, proteins, and carbohydrates
- Know the difference between a monosaccharide, disaccharide, and polysaccharide
- Why is it important to have an external source of protein?
- What is the difference between an unsaturated fat and saturated fat?

Homeostasis:

Be able to give examples of and explain the following:

- Thermoregulation, Osmoregulation, Waste Management
- Effector, Sensor, Coordinating Center
- Negative Feedback/Dynamic Equilibrium
- Hypothermia
- *Article – Degree of Luck

Cell Structure and Function:

- What are the three parts of the cell theory (and know how to apply them)? Who made the cell theory?
- Know and explain the 6 general characteristics of cells.
- Know the functions of the following structures (as well as which cells they occur in)
    - Nucleus
    - Mitochondrion
    - Nuclear membrane
    - Ribosome
    - Cytoplasm
    - Golgi body/apparatus
    - Chloroplast
    - Cell wall
    - Plasma membrane

Cell Membrane and Transport:

- What is a phospholipid / phospholipid bilayer?
- What proteins are involved in the cell membrane? What do they do?
- What is the "fluid mosaic model?"
- What is Passive Transport? Explain the different types of diffusion (simple, facilitated, osmosis)
- What is active transport?
- What are isotonic/hypertonic/hypotonic solutions? Know examples of each
- What are exocytosis/endocytosis/phagocytosis/pinocytosis?
- Diffusion is the movement of molecules from an area of _____ (high/low) concentration to an area of _____ (high/low) concentration

Energy:

- What molecules carries energy in our body?
- How is energy released?