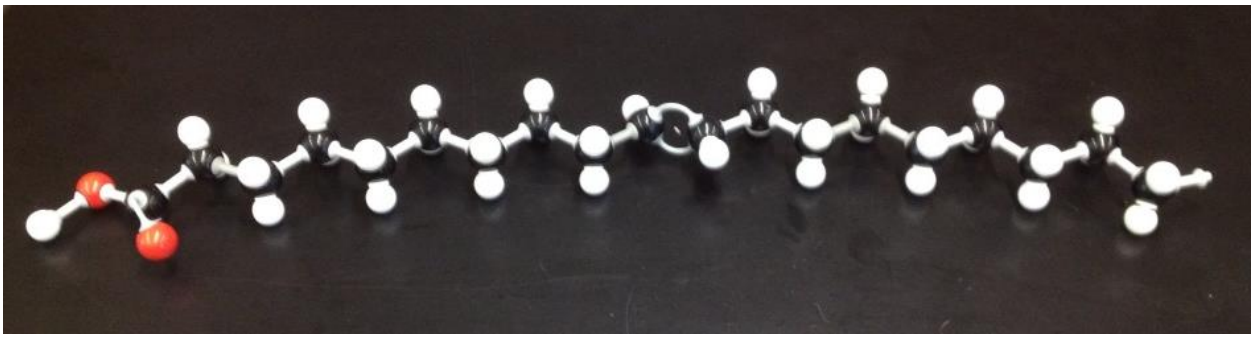
Introduction to Physiology

BIO 130
Laboratory Manual

2017



Dutchess Community College
Department of
Allied Health & Biological Sciences (AHBS)

BIO 130 Laboratory Manual
DCC, AHBS Dept.

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Preface

Format of the BIO 130 Lab Manual

The material in this lab manual is designed to encourage discovery-based learning.

Each Lab is constructed in alternating fact/question/conclusion format so that concepts are presented in reasoned sequence with statements and questions alternating, leading you to make conclusion about a topic.. After performing lab experiments, you will be asked to draw conclusions based on your interpretation of the results. As much as possible, the manual avoids a step-by-step directional approach. Instead, it is hoped that you can discern and anticipate procedures that will give you controlled experimental results. BIO 130 is a course in which it is you develop your best practices – both in terms of scientific knowledge and in study habits. It is hoped you will take these with you to success in your future courses.

The manual is organized by semester week. Each week's front page gives the lecture topics, an overview of the class's lab topics, and specific Assignments, if any. The focus of lab activities will generally correspond and relate to lectures topics. Your professor may use the same Assignments or devise his/her own. Assignments may be supplemented with quizzes.

Table of Contents

Week 14 103-

Lecture topics

see online text: https://openstax.org/details/anatomy-and-physiology

Ch 3: Cell Growth and Division at
https://cnx.org/contents/FPtK1zmh@8.86:6iouz0Jo@5/Cell-Growth-and-Division

- -Cell Cycle
- -Interphase
- -Structure of chromosomes (compare to chromatin)
- -Mitosis and cytokinesis

Cell division: mitosis followed by cytokinesis

- -Phases of mitosis
  - -Prophase, Metaphase, Anaphase, Telophase

Lab 14

Microscopic examination of Mitosis 104
(whitefish, onion root tip slides)

End-of-semester review (notes page) 108

Week 15 109

Final Exams

BIO 130 Course Overview

Required Texts:

1) Timberlake, K. Chemistry (13th edition) – An Introduction to General, Organic & Biological Chemistry. Pearson. ISBN: 013-442135-3

2) BIO 130 Laboratory Manual, Fall 2017 (1st Edition)– Allied Health & Biological Sciences, DCC Publication

3) Online reference (free): https://openstax.org/details/anatomy-and-physiology
   a) Ch 1- Section 1.2 Structural Organization of the Human Body
      https://cnx.org/contents/FPtK1zmh@8.86:Xh_25wmA@7/Structural- Organization-of-the
   b) Ch 1 - Section 1.5 Homeostasis
      https://cnx.org/contents/FPtK1zmh@8.86:8Q_5pQQo@4/Homeostasis
   c) Ch 1 - Section 1.6 Anatomical Terminology
      https://cnx.org/contents/FPtK1zmh@8.86:F-TuqKAF@4/Anatomical-Terminology
   d) Ch 3 - Section 3.5 Cell Growth and Division (cell cycle)
      https://cnx.org/contents/FPtK1zmh@8.86:6iouz0Jo@5/Cell-Growth-and-Division

Assignments:

Assignment 1	Week 1	Writing a Scientific Report
Assignment 2	Week 3	Atomic Structure, Electron distribution, Periodic Table
Assignment 3	Week 4	Graph: Buffers & buffer capacities
Assignment 4	Week 9	Osmosis; Effects of temperature
Assignment 5	Week 12	Microscope: Two-minute in-class drill for focusing to 100x

Determination Of Final Grades

7 Exams	70%
Assignments and/or Quizzes	10%
Comprehensive Final	20%
	100%

Academic Accommodations

Dutchess Community College makes reasonable accommodations for students with documented disabilities. Students requesting accommodations must first register with the Office of Accommodative Services (OAS) to verify their eligibility. After documentation review and meeting with the student, OAS staff will provide eligible students with accommodation letters for their professors. Students must obtain a new letter each semester and discuss their accommodation plan with their instructors as soon as possible to ensure timely accommodations. The Office of Accommodative Services is located in the Orcutt Student Services Building, Room 201, phone # (845)-431-8055.

Student expectations:

To enter BIO 130 students a) should have received a grade of C or better in DCC's BIO 030 or b) have been referred to this course by their scores on the BIO placement exams. It is expected that all students taking BIO 130 have computational skills.

Course description:

Course content includes biochemistry, cell, cell transport and division mechanisms, the laboratory report and laboratory techniques. This course requires basic computational skills. This course is a prerequisite for BIO 131 for those students referred after testing. A grade of C or better is required to take BIO 131. This course does not fulfill the elective requirement of the LAX student.

Course objectives:

This course will give you the opportunity

- to become familiar with laboratory safety procedures and laboratory equipment
- gain experience in experimental design and graphing data
- to learn the characteristics of inorganic compounds (ions, salts) and their importance in physiology
- to learn some physiologically important chemical reactions (oxidation-reduction, hydrolysis, dehydration synthesis)
- learn the basis of the pH table and the roles of buffer systems in maintaining pH homeostasis
- learn about physiologically relevant gases (oxygen and carbon dioxide) and basic gas laws (partial pressures - Dalton's Law; pressure/volume interactions - Boyle's Law)
- learn the characteristics of Mixtures, factors affecting solubility and properties of solutions
- learn about physiologically important transport methods; e.g., osmosis, the effect of isotonic, hypotonic, hypertonic solutions on water movement across cell membranes
- learn the characteristics of the biochemically important organic families (carbohydrates, lipids, proteins) and functional groups associated with complex organic biomolecules
- learn the mechanisms of biologically important processes (elnzyme action, cell metabolism and respiratory pathways)
- learn to use the light microscope for studying some basic cell processes (e.g., mitosis);
- learn to prepare a tissue slide for histological examination in the microscope
- to become familiar with basics of anatomy (body systems, levels of structural organization, anatomical terminology, body systems)

Course Student Learning Outcomes

1. Students will integrate basic biochemistry with physiology. (3,6)
2. Students will integrate and explain the roles of buffer systems, the respiratory system and the urinary system in maintaining homeostasis with respect to pH. (3,4, 6)
3. Students will integrate physiologically important gases, gas laws with respiratory system function (4,6)
4. Students will apply osmotic principles to the movement of materials in cellular systems. (3, 6)
5. Students will compare enzyme concentrations with rates of metabolic breakdown of organic compounds (6)
6. Students will use the microscope to study basic cell mechanisms (3,6)

Institutional Student Learning Outcomes

- Scientific Reasoning Outcome: Students will apply the scientific method, develop hypotheses, analyze results and draw conclusions (ISLO 3)

- Quantitative Reasoning Outcome: Students will work with graphical,numerical or symbolic models to solve problems and interpret results. (ISLO 4)

- Critical Analysis and Reasoning Outcome: Students will formulate or evaluate arguments, problems or opinions and arrive at a solution, position or hypothesis based on carefully considered evidence. (ISLO 6)

Tips for Success in Anatomy & Physiology (See also text Ch 1 – A Study Plan, Use Active Learning)

- Make use of all help that is available
    - Routinely visit your professor at office hours
    - Go to Biology Open Lab – Washington Center, 3rd floor
        - this is an informal setting where students may also set up study groups
    - Attend tutoring sessions. Peer and professional tutoring is available at
        - Math and Science Center- Washington Center, 2nd floor
        - Academic Services and Testing- Hudson Hall, 3rd floor
        - C-STEP offices (ask about eligibility)- Hudson Hall, 4th floor –
    - Visit the Writing Center, Hudson Hall- 5th floor to gain greater expertise in all writings, including lab reports
- Expect to schedule at least 2-3 hours of study for each class hour. For BIO 130, you should be studying at least 10-15 hours each week.
- Study every day, not just before an exam.
- Study in ½ hour blocks then take a break. Cramming is counterproductive.
- Read the relevant class topic BEFORE coming to class. It's difficult to grasp and retain subject matter when hearing a topic you've never been exposed to before.
- Ask questions in class.
- Always come to labs prepared by reading lab exercise for that day.

- Get in the habit of taking good class notes. For science material, note-taking extends beyond 'flash cards'. The latter are meant primarily for memorizing single-world definitions.
    - The following URL link describes one method, the **Cornell system of note taking**. http://lsc.cornell.edu/study-skills/cornell-note-taking-system/
        - Most people are visual learners so students may also find it useful to organize their notes graphically. In the technique called **concept mapping,** important concepts and relationships are represented and organized by boxes, circles, arrows – you can devise the system that's most useful for you. The link below gives a visual example of a concept map.
      http://www.inspiration.com/visual-learning/concept-mapping
- Class notes are meant to be reviewed shortly (optimally within two hours) after class, integrated with text readings, then re-written and expanded, if needed. Handwritten notes are best because it slows you down and provides feedback to the brain. Vision and motor senses make for better memory.
- Learn to integrate material. The material of science builds on previous material. There is no such thing as memorizing subject matter and then considering it 'done'. You will be expected to constantly add new details to previously presented material.
- If you don't know the meaning of a word, look it up immediately. In addition to learning the subject matter of physiology you are also learning a new language. You learn by constantly using the words.
- Grammar and Format count. Good grammar includes correct spelling. People who read constantly are good spellers because they repeatedly see the words. To learn to spell, say the word out loud and write the word as you say it. Format involves the logical organization of topics and clarity (statements are written in a clear and concise manner). If you need help with grammar and format, visit the Writing Center in Hudson Hall.
- Unless instructed otherwise, homework assignments are to be submitted typed with pages stapled. To submit work in any other form is unprofessional.

Week 1

Lecture:

Review of Course Topics, Expectations
Ch 1, Section 1.4 - Key Math Skills
p12 – Calculating a percentage
p14 - Interpreting graphs
Ch 2 (Chemistry & Measurements)
- Units (volume, length, mass temperature, time)
-Significant figures, Section 2.3
-Metric prefixes and equalities, Section 2.4

Lab 1 Topics overview:

Lab Rules and Safety procedures
Introduction to lab equipment
Scientific method; Designing an experiment
-Pre-lab reading: Review the Scientific Method in your text -
(Ch 1, Section 1.2 Scientific Method: Thinking Like a Scientist)
Format for Scientific Reports
Graphing rules

Lab Materials neede:
gloves, safety goggles, paper towels
funnels, graduated cylinders (10 cc, 100 cc , Beaker (small, large), crucibles, test tubes, Erlenmeyer flasks,, watch glasses, forceps, milliliter plastic bulb pipettes, micropipettes, rulers (meterstick, millimeter), refractometers, hydrometers, digital scale, stir plates and stir bars

Assignment 1 Writing a Scientific Report **Due date** _____

LAB 1

Lab Rules and Safety Procedures

ARRIVE to class on time. Your professor will outline the lateness policy.

DO NOT enter the room wearing open-toed shoes.

DO NOT enter the room with food or drink.

In an effort to discard edibles -

- DO NOT place them on the window sills in the hallway.
- DO NOT place them on the lab entryway hutch shelves
- DO NOT place them on the floor
- DO NOT throw them into the lab wastepaper baskets.

WEAR gloves and safety goggles

DO NOT bring activated technology devices into classrooms. All cell phones should be turned off and put out of sight. Your professor will notify you of any exceptions and will indicate if laptop use is permitted.

DO NOT place any items under lab tables or on counters. Place all bags and bulky items in the hutch at the door entrance. Professors typically lock the door after class starts so items will be safe.

LEAVE LAB TABLES as you found them. Tables should be wiped clean and any materials returned to their place.

TREAT LAB EQUIPMENT WITH CARE. When using microscopes, oculars and objectives should be cleaned with lens cleaner and lens cleaning paper before returning scopes to the cabinet. Slides should also be cleaned with lens cleaner, especially if oil has been used. Equipment should be rinsed after used and left on the sink counters. Lab technicians typically autoclave materials after use.

OSHA RULES:

- The Occupational Safety and Health Administration (OSHA) https://www.osha.gov/ sets guidelines for safety in all types of working conditions. All science laboratories follow OSHA rules
- Your professor will review the rules concerning lab protocol and safety.
- After review, ask any questions you may have.
- After clarifications, you will be given a pledge sheet to sign and return.

Introduction to lab equipment

Each lab item has a specific name. Identify each item from lab samples or online images and for each item note its use. Define the boldfaced terms.

1. Funnel	-If used for filtering **mixtures**, filter papers come in different **pore sizes**
2. Graduated cylinder	-Note: the metric unit, -Note: the standard temperature notation stamped on each cylinder
3. Beaker	-Note the difference in **meniscus** formation between a graduated cylinder and a beaker
4. Crucible	
5. Test tube	
6. Erlenmeyer Flask	
7. Watch glass	
10. Forceps	
11. Stir rod	
12. Millimeter pipette	
13. Micropipette	Your instructor will demonstrate its use. Practice pipetting designated amounts of distilled water; e.g., 10 microliters, 30 microliters, 100 microliters
14. Rulers -Centimeter/Millimeter -Meterstick/Yardstick	
15. Refractometer; or a hydrometer)	for measuring **specific gravity**
16. digital scale	most have automatic **tare** capabilities
17. parafilm	Why and how is it used?

Scientific method, Experimental design

Pre-Lab reading:

Review the Scientific Method in your text (Ch 1, Section 1.2 Scientific Method: Thinking Like a Scientist)

During Lab:

This is a group exercise concerning the issue below. Your professor may permit use of cell phones and/or computer research. This is also a good exercise in using effective search terms for online research. Class discussion is encouraged.

THE ISSUE

The Vitamin D controversy. Some medical doctors recommend that adults should be taking Vitamin D supplements. Other doctors say most people have sufficient Vitamin D and supplements are not needed.

In class activity:

A. What questions should you be asking in order to critically evaluate this issue? Have a class discussion to determine if your group overlooked some critical questions. On a separate piece of paper, list the critical questions.

B. On separate paper, design an experiment to test an effect of Vitamin D.
Have other members of the class act as 'reviewers' of your proposed experiment. What comments were made?

Homework

Assignment 1 (below)

Instructional Format for Writing Scientific Reports

Once an experiment is completed it is written up for communication to colleagues. Most scientific writings have a standard format of presentation. Use the 'thought experiment' above as your writeup.

Title: (do this last). Title should be informative and pertaining to the subject matter. The title page (front of the paper) should also contain your name, Course & Section, Date submitted.

Abstract: a short overview of the full length paper (do this last)

Introduction: a review of the issue (previous information) and rationale for the experiment

Hypothesis: the hypothesis to be tested should be clearly stated**.**

Experimental design: This is the creative part of an experiment. How will you test your hypothesis so the results are convincing to the reader?

Many academic lab manuals ask students to label this section "Materials and Methods". This tempts the student to simply make a listing of all materials used in the experiment without explanation. You should strive to explain what you did with the materials.

Results (Graphs): This section contains one or more visual representations of the data (usually graphs and/or tables)
The visuals are generally labeled 'Figure 1' or 'Table 1" and contain a Caption (a short verbal description highlighting the data results shown).

General Rules for Graphing:

NOTE: For this exercise you do NOT need to make a graph but answer the questions below:

a) Which direction on the graph contains the X-axis? Y-axis?
b) Define independent variable. Which axis contains the independent variable?
c) Define the dependent variable. Which axis contains the dependent variable?
d) Based on your experiment, what information would be appropriate
on the X-axis?
on the Y-axis?

Discussion and Conclusions: This section gives a more thorough interpretation of the results. It is also the place to go beyond the data for the purpose of speculating (e.g., suggesting explanations for unexpected results), suggesting improvements in methodology or suggesting future questions.

References: You must cite your sources for statements made that are not your own observations.

There are many ways to cite articles from a scientific journal: e.g,

Author last name, first name. Name of the scientific journal, Vol #: pp # (date)

For a book:

Author last name, first name. *Book Title*, Edition #. Publisher, City, (date), page #

Assignment 1

Due Date: _____

Write up a scientific report based on the '*The Vitamin D controversy*' 'thought experiment' discussed in class.

To organize the report, follow the *Instructional Format for Writing Scientific Reports* above. (You have no actual data to graph but you set up some expected data.)

Reminder:

All homework is to be typed, pages stapled before submission

Week 2

Lecture:

Ch 4 – Atoms & Elements; Ch 5 - Radioactivity
- Elements and Symbols
- Periodic table
- Groups & Periods
- Metals & Nonmetals
- Biologically relevant elements
- Atom structure (Bohr's atom), Subatomic particles & charges
  - Atomic Number (Z) and Atomic Mass
  - Isotopes (Ch 4); Ch 5 Radioisotopes
- Ch 5: Radioactivity defined
  - Sect 5.5 - Medical applications using radioactivity
  - Medical scans using radioisotopes: PET, CT, MRI
- Electron shells as Energy levels
- Electron arrangement of biologically important elements
- Trends in periodic properties (group number, valence electrons)

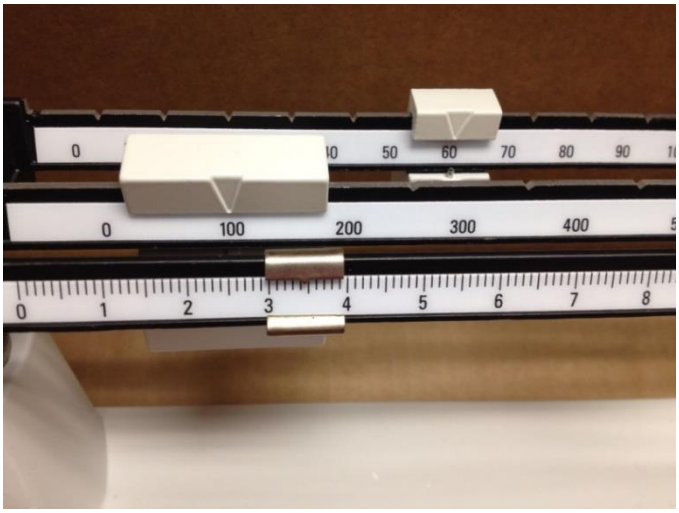
Lab 2 Topics overview:

Measuring Mass with triple beam balance
Significant figures and Rounding off
(coordinates with Ch 2, Section 2.3 p31)
Common U.S. System conversions (temperature, mass)
(coordinates with Ch 3, Section 3.3 p67)

Lab Materials needed:
triple beam balance
glassine tare papers (or non-absorbent equivalent)
coins (pennies)
beakers (10 cc, 100 cc)
plastic bulb pipettes

LAB 2

Measuring mass (g) with a triple beam mechanical balance



- To achieve precise object weights, the scale must first be **zeroed** and **tared**.
- The middle beam reads the object in units of 100s,
- The back beam reads weight in units of 10s
- The front beam gives the object's weight in units from 0-10. Each unit number is further subdivided into 10 lines (each corresponding to 0.1g). The weight is read to the nearest unit on the scale (to the tenth of a gram) PLUS AN ESTIMATE of the nearest number between the graduation marks.
- The final recorded weight includes the estimate value, written as a hundredth of a gram. How many digits are written for the measurement relates to the issue of significant figures

Record the weights of the following items (use correct metric abbreviations)

A Penny: _____

A 10 milliliter Beaker:: _____

A 100 milliliter Beaker: _____

Your pen: _____

Significant figures and Rounding Off.

These concepts relate to the issues of precision, accuracy, certainty in measurements and measuring instruments.

As an example, refer back to our measurement on the triple beam balance. Assume we take repeated measures of an object place directly on the pan without first taring the balance. We may get similar numbers with each weighing but each measure will not represent the true weight of the object because we haven't subtracted away the weight of the pan. In other words, our measures showed high precision (were all the same) but low accuracy (none of the numbers actually represented the true weight of the object). In science, the aim is for both high precision and high accuracy.

Also to be considered is how the measurement is written. The triple beam balance has an accuracy out to 0.1 g. Therefore, writing a weight as 373.55249 g is misleading because the balance is not capable of the accuracy being implied by the written number.

The above example illustrates the importance of significant figures. They inform the reader about the accuracy of the measuring device. In the above numerical example, since the triple beam balance is accurate out to one tenth of a gram, we can express a measurement out to 0.1g plus the estimated number based on our 'best guess' between the lines; for example, 373.55 g. The number therefore has five significant figures. Your text gives you the rules for significant figures in measured numbers.

The number of significant figures also determines rounding off numbers. This is most often seen when using calculators for multiplying or dividing numbers. For example, a calculator shows the product of division to be 3.473412698. We must know how many significant figures there are in our measurement in order to determine which numbers are relevant. Assume that there are three significant numbers. The rounded off number must then contain an equal number of significant figures If the designated last number is <4, round down; if >5 round up. For the above example, the number would be written 3.47.

 Indicate the number of significant figures for:

3.8 g _____

8.008 g _____

75 L _____

18.00 g _____

3.5 x 10E4 m _____

2.90 x 10E-03 _____

0.0002 mcg _____

0.025 s _____

,000 m _____

Round off the following:

75.2534 to three significant figures _____

3.89 to two significant figures _____

4,578 to two significant figures _____

4,578 to three significant figures _____

4.71 x 10E4 to two significant figures _____

Common U.S. System conversions factors

Temperature: Converting between ^{o}F and ^{o}C.

- There are two primary conversation formulas, one using fractions and another using decimals. The decimal formulas are more convenient to use:

$^{o}F = 1.8 \times (^{o}C) + 32$ $^{o}C = (^{o}F - 32) / 1.8$

You should memorize the three temperatures conversions shown in the table below. When doing other temperature conversion problems any one can serve as a confirmation to verify that you are using the correct formula.

	°C	°F
Boiling water		
Freezing water		
What is standard room temperature?		

Examples: Convert the following temperatures

A fever of 103 °F = _____ °C

Express the average normal body temperature of a healthy adult in

°F _____

°C _____

A person is considered hypothermic if body temperature drops to 95 °F. Express this temperature as a centigrade value. _____

Mass: Converting between pounds and kilograms; grams

2.2 pound (lb or #) = 1 kg

1 kg = ? mg

1 pint (pt) = 473 mL

1 L = ? mL

Examples:

The ideal weight for a male 5 feet 11 inches is 155 lbs.

Express the weight in _____ kg

The ideal weight for a woman 5 feet 6 inches is 58.967 kg

Express this weight in pounds to 3 significant figures. _____

Week 3

Lecture:

Ch 6 – Ionic and Molecular Compounds
- Ions: Transfer of Electrons - Cation, Anions
- Ionic compounds (salts)
- Polyatomic ions and their formulas
- Molecular compounds: Sharing electrons
  - Covalent bonds, Polar covalent bonds
  - Electronegativity and Bond Polarity
    - Hydrogen bonds
      - Water

Ch 7 – Chemical Quantities and Reactions
- The Mole, Section 7.1
  - Avogadro's Number, expression in scientific notation
- Energy in chemical reactions, Section 7.9
  - Rates of reaction
    - -effects of temperature, concentration of reactants

Lab 3 topics overview:

Mass/Volume relation
Density (coordinates with Ch 2, Section 2.7, pp46-49)
Specific Gravity (coordinates with Ch 2, p50)

Lab Materials needed:
gloves, safety goggles, paper towels
for Volume measurement: digital scale, 150 mL beakers, 100 mL graduated cylinders, plastic bulb pipettes, wax pencils
for Density: distilled water, oil, ethyl alcohol (100% if available, or 95%); digital scale, 100 cc graduated cylinders
for Specific gravity: distilled water, 10% glucose, refractometers

Assignment 2: Atomic Structure, Electron distribution, Periodic Table

LAB 3 (coordinates with Ch 2, 3)

Mass/Volume relation

In the previous Lab we measured the 'Mass' of a substance using a balance scale. The unit of mass was recorded as grams (g).

In addition, all matter (solid, liquid or gas) takes up space. **Volume** is a measure of the three-dimensional space occupied by matter. The metric unit of volume is the liter (l). Note: When writing in script or typing, a small 'ell' may be confused with the number 'one'. To avoid confusion, it is preferable to abbreviate 'liter' with a capital 'ell' (L)

Most of our body composition is **water** so liquid measurements are extremely important in biology. **Liquid volumes** are measured directly in a container.

Ques: You have various container options: graduated cylinders, beakers, flasks ,all of differing sizes. On what basis do you choose the most appropriate sized container? (Hint: Should you measure a one milliliter volume in a 100 milliliter beaker? If not, why not?)

Ques: When preparing solutions in a chemistry laboratory there are many solvents that can be used. The **biological solvent** is water so that is the only solvent we consider when preparing solutions in a biology laboratory. The solvent used in the solution is **distilled water** (DH_2O) or distilled **deionized water** (DI H_2O).

- What is

  - distilled water?

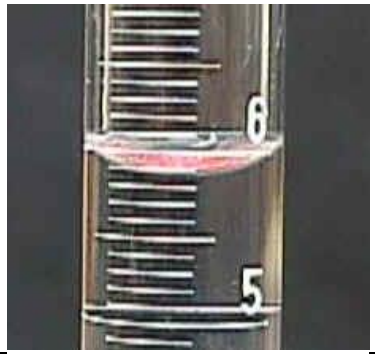
  - deionized water?

- How do they differ from tap water?
- Injectable solutions are prepared with sterilized distilled DI water. Why is the use of

DI water preferable to tap water?

Measuring volumes

The photo below shows a 10 mL graduated cylinder filled with distilled water. When water is the liquid in a container, a distinct **meniscus** is seen. The smaller the container, the more conspicuous the meniscus, an advantage for accurate measurement. The meniscus seen when water interacts with glass is due to water's chemical properties as a **polar covalent molecule**. A meniscus is not obvious when other substances; e.g., alcohol, a **nonpolar molecule** is poured into glass. Your text discusses the chemistry and differing properties of polar and nonpolar molecules.



Ques: What is the correct method of reading the volume?

What is the unit (written as an abbreviation)? _____

Record the volume of water in the cylinder. _____

Factors affecting volume.

The volume of a substance is affected by temperature and pressure meaning that deviations from standard reference values for one or both variables can be a source of lab measurement error. To avoid error, manufacturers stamp **calibration** information on their labware. (The extent to which labware is carefully calibrated should impress upon you the importance of precision in measurements.) The following information is typically given:

- maximum volume in mL
- temperature: 20 ^{o}C (defined as **standard room temperature**)

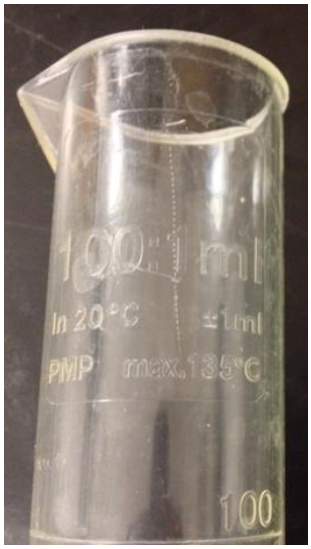
Ques: Convert this temperature to ^{o}F _____

- +/- 1 mL : tells the user to expect volume accuracy within one milliliter when making solutions at the standard temperature.

- pressure: **standard atmospheric pressure** is defined at sea level (760 mm Hg)

Everyday labware assumes sea level working conditions so the pressure calibration stamp is often omitted.

The photo below shows a 100 mL graduated cylinder with typical calibration information:



Mass/volume relation

Objective: Compare the mass and volume of two liquids - distilled water and ethyl alcohol (ETOH), 95% or 100%

Method:
-Using two 150 mL beakers, fill one with DI H2O and the other with 95% ETOH
-Label two empty 100 mL graduated cylinders with a wax pencil and weigh each on a digital scale. Make sure the scale is tared to 'zero' before weighing.
-Using the table below, record the mass of each cylinder in Column 2 of the appropriate row.

-Volume measure
-From the 150 mL beakers pour each liquid into its marked and pre-weighed 100 graduated cylinder up to the 100 mark. For greater precision, first pour about 90 mL liquid into the graduated cylinder then use a plastic bulb pipette to carefully fill to the 100 mL (reading from the bottom of the meniscus)

-Mass measure

- Weigh each filled cylinder on the tared digital scale and record its total mass in Column 3 of the table.

-To get the mass of liquid alone subtract out the weight of the cylinder.

-Record the mass of each liquid in Column 4 of the appropriate row.

	1 Volume measured (mL)	2 Mass of empty Cylinder (g)	3 Total Mass: Cylinder + Liquid (g)	**4 Mass of Liquid alone (g)**
DI H2O	100			
95% ETOH	100			

Results and Conclusions:

a) What is relation between volume and mass for water?

Standard reference tables give an **equivalency** such that **1 cc water (volume) = 1 g water (mass)**. Did you verify this volume/mass equivalency for water? If not, propose some reasons why you did not.

b) Is the mass of alcohol the same as its volume?

How does mass of alcohol compare to that of water?

Standard reference tables indicate that for alcohol, mass and volume measures may not be equivalent. In addition, the mass of ethanol is less than the mass of water.

Density (coordinates with Ch 2, Section 2.7, pp46-49)

The experimental results above indicate that a third factor must be considered when describing matter: Density is a consideration of the relation between mass and volume. It is important the mass of substances can differ despite their having equal volumes.

Density reflects how tightly packed a substance is. For example, feathers and lead may have the same mass (e.g, 1 kg) but feathers will take up much more space (volume) than the same mass of lead. In other words, feathers are less dense (less tightly packed). Two people may weigh the same (ignore for now that weight is not the same as mass) but the muscular athlete sinks in water whereas the individual with a high ratio of (body fat or adipose tissue): muscle floats.

Density also affects the outcomes of the laboratory tasks such as preparing solutions. Some solutions require the mixing similar substances. For example, if you add 50 cc alcohol to 50 cc alcohol you get a volume of 100 cc. But if you were to add 50 cc pure (100%) alcohol to 50 cc water, your final volume would be 96 cc. **Volume contraction** occurs because attractive forces between alcohol and water cause the molecules to move closer(pack more tightly). This variability accounts for the different procedures used for making solutions, e.g., making mixtures by % volume/volume (v/v) or % weight/weight (w/w). These procedures will be explained in Ch 9.

Calculating density of water

Density of substances are typically compared to the density of water. Substances less dense than liquid water float and those more dense will sink; e.g., a penny sinks but styrofoam or ice floats.

Determine water density using the data you recorded above. Write the value in the table, including the units. The **formula** for density is:

Density (D) = mass/volume in g/mL = g/cc or g/cm^3 (grams/cubic centimeters)

	Volume measured (mL)	**Mass of Liquid alone (g)**	**Density**
DI H2O	100		

The reference value for the density of water $_{(l)}$ is: 1 g/cm^3

Specific Gravity (sg) (coordinate with Ch 2, p50)

Specific gravity is 'relative density' in which the ratio of a substance's density is compared to the density of water. In physiology, specific gravity is often used to determine the concentration of particles (solutes) in urine. A patient's **urinalysis** result typically includes this measure and is presented as follows:

Component	Observed value	Reference range and Unit
sg, urine	1.008	1.005 – 1.029

A sg value higher than the upper end of the reference range may indicates a state of **dehydration**. (Athletes may measure their sg values to verify they are drinking adequate amounts of water). A sg value below the lower end of the reference range indicates a very dilute urine. Further tests must be performed to determine the reason.

The **formula** for Specific gravity (sg) is:

density of sample / density of distilled water

The sg value should be carried out to three decimal places and there is no unit following the number. Specific gravity is one of the only physiological measures that is 'unitless'.

Objective

Determine the specific gravity of two solutions (glucose and water) using a **refractometer**

Method:

Your professor will demonstrate use of the refractometer. First determine the sg of distilled water. Rinse the refractometer, then determine the sg of a 10% glucose solution.

	Observed value	**Reference value**
Distilled water:		
10% glucose:		

Do an online search to determine the reference values for each substance. Do they match your readings?

Assignment 2 (write your answer on these sheets, tear and submit)

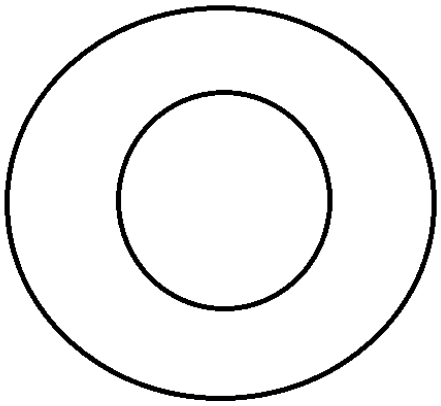
Atomic Structure

Name: _____

Due date: _____

- **Atomic structure (Bohr model) (Ch 4, 6): major subatomic particles, valence electrons**

1. For the atom shown below, indicate the 3 major subatomic particles a) in their proper location; b) with their proper symbol and charge. (Inner circle = atomic nucleus)



- **Periodic Table of Elements**

Examine the Periodic Table in your text (tables can also be found online).

2. The Periods correspond to the (rows? columns?)

3. The Groups (or Families) are organized (horizontally? vertically?)

4.The most abundant biologically relevant Elements are in Groups 1A, 2A, 4A, 5A, 6A, 7A.

Some of 'transition elements' are also **trace elements** in the body.

5. . Define a trace element.

6.. Write the name of the following trace elements:

Fe:

Cu:

Zn

Each element on the Periodic Table is identified by a symbol, an atomic number (identified as AN or as 'Z'), and an **atomic mass**. The atomic mass is not typically a whole number because it reflects the weighted average of all **isotopes** of a given element.

7. Define an isotope.

- **Mass Number (MN)**

Some texts indicate the **mass number (MN) of an element** instead of its atomic mass. Mass number is the sum of protons and neutrons in the atomic nucleus of the element and therefore always a whole number.

Carbon has three known isotopes indicated as C-12, C-13, C-14.

8. C-12 has 6 protons and 6 neutrons. What is its mass number? _____

9. C-13 has 6 protons and 7 neutrons. What is its mass number? _____

10. C-14 has 6 protons and 8 neutrons. What is its mass number? _____

11. Can Carbon atoms contain differing proton numbers? Explain your answer.

12.
The table below contains some of the most abundant biologically important elements. Review the Periodic Table of Elements in your text (or online) in order to complete the column information for each element listed.

Element name	Symbol	Atomic number	# of protons	Group # (the 'A' group #s)	# of **valence electrons**
sodium from 'natrium'					
potassium from 'kalium'					
calcium					
carbon					
nitrogen					
phosphorus					
oxygen					
chlorine					

13. What information on the periodic table is given by the atomic number?

14. In the atomic structure shown below, put the letter 'A' where the **valence electrons** are located. Electron shells represent energy levels. Put the letter 'B" at the lowest energy shell. Put the letter 'C' at the highest energy shell.

NOTE: The highest energy shell is the most reactive and therefore participates in chemical bonding.

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Week 4

Lecture:

Ch 10 – Acids and Bases and Equilibrium
- Acids and Bases
  - -naming of acids; physical & chemical characteristics
- Bronsted-Lowry acids & bases
  - -hydronium ion
  - -conjugate acid-base pairs
- Strengths of Acids and Bases
- Dissociation of Water (amphoteric molecule)
  - - hydronium ion, hydroxyl ion
- pH scale defined
  - -expression of concentration in scientific notation
- Neutralization reaction
- Buffers
  - -Chemistry link to health: antacids

Lab 4 topics overview:

pH, pH indicators (colorimetric assays for pH)
Buffers; Graphing data in Excel

Pre-lab – effective ranges of some pH indicators

Assignment 3:

Graph: Buffers & Buffer Capacity **Due Date:** _____

Lab Materials needed:
-gloves, safety goggles, paper towels

pH & pH indicators expt:
-wax pencils & labels
-distilled water
-pH indicators (colorimetric assays for pH): pH paper strip *(Hydrion*), litmus, phenolphthalein
-forceps for pH paper
-150 or 200 mL beakers, 50 mL graduated cylinders, stir rods, graduated transfer pipettes with bulbs
-spot plates

Buffering expt:
-gloves, safety goggles, paper towels, wax pencils
-buffer (acetic acid/sodium acetate), distilled water
-0.1M hydrochloric acid, 0.1M sodium hydroxide
-pH paper, forceps
-50 cc graduated cylinders, 150 cc beakers, 1 ml plastic bulb pipettes, stir rods
-computers, Excel software

Lab 4

Effective range of pH indicators

There are many pH indicators and each has an effective range. That is, the color changes are accurate only within a certain range of pH values.

pH indicators permit a qualitative indication of the pH of a solution by turning a specific color when added to the solution. These color change indicators are known as 'colorimetric assays'. Litmus is a well-known pH indicator. Litmus is a dye extracted from a plant-fungus organism known as a lichen. It comes either in solution or papers can be treated with the dye and used as 'litmus paper'.

PRE-LAB Assignment - In preparation for this lab, look up the effective ranges of pH indicators indicated in the table below. Write their pH ranges and color changes in the appropriate columns.

pH indicator	**Effective pH range**	**Color at low end of pH range**	**Color at high end of pH range**
Litmus			
Phenolphthalein			
Bromothymol blue			
Hydrion paper			

Questions:

What is the normal pH of human plasma? _____

Which pH indicator above is most useful to measure blood pH? _____

Colorimetric assays of pH values

Objective:

To measure the pH of chemical compounds with pH indicators.

In this experiment, you will test the effectiveness of three pH indicators (litmus, phenolphthalein, and *Hydrion* paper) for measuring the solutions of varying pH.

Ques: Indicate below 1) the expected pH of the following substances and 2) if this pH is acidic, neutral. or basic.

Distilled water: _____This is _____

0.1M hydrochloric acid: _____ This is _____

0.1M sodium hydroxide _____ This is _____

Methods:

a) For pH indicators that are in solution (litmus, phenolphthalein), use the spot plate and a dropper

-On the spot plate, use the wax pencil to label two columns by a pH indicator.

-To each well of the spot well, add three drops of test solutions as shown in the table below. (Clean the dropper between each application by rinsing it in a beaker filled with DH_2O)

Spot plate organization

Litmus test	**Phenolphthalein test**
DH_2O	DH_2O
HCl	HCl
NaOH	NaOH

-Add 3 drops of litmus solution to each well solution in the 'Litmus' column

- Add 3 drops of Phenolpthalein to each well solution in the second column.

-Record the color changes in the table below.

b) For the *Hydrion* paper, you will need forceps to hold a torn paper strip and a beaker. Using the beaker as a catch vessel, drop a test solution on the pH paper and record the pH associated with the color change. Repeat the process for each of the test solutions using a clean test strip each time (Place used pH strips on a paper towel for later disposal in the garbage).

Record the data in the table below.

(For cleanup: Solutions can be disposed of in the sink. pH test strips must be disposed of in the garbage cans.)

pH indicator	**pH of Distilled water**	**pH of 0.1M HCl**	**pH of 0.1M NaOH**
Litmus -color turned in:			
Phenolphthalein -color turned in:			
Hydrion paper -pH reading in:			

Ques: According to standard pH tables, water has a pH of 7.0. Does this match your data?

If not, it's because you must consider that the water is exposed to the atmosphere which contains carbon dioxide. The gas dissolves in water, lowering the pH. You will examine the effect of CO_2 on pH in the next lab.

Ques: Based on the color turned by each pH indicator, what conclusions can you make about which pH indicator is best used in neutral, highly acidic or high basic (alkaline) solutions? For example, is litmus a valid indicator for measuring the pH of HCl? If not, why not.

Buffers

Buffers function to resist changes in pH. In other words, a buffer works in aqueous (aq) solution to maintain the proton concentration, [H+], at a constant value despite addition of acids or bases to that solution.

A buffer consists of a weak acid (**proton donor**) and its conjugate base (**proton acceptor**). The generic buffer equation below shows the weak acid in **equilibrium** with its conjugate base:

HA (weak acid) $\rightleftharpoons$ A^- (anionic conjugate base/salt of the weak acid) + H^+ (proton) *

The term 'conjugate' simply refers to the fact that the behavior of an acid and base are coupled: in order for an acid to give a proton there must a base to receive it.

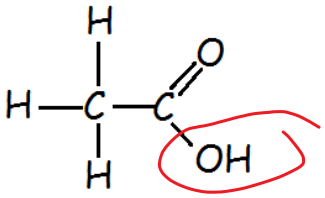
* Although we often refer to acidic solutions as having 'free hydrogen ions' or 'free protons', we are actually talking about the **hydronium ion**, $\mathbf{H_3O^+}$ (review Ch 10 discussion of hydronium formation)

Examples of compounds that act as buffers are acetic acid and carbonic acid.

The **molecular formula** for acetic acid (a component in vinegar) can be expressed as

CH_3-COOH

The **molecular structure** of acetic acid can be represented as shown below. The hydrogen acting as a proton donor (dissociated proton) is the atom bonded with oxygen (circled region).



Note the names of the buffer constituents and salts:

acid:	acetic acid
conjugate base (anion):	acetate
salt of the acid:	sodium acetate

Acid strength

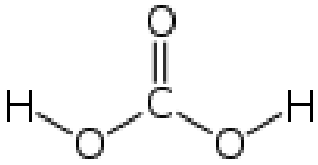
An important descriptive property of a buffer is that is a **weak** acid.

Acid strength refers to the ability of the hydrogen atom to dissociate from the molecule. Strong acids typically dissociate completely in water (e.g., HCl > H+ Cl^-) whereas weak do not.

One of the **factors that determine acid strength** is **electronegativity** of atoms in a chemical bond. Recall from Ch 6 that highly electronegative atoms act very much like a magnet, pulling electrons away from other atoms. Oxygen is a common component in many buffer systems and is also a highly electronegative atom.

We can illustrate the role of electronegativity in determining acid strength using as an example **Carbonic acid**, a weak acid.

The **molecular formula** of carbonic acid is H_2CO_3. Its **molecular structure** is shown below.



Carbonic acid contains two hydrogen atoms. If both could dissociate easily it would be a double 'proton donor' suggesting it should be a strong acid. But the oxygen atoms are highly electronegative, exerting a strong 'pull 'on the hydrogens. Because Hydrogen atoms cannot easily dissociate and go into aqueous solution, the molecule is a weak acid.

Ques:

What is the name of the conjugate base of carbonic acid? _____

What is sodium bicarbonate? _____

Making physiological connections:

The **carbonic acid-bicarbonate acid buffer system** is one of the important **extracellular buffers**. Its precursor molecule is CO_2, a waste product of **cellular metabolism** (Ch 18). Enroute to the lungs to be exhaled, this **respiratory gas** (Ch 8) interacts with water in **plasma**, acting as the buffer system in the **homeostatic regulation of blood pH**.

Buffer effectiveness

A buffer can resist changes in pH up to a certain point. If acid or base concentrations become too high, the buffering capacity of a solution is exceeded and pH values change with successive additions of acid or base.

Assessing Buffer Effectiveness

Objective:

To determine if two substances, (water and acetic acid/sodium acetate solutions) are effective buffers (i.e., resist changes in pH upon addition of a strong acid or a strong base)

Method:

-Set out four 250 mL beakers. With a wax pencil label one pair 'DH_2O' and the other pair "Buffer'. Use a 50 mL graduated cylinder to pour the appropriate substance into each beaker. (Be certain to rinse the cylinder with Dwater between each fill.)

-**Baseline pH reading** (0 mL acid or base condition): Before adding any acid or base, measure the pH of the solutions in each of the four beakers using Hydrion pH paper. Do not submerse any pH papers in the beakers. Instead, remove a solution sample using a stir rod (used to prevent removing large volumes) and touch the wet rod onto a clean test strip that you are holding with forceps. Use paper towels as a drip pan. (Record the pH (to the nearest 0.5 unit value) in the table below. (Place the used strips on the paper towels for later disposal in the garbage.)

-To test buffer capacities, successively add 2 mL of either acid or base into the appropriate beakers, recording the solutions' pH after each 2mL addition. Stop the experiment after adding a total of 22 mL acid or base. Record the pH data (estiated out to 0.5 pH units) in Columns 2 and 3 of the table below.

0.1M HCl added (mL)	DH_2O	Acetic acid/NaAcetate solution
0		
2		
4		
6		
8		
10		
12		
14		
16		
18		
20		
22		

	pH	pH
0.1M NaOH added (mL)	DH_2O	Acetic acid/NaAcetate solution
0		
2		
4		
6		
8		
10		
12		
14		
16		
18		
20		
22		

Assignment 3

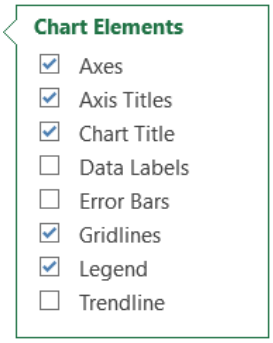
Due Date: _____

Graphing the buffer data in **Excel**.

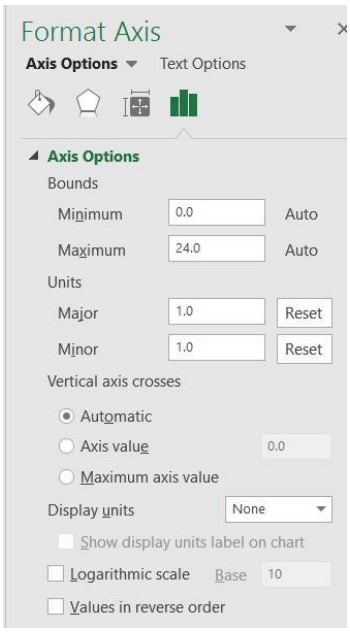
Represent the buffer data collected in lab in a graph. The following items should be included:
1) Graphic representation of the data using Excel (2016).
2) Label the graph with an informative title
2) Properly labeled X- and Y- axes
3) A figure caption providing a summary of the experiment . Figure Caption is a separate page indicating numbering the graph "Figure 1." followed your typed summary. The caption page should be stapled to the graph.
   a) Purpose
   b) Overview of procedure
   c) Analysis of Results
   d) Major conclusions
4) Write your name on the graph (1st page) in the top right corner of the page.

Excel 2016 graphing instructions are given below. You can receive further help by going to the tutoring center – e.g., Math & Science Center, 2nd Fl Washington Center.

1. Open an Excel spreadsheet and type in the data using the same column and row format as the table above.
2. Highlight the entire table including the 1st row headings
3. Click the 'Insert" tab at the top of excel screen
4. To the right of the "Recommended Charts' area and above the region labeled 'Charts', click on the icon's carat to select a graph option
5. Choose the option entitled : 'Scatter with lines and markers'
6. Click anywhere within the graph. A '+' sign will appear at the top right of the graph.
7. Click the + sign to see the options in the box labeled "Chart Elements". Click the elements indicated in the figure below.



8. Type the appropriate information into the Axes titles and Chart Titles areas.
    a. informative chart title
    b. appropriately labeled X- and Y- axes
9. Click the + at the top right of the graph, choose 'Axes', then Click the 'triangle', then click 'More Options'. A screen labeled 'Format Axis' will appear giving you "Axis Options'. Under 'Units' you can format the major and minor axis lines to make the graph easier to read.



10. Analyze the graphed results (which substance acts as a good buffer and why) and type up the summary page (Figure Caption).

Week 5

Lecture:

Ch 8 – Gases

- Kinetic theory of gases
  - pressure, volume, temperature
- Measures of gas pressure & its units: barometer
- Pressure & Volume relation (Boyle's law)
  - -pressure-volume relation in breathing
- Partial Pressures (Dalton's law)
- Chemistry link to health: Hyperbaric chambers

Lab 5 topics overview:

Gases: Measuring respiratory CO_2 with pH indicators – effects of exercise

Pre-Lab Preparation:

Ch10 – Chemistry link to Health (Buffers in Blood Plasma), p353 (the carbonic acid/bicarbonate buffer system)

Lab Materials needed:

gloves, goggles, paper towels, wax pencils, plastic bulb pipettes, stir rods
beakers (500 mL 200 mL), flasks
pH indicator (phenolphthalein), 0.1M NaOH
saran wrap, extra long straws

Lab 5

We saw in Lab 4 that the carbonic acid-bicarbonate buffer system is an important intermediary between a cell's production of a waste product, CO_2 (consequence of cellular respiration, Ch 18) and the exhale of the gas by the lungs (review Lab 4, Making Physiological Connections). As will be discussed in Ch 18, when cellular energy demands increase the metabolic processes rev up and CO_2 production increases. One factor that increases the body's energy demands is exercise.

Objective:

Determining the effect of increased energy demand (eg., running, jumping) on exhaled CO_2 Exhaled carbon dioxide will be assessed by recording the time it takes for a pH indicator solution to turn color.

Pre-lab Ques:

Exhaled carbon dioxide will be assessed using the pH indicator Phenolphthalein. In order to understand the rationale for its use, it is necessary to 1) effective range of the pH indicator, 2) the colors it turns at its low and high range. The method calls for exhaling into water. You should also know 3) the pH changes that occur when the gas dissolves in water. You can determine this by looking up the reaction in Ch 10 (Buffers), p353.

a) Write the formula and name of the first product for the change in #3:

$CO_2 + H_2O$ >

b) Given the product indicated above, predict what color the pH indicator will turn when CO2 is exhaled into the water.

_____

c) Based on your prediction, state the reason for adding NaOH at the start of the procedure.

d) Why is sodium hydroxide added to the solution before exhale?

Method:

-REMEMBER: Goggles and gloves at all times!

- Make a stock solution of the pH indicator solution:

To a 500m mL flask, add 400 mL Dwater, 2.0 mL NaOH (use a plastic bulb pipette), and 16 drops of phenolphalthein pH indicator solution. Stir the solution with a glass stir rod.

What is the start color? _____-

-Work in groups with a subject (who has no respiratory problems), time keeper, data recorder, solution preparer and monitor.

-Prepare a working solution for a control condition (resting breathing).

-Pour 100 mL stock solution into a 200 mL Erlenmeyer flask. Label the flask 'Pre-exercise'

-Cover the flask with saran wrap and punch a hole big enough to fit 6 straws into the solution. (The wrap should be secure to prevent splashing on exhale). Place the flask on white paper so the color change is easily observed.

-At the start time exhale without effort through the straws. Record the time (min) it takes for the indicator solution to turn color. Write the results n the table below.

-Exercise condition.

-Engage in exercise by running down and back up the three flights of stairs (remove gloves and glasses first).

-While the subject is exercising, another team members should prepare the second pH indicator solution. From the stock solution, pour 100 mL into another (or cleaned) 200 mL flask labeled 'Post- exercise'. Prepare this second flask as indicated above.

-When the subject returns, put goggles and gloves back on and immediately begin exhaled into the solution. Record the time it takes for the solution to turn from pink to clear in the table.

Condition

	Resting breathing	Exercise
Time for pH indicator solution to turn color (min)		
Group 1volunteer		
Group 2 volunteer		
Group 3 volunteer		
Group 4 volunteer		
Group 5 volunteer		
Group 6 volunteer		
Average		

Ques: Exhaling CO_2 into water turns the pH of the solution from

_____to _____

Does the result match your pre-lab prediction? _____

Critical thinking PostLab Ques for <u>Classroom discussion</u>: (research the answers in your text or online, as needed):

1. What is the relation between exercise intensity and the amount of glucose used by cells? Why do cells need glucose?

2. What is the normal blood pH?

How will shallow or depressed breathing affect blood pH? Explain your reasoning.

3. A person suffering anxiety-induced hyperventilation is often encouraged to breathe into a paper bag.

During hyperventilation, what is the change in

blood CO_2 levels?

blood pH?

What is the clinical term used for this change?

Week 6

Lecture:

Ch 9 – Solutions

- Solvent, solute defined
- Water as a biological solvent
- Solutions with ionic and polar solutes
  - water solvent 'dissolving' ions (formation of hydration shells)
- Solutions with nonpolar solutes
- Equivalents & Milliequivalents of electrolytes in clinical medicine

- Solubility
  - Saturated and Unsaturated solutions
    - Clinical link to health: gout, kidney stones – a problem of saturation in body fluids
  - Effects of temperature on solubility
    - Henry's Law
- Solution concentrations - % mass per volume
- Molarity concentration
- Properties of solutions: solutions, colloid, suspension

Lab 6 topic overview:

Preparing solutions of varying concentrations (coordinates with Ch 9- water dissolves salts)

Lab Materials needed:

gloves, goggles, paper towels
triple beam balance, digital scales,
magnetic stir plate and stir bars; glass stir rods
micropipettes (1ul, 50ul, 100 ul), plastic bulb pipettes
graduated cylinders (5ml, 10ml, 100 cc), beakers, (10, 50, 100 cc),1 1L flasks
sodium chloride crystals, Dwater

Lab 6

When you make up a 1% salt solution you are preparing a mixture containing solute and solvent. Chemists define a **solute** as the substance in lesser amount; **solvent** is the substance in greater amount. In biology, the solvent is typically water. The solution is referred to as an aqueous solution (aq)

In a 1% NaCl solution the solute is_____ and the solvent is _____.

Solutions are considered **homogenous mixtures** because they form a **single phase**. Prior to mixing, the solute (salt) is a solid, the solvent is a liquid and when first placed in a container together the white crystals are visible. Once water's **polar covalent molecules dissolve** salt by forming **hydration shells** around each ion, the salt crystals become 'invisible' and cannot be differentiated. The substances have formed a single phase. Be certain you understand how water dissolves salts by reviewing Ch 9 – Solutions with ionic and polar solutes, pp288-.

Electrolytes are important components of body fluids and electrolyte solutions are administered as intravenous (i.v.) drips to maintain blood plasma electrolytic balance. Recall that electrolytes are defined as substances that produce ions when dissolved in water (Ch 9).

Ques: Which two ions are in greatest abundance in blood plasma (an **extracellular fluid**). Research your text or online, as needed.

Carbohydrates are important sources of energy for the body (Ch 13) and nurses may be required to administer i.v. drips of '**dextrose**'. A typical dextrose solution designation is **D5W**.

Ques: Answer the following questions, researching the answers, as needed. If necessary do an online search.

What is dextrose?

Is there a difference between dextrose and glucose?

What is the meaning of 'D5W'?

Expressing the concentration of solutions

Ch 9 discusses various ways scientists express solution concentrations, e.g., % mass per mass (m/m), % mass/volume (m/v). Note that in clinical medicine solution concentrations are still described by 'weight'; e.g., a % m/v solutions may be labeled **% weight per weight** (w/w). Recall the distinction between terms: Mass refers to the amount of matter whereas weight includes the force of gravity acting on a mass. Your weight on the moon will differ compared to that on earth but your mass has not changed. Because we are all on earth, the life sciences often use mass and weight terms interchangeably.

Biologists also shuffle between units of measure. The base unit of mass is the *kilogram* in the SI system (International System of Units, SI) whereas it is the *gram* in the *cgs* system of units (centimeter-gram-second system).

A full listing of the base SI units can reviewed in Ch 2 Section 2.1 – Units of Measurements p26 or online: http://physics.nist.gov/cuu/Units/units.html

In this lab, we will **focus on preparing mass/volume percent (m/v) solutions**. Percentage by volumes (%v/v) are rarely used in allied health fields because the volumes do not always sum. Recall the volume contraction that occurs when alcohol is added to water (Lab 3).

Ques:

What is the base unit for

mass in the SI system? _____ cgs system? _____

length in the SI system? _____ cgs system? _____

Critical reasoning: Why do you think biologists prefer to express mass and length units using the cgs system?

Objective:

To prepare a 5% sodium chloride solution, m/v.

Percent means 'the number of parts per hundred'.

Formula for m/v % = $\frac{\text{mass of solute (g)}}{\text{solution volume (100 mL)}}$ x 100%

(solution=solute **+** solvent)

Method:

Weigh out 5 grams salt using the digital scale. Pour the solute into a 100 mL graduated cylinder. Add enough distilled water to the cylinder to bring the final volume of the salt and water mixture to 100 mL. View the cylinder at eye level so you can clearly see the meniscus. (Note: Do not simply add 100 mL water to the salt already in the cylinder. If you did, you would be diluting your desired percentage.)

Ques: How would you prepare a 5.0% NaCl solution if you needed a final volume of 250 mL? Give your answer in three significant figures.

Quick solution hint: 250 mL is how many times larger than 100 mL? Multiply that number by the desired 5 (the desired percentage of solute).

Perform the following check you got the correct answer: (your number in g divided by 250 mL) x 100%. The result should match the original value, 5.0%

The longer version for the solution: This is a proportion (ratio) problem (if…then): If there are 5 g in 100 mL then how many g are in 250 mL. Proportion problems are set up as follows:

$$\frac{5\text{ g}}{100\text{ mL}} = \frac{x\text{ g}}{250\text{ mL}}$$

Now cross multiply: 100x = 5 x 250 Solve for x

Ques: Assume that you have prepared a solution by dissolving 25 g glucose in 475 g distilled water. Determine the m/v% of the solution.

Hint: What is the m/v% formula?

Physiological levels of sodium and chloride.

Sodium and chloride are the most abundant electrolytes in blood plasma. A solution that mimics the blood plasma sodium chloride is called **physiological saline or normal saline**. In relation to a process of osmosis, it is called **isotonic saline.** We will delay discussion of **osmosis** (Ch 9, p310) until we introduce the concept of cell membranes (Ch 15, p536)

Ques: What is the percentage sodium chloride concentration of physiological saline?

_____

Prepare 200 mL of physiological saline using the triple balance beam.

Ques: how many grams of solute will you weight out? Express your answer in two significant figures. (Always include the metric unit abbreviation.)

_____

Week 7

Lecture:

Ch 11 – Introduction to Organic chemistry
- Organic compounds defined
- Hydrocarbons: saturated, unsaturated bonds
- Cis-Trans isomers
  - -Chemistry link to health: hydrogenation of unsaturated fats

Ch 12 – Functional groups
- -hydroxyl
- -carbonyls: aldehydes & ketones
- -Chemical link to health: oxidation of alcohols to aldehydes

Ch 14 – Functional groups
- -carboxylic acid
- -ester
- -amines

Chemistry link to health
- -carboxylic acids in metabolism
- -salicylic acid from a willow tree
  - -acetylsalicylic acid (aspirin)

Amines, Ammonia, Ammonium salts

Amines in health & medicine: biogenic amines

Lab 7 topic overview:

Chemical and structural formulas (coordinates with (Ch 6, 11, 13)

Molecular modeling (ball-and-stick models)

Molecular compounds
- -polar & nonpolar molecules
- -functional groups: coordinates with Ch 12, 14
  - -hydroxyl, aldehyde, ketones, phosphate; carboxylic acid, ester; amino, ammonia, ammonium ion

Lab Materials needed:

gloves, goggles, paper towels

Lab 7

Objective:

In this lab, you will compare the chemical formulas and molecular structure of biologically important molecular compounds. In previous chapters you studied the crystalline salts. The focus here in on molecules.

Ques: What is the difference in bond type between a salt and a molecule?

Salts: _____ Molecules: _____

	Ionic bond	Covalent bond	
		polar	nonpolar
Electronegativity difference (high, medium or low?)			
Electron behavior (share, share unequally, transferred?)			
Example	NaCl	H_2O	CO_2

Polar and nonpolar molecules

In the space below, draw the molecular structures of water and carbon dioxide. Supplement your drawings with a molecular model of each molecule.

Ques:

-Linear (symmetrical) molecules are (polar? nonpolar?)

-Explain the how **water dipoles dissolve salt** by drawing the interactions between a water molecule and sodium chloride crystal. Explain what is meant by a **hydration shell?**

Functional groups

There are certain molecular groupings, called **functional groups**, that are part of a larger **organic compound** and are responsible for the characteristic chemical reactions of the compound. For large organic **macromolecules**, the **hydrocarbon** portion acts as a 'skeleton' from which hangs the functional group. It is the atom arrangement of the functional group that is uniquely reactive.

Organic molecules can be represented in various ways:

1) **Molecular formula**:

e.g, ethyl alcohol *aka* ethanol (drinking alcohol) = C_2H_6O

This is the least informative representation of an organic molecule because many organic families have the same formula but their atoms are arranged differently. (These are called **isomers** - e.g., Carbohydrates Ch 13)

An alternative molecular formula representation of ethanol = C_2H_5**OH**

This method shows the reactive functional group, a hydroxyl (-OH) but it is still difficult to deduce shape from the formula. .

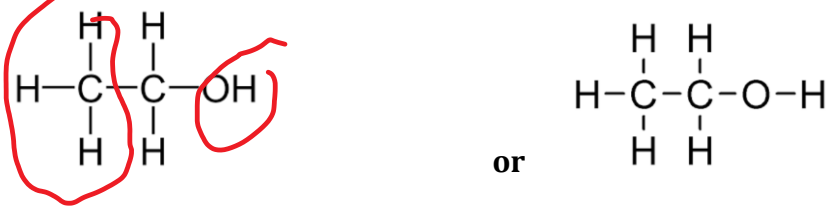
2) **Structural formulas** are more informative (Ch 11, Ch 366) because they identify the functional groups. There are two versions of structural formula representations:

a) **condensed structural formula**

ethanol: **CH_3**-CH_2-**OH** Boldface indicates the functional groups.

b) **expanded structural formula**

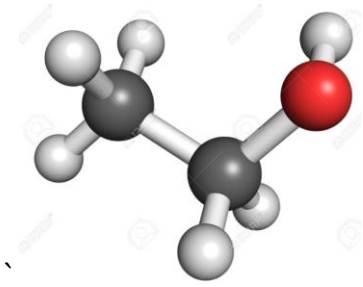
ethanol



The two functional groups are circled.

3) Ball-and-stick models shows the atoms and bonds in three-dimensional form. Each atom is color-coded

ethanol



Ques: Based on the ball-and-stick structure above, write the atoms represented by

white _____

black _____

red _____

Functional group Exercise

Below is a list of biologically important functional groups. Identiy each with respect to: as to name, molecular formula, structural formulas (2-dimensional drawing on paper; 3-D ball-and- stock modeling, function.

Research the groups using your text or online, as needed. (If there is no computer access, you can use a cell phone).

The first group is partly completed. **NOTE**: it is customary to add a bonding line to a functional group to indicate it will bond to the rest of the molecule.

Function group name	**Molecular formula**	**Examples**	**Drawing based on ball-&-stick model**	**Chemical property**
hydroxyl	-OH	water…and?		polar; increases molecule solubility
aldehyde				
ketone				

carboxylic acid				
amine				

Ques: Amines, ammonia, ammonium ion

The **amine** is an component of **amino acids**, the **monomers** of Proteins (Ch 16)

Amino acid breakdown (catabolism) in the body results in the production of toxic **ammonia** which is subsequently detoxified.

Write the molecular formula of ammonia _____

Ammonium is a **polyatomic ion** (Ch 6) also formed in the body.

Write the formula and charge for ammonium: _____

Draw the structural formula of ammonium. Make a a ball-and-stick model of the ammonium ion and compare it with your drawing.

Week 8

Lecture:

Ch 13 – Carbohydrates
Carbohydrate formation from simple inorganic molecules (carbon dioxide & water)
Types of carbohydrates: mono-, di-, poly- saccharides defined
D-glucose: molecular formula, chain vs ring structures
- -Chemical link to health: hyperglycemia, hypoglycemia; Diabetes mellitus

Chemical properties of monosaccharides
- -oxidation and reducing sugars
- -Colorimetric test: Benedict's test for glucose, a reducing sugar

Disaccharides
- glycosidic bond
- maltose, lactose, sucrose

Polysaccharides
- starch types (amylose, amylopectin)
- glycogen
- cellulose

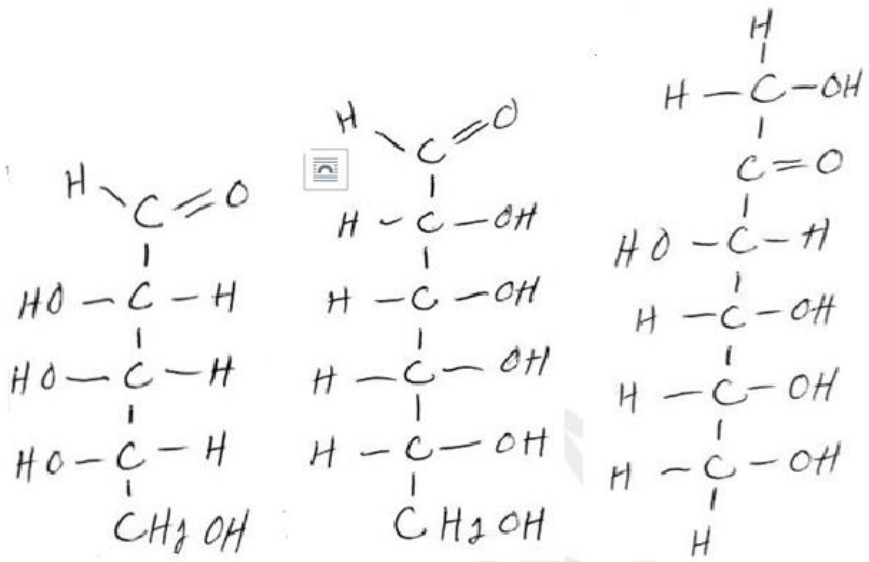
Lab 8 topic overview:

Carbohydrates: chemical structures and Molecular modeling
Characteristics of sample monosaccharides (glucose, fructose), disaccharides (sucrose), polysaccharides (starch)
Colorimetric tests: Benedict's, Iodine tests for glucose, sucrose, starch

Lab Materials needed:
gloves, goggles, paper towels
molecular modeling kits
Reagents for colorimetric tests for Carbohydrate: Benedict's, Iodine
1% glucose, 1% sucrose, 1% starch
test tubes, test tube racks, test tube holders, plastic bulb pipettes, 500 cc beakers
wax pencils, parafilm, scissors (for cutting parafilm, if necessary)
hot plate
spot plates
container for dirty glassware

Lab 8

The diagrams below show some molecules in the **Carbohydrate family** (Ch 13). The **straight chain** structure is shown instead of the **ring structure**. In aqueous solution both forms exist.



Name:	#1 ribose	#2 glucose	#3 fructose

For each molecule above (#1, #2, #3):

-**Circle the functional groups** and answer the questions about the molecules.

-Write the <u>molecular formulas</u> for

#1 _____

#2 _____

#3 _____

- Which numbers represent a **pentose sugar**? _____ **hexose sugar**? _____

-What common molecule hangs off each carbon atom? How does this relate to the family name?

- All three molecules above are simple sugars called **monosaccharides.** How can you identify a simple sugar by its name?

_____

- Carefully study the structure of molecules #2 and#3. Why are they called **isomers?**

Disaccharides are formed when two monosaccharides combine in a covalent bond called the 'glycosidic bond' (Section13.6). The bond formation requires a specific enzyme. Fill out the table below that lists three common disaccharides.

Disaccharide	Common name and/or foods containing the sugar	Monosaccharide composition		Enzyme needed for **dehydration synthesis** reaction
sucrose				
maltose				
lactose				

Naming carbohydrates and enzymes:

If a molecule's suffix is *-ose*, it is a _____ whereas

if the suffix is *-ase* the molecule is a(n) _____

Enzymes are often named for the molecule they act on (their **substrate**). What is the name of the enzyme acting on the starches amylopectin and amylose?

_____

Molecular modeling: sucrose

Disaccharides are formed by **dehydration synthesis** and digested by **hydrolysis** (splitting H-OH).

Illustrate the process of dehydration synthesis in the formation of sucrose.

Use your text to model the two monomers _____ and

_____ then perform the dehydration synthesis (removal of water (-OH from one molecule, H from another) to form the sucrose disaccharide. (Alternatively, you may draw the dehydration synthesis, if time is running short).

Polysaccharides

Starch is a **polysaccharide** found in plants. These **complex carbohydrates** are typically shown in their **ring structure** (Section 13.7).

The starch **polymer** is formed of repeat units of the monomer _____

held in_____ bonds.

When starch is digested an **intermediary disaccharide** is formed the final **hydrolysis** of the polymer to its monomer. What is the name of this intermediary product?

_____

Starch **exists in two forms** – 1) A**mylopectin** and 2) **Amylose.** Use your text (Section13.7, p459) to study the structure of the two starch forms.

Branching determines molecule <u>density</u>: Note that <u>amylopectin is highly branched</u> whereas <u>amylose is a helix</u> without side branches. Branching decreases the packing (density) of amylopectin allowing enzyme to act more efficiently in breaking (**hydrolyzing)** the glycoside bonds (**hydrolysis**).

In nutrition, density differences form the basis for consideration of the glycemic index of different carbohydrate-containing foods. Amylopectin has a higher glycemic index than amylose because it is more easily digested and, as a result, more monomer gets absorbed into the bloodstream.

What is the condition of high blood glucose called? _____

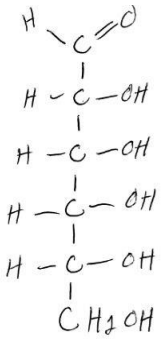
What disease, if untreated, is characterized by high blood glucose levels?

_____

Benedict's test for presence of a reducing sugar

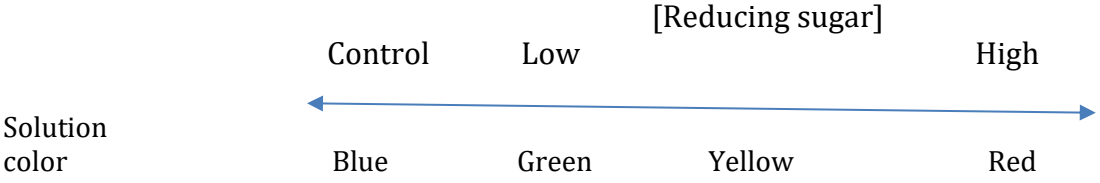
The term 'reducing' refers to an oxidation-reduction (redox) reaction, a process that will be discussed in detail at a future date in relation to metabolic pathways (Week 12- Ch 7, Ch 18). For purposes here, we can define a reducing sugar as a monosaccharide that contains an aldehyde functional group (or can form an aldehyde in water).

Ques: Is glucose a reducing sugar? _____. If so, circle the relevant functional group.



Benedict's solution is a **reagent** long used in medicine to determine the presence of glucose in urine. Urine is normally glucose-free but 'spills' into the urine of people with uncontrolled diabetes mellitus. (Stanley Rossiter Benedict (1884 –1936) is the chemist credited with formulating the solution. It is presumed to have been at the urging of doctors who at that time had to test for urinary glucose by tasting a patient's sample!)

Benedict's is a **colorimetric test** because the copper-containing solution turns color when it reacts with a reducing sugar (e.g., glucose). It also turns a range of colors that allows a **qualitative** determination of the amount of reducing sugar present.



Ques: A patient is said to have shown a **'strong positive result'** to Benedict's.

What color would have been seen? _____

What color indicates a '**negative result**'? _____

Iodine test for starch. Iodine (Lugol's solution) tests for the presence of starch. The control condition (iodine alone) is yellow. In the presence of starch it turns a dark.

Objective: Perform Benedict's and Iodine colorimetric tests to determine the reducing sugars. You will summarize your Results in the table below.

CHOs	type of CHO (mono-, di-, poly-, saccharide)	**Benedict's test** Test Color	+ or – result ?	**Iodine test** Test Color	+ or – result?	**Reducing sugar?**
glucose						
sucrose						
starch						

CONTROL			
	Composition?	Treatment?	Result?
for Benedict's test			
for Iodine test			

Method

Benedict's test:

-This test requires that the Benedicts and test solution be heated to a boil in order to see the result (All other reagent tests can be performed at room temperature.)
-Before starting any other procedure, set a 500 mL beaker 1/3 filled with tap water on the hot plate so it can come to a boil before samples are placed inside.

Experimental conditions:
-Each of the three test substances will be prepared to determine if they yield a + result with Benedict's.

-Using a plastic bulb pipette, add into three different test tubes: 5 drops Benedicts
+ 1 mL 1% glucose solution
+ 1 mL 1% sucrose solution
+ 1 ml 1% starch solution

-Cover each tube with parafilm and mix the contents (gently upend the tube).
-Be certain to identify each test tube with its contents. You can use the wax pencils to label the tubes.
-The test tube mixtures will then be placed in the beaker (with already boiling water) and boiled for 3 minutes. Use test tube holders.
-Record the color changes in the appropriate column of the table above.

Iodine test:

- This test is performed at room temperature using in the white porcelain 'spot plates'.
-Experimental condition:
- Using a plastic bulb pipette, add a few drops of Iodine + an equal number of drops of starch.
-Record any color change in the appropriate column of the table above.

Control conditions:

-What is the appropriate '**Control'** for the

-Benedict's test? Write out the procedure.

-Iodine test? Write out the procedure

-Should the control conditions yield a + or – result. Why?

-Record the obtained results in the table above.

-Cleanup: all liquids can be disposed of in the sink. Glassware and pipettes are to be placed in the 'Dirty glassware' container. Spot plates can be rinsed with tap water and dried with a paper towel.

Conclusion: Which of the carbohydrates are reducing sugars?

Week 9

Lecture:

Ch 15 – Lipids; Cell membranes and transport

- Overview of types of Lipids and their structures
- Fatty acids
  - -saturated, mono- and poly- unsaturated
  - -cis and trans isomers of some common fatty acids
  - -Chemistry link to health: omega-3 fatty acids
- Prostaglandins
- Waxes
- Triacylglycerides (animal 'fats')
  - -ester bonds
- Melting points of fats and oils
- Hydrogenation: converting unsaturated fats to saturated fats
  - -trans-fat formation
- Hydrolysis of triglyceride
- Phospholipids and Sphingomyelins
  - - Chemistry link to health: Pulmonary surfactant & Infant respiratory distress syndrome
- Steroids: Cholesterol, Bile salts, Steroid hormones
  - Cholesterol
  - Lipoproteins (transporters for lipids)
  - Steroid hormone structures and locations

Cell Membranes

- -phospholipid bilayer and structure
- -fluid mosaic model
- -transport through membranes
  - diffusion
  - facilitated diffusion
  - active transport

Ch 9 Osmotic pressure pp310

- Dialysis p312
- Isotonic, Hypotonic, Hypertonic solutions pp311-312

Lab 9 topic overview:

Cell membrane & transport mechanisms
(coordinates with Ch 15, Ch 9-osmotic pressure)
Cell transport processes:
-diffusion (in liquid, in agar);
-Osmosis: using a dialysis membrane, effects of temperature

Lab Materials needed:
gloves, goggles, disposable lab coats, paper towels, trays
Diffusion:
potassium permanganate crystals; lab scoops or spatulas; forceps
100 mL beakers, centimeter rulers, wax pencils, thermometers
petri dishes & lids w/ agar
digital scales and glassine papers
refrigerator

Osmosis:
molasses; dialysis tubing, string
250 cc beakers, thermometers
digital scale, weight boats

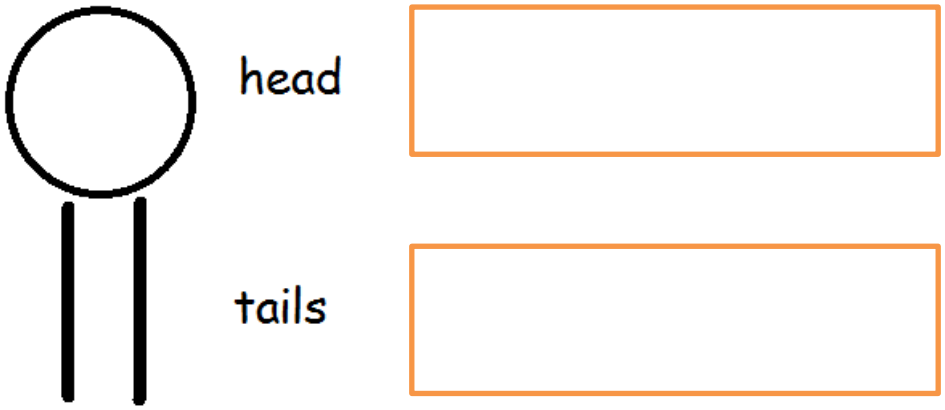
Assignment 4: Osmosis, effects of temperature

Due Date: _____

Lab 9

The cell membrane (Section 15.7) is 'selectively permeable' meaning it permits some but not all substances to move between the **intracellular** and **extracellular** environments. In chemical composition, the membrane belongs to the **lipid family** and is formed of **phospholipids** (Section 15.6). A membrane phospholipid is schematically diagrammed as shown below.

Ques: In the boxes, write the chemical composition of the head and tails.



Ques:

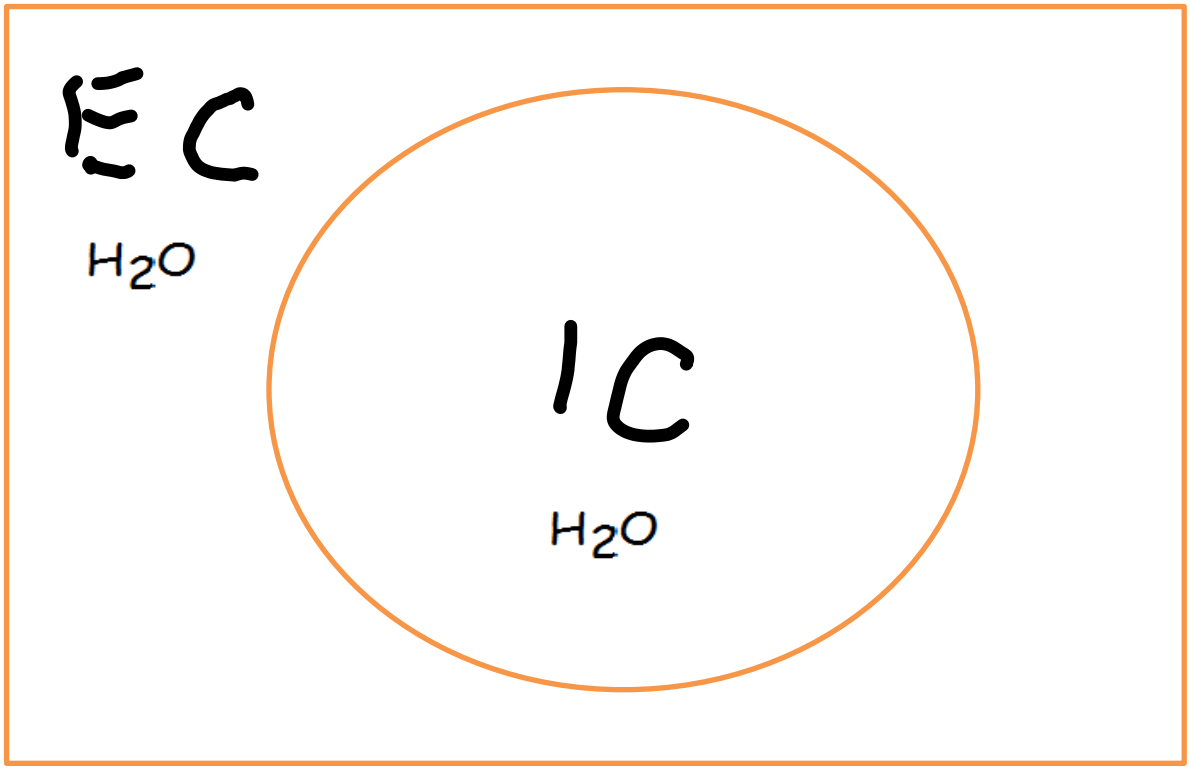
-Explain why the head is said to be 'polar'.

-Explain why the tails are said to be 'nonpolar'.

The core structure of a membrane is a **phospholipid bilayer.** In addition, the membrane contains **cholesterol (**belongs to a subfamily of lipid – **a steroid,** Section 15.6 p530) and **membrane proteins** (that perform various functions).

Ques: The diagram below shows a hypothetical cell in its environment where both extracellular (EC) and intracellular (IC) compartments contain water. **Draw the correct arrangement** of the core structure only - the phospholipid bilayer – as it would be around at the periphery of the cell.

(Hint: consider the relation between water and the characteristics of the phospholipid's head and tails. It may help to **draw the polar covalent water** (with charges) in the space below before drawing the phospholipid arrangement).



Diffusion is a passive transport process: Substances diffuse down a gradient; that is, they move from a region of higher concentration to a region of lower concentration toward equilibrium (no net movement). In the cell, gases and small molecules diffuse easily across the phospholipid bilayer. For example, CO_2 is a waste product of cellular respiration (Ch 15). The gas is in higher concentration inside the cell so it diffuses out of the cell into the extracellular space (down its gradient).

Diffusion requires no energy input to move substances. The process occurs because the atoms and molecules have **kinetic energy** (are in motion and subject to random collisions). The direction of movement ('downhill') is determined by concentration differences that exist 'uphill' and 'downhill'. When a substance reaches equilibrium it cannot reverse itself and go back 'uphill'---unless there is an input of energy. The latter is an active transport process.

Ques: How will increasing temperatures affect kinetic energy? rates of diffusion?

Objective: Diffusion occurs in the absence of a cell membrane. In these experiments diffusion rates of dye crystals (potassium permanganate, $KMnO_4$) in either water and agar. You will also study how temperature affects rates of diffusion

CAUTION: Potassium permanganate stains skin and clothing. Use trays beneath the bottle to avoid spilling on benchtops. Wear a disposable lab coat, make sure goggles and glove are on.

NOTE: Work in groups and divide the tasks to save time.

a) Diffusion in liquid

Method:

-Fill a beaker with100 mL tap water and add some crystals of potassium permanganate using the lab scoop or spatula. Note the location of the dye at the start period. Record the time it takes for the dye to diffuse throughout the beaker (equilibrium).

-Either draw the 'before' and 'after' conditions below or take cell phone photos.

b) Diffusion in agar; Effects of temperature

Objective:

Compare the rates of diffusion of potassium permanganate crystals in a an agar petri dish at a) room temperature; b) in cold (refrigerator)

Method:

-First equilibrate two labeled petri dishes (write on the lid with wax pencil) at the temperatures that they will be subjected by leaving them in their assigned locations for 10 minutes.

-Record the temperatures of their environment:

Room temperature: _____ Refrigerator temperature: _____

Ques: You will have to control for dye volume placed in each petri dish. Why should the dye amounts be the same? (Hint: What factor determines diffusion rate? What variable are you studying? Can you come to a conclusion about factor 'x' if the variables 'x', and 'y' were changed at the same time?)

-punch a small well in the agar of each dish (of the same size) and fill each well using the spatula tip or forceps.

-Measure the radius of each dye at time 0 in millimeters. (Keep the cover on and place the ruler on the cover). Record the data in the table below.
-return the dishes to their proper locations and continue 15 min readings until the halo radius size no longer changes. (You may not need all the table columns)

Result:

Write an informative title for the table:

	0 min	15 min	30 min	45 min	60 min	75 min	90 min
Radius (mm) at room temperature							
Radius (mm) in cold							

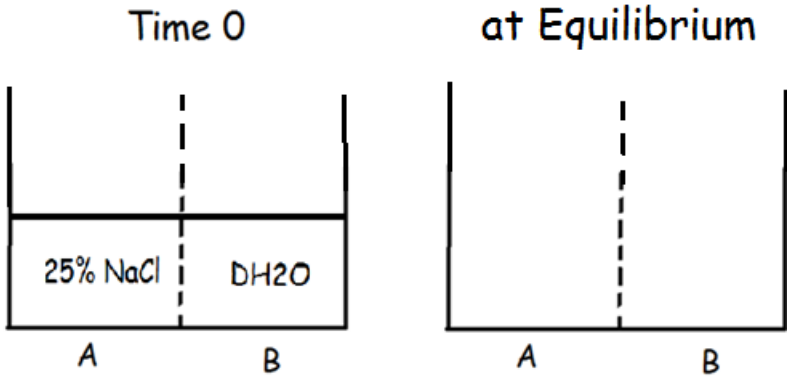
Conclusion:

This experiment provides a clear example of the difference between Result and a Conclusion. The *Result* in a scientific writeup describes the data: in this case dye radius differences as a function of temperature. The *Conclusion* is the explanation for the result (i.e., why the result occurred).

c) Osmosis, effects of temperature:

Objective: Study the osmotic movement of water across a selectively permeable membrane (dialysis tubing filled with molasses) and the effects of temperature on rates of osmotic flow.

Hypothesis: Using the diagram below draw a scenario of osmosis across the selectively permeable membrane (dashed line). Draw an arrow indicating the direction of water movement. (Hint: water moves toward the solute.) At equilibrium, draw the expected final fluid levels in each compartment.



Method:

- Dialysis tubing (the selectively permeable membrane) will be filled with molasses and placed in a beaker of either cold, room temperature and hot water. Osmotic movement of water is indexed by measuring weight changes in the dialysis bag over time (in grams).

-Set up three 250 mL beakers and with wax pencil label the three test conditions.

-Dialysis tubing should be pre-soaked in a container of water

-Prepare three dialysis bags. Tie one end of the tubing with string, fill each bag with molasses, about 2/3 full, tie the other end with string.

-Place each bag in a beaker of water in cold (1 ^{o}C), room temperature , 60 ^{o}C. Verify the temperatures with thermometer readings.

-Record the bag weights (to the nearest 0.1 g) in the table below at Time 0 and every 15 min to 75 min.

Results:

Informative title:

Weight (g) at	Time 0	15min	30 min	45 min	60 min	75 min
molasses in cold						
molasses at room temp						
molasses in heat						

Assignment 4

Due date _____

On separate sheets, write up the Results and Conclusions of this Osmosis Experiments

Results:
Graph the results in Excel
-include axes labels, information title
-Caption legend (separate page from graph)

Conclusion:
Explain the relevant concepts relating to the Result(s).

Format:
1. Cover page with your name, Course section, date submitted
2. Graph's Caption Legend typed on a separate sheet
3. Conclusion typed on a separate sheet
4. Cover page, graph, Caption Legend, Conclusion stapled.

Week 10

Lecture:

Ch 16 – Amino acids, Proteins, and Enzymes
- Proteins and Amino acids
- Amino acid structure & classifications
  - -nonpolar (hydrophobic); polar (hydrophilic)
- Chemical link to health: essential amino acids and complete proteins
- Protein structure
  - -Primary (peptide or polypeptide chain)
  - -Secondary (alpha helix, beta-pleated sheet)
    - -Collagen
    - -Protein structure & Alzheimer's disease
  - -Tertiary structure
  - -Quaternary structure
    - e.g, Hemoglobin
      - Chemistry link to health: sickle cell anemia
- Denaturation of proteins
- Enzymes
  - -naming enzymes
  - -enzymes as catalysts
- Factors affecting enzyme activity
  - -temperature, pH, enzyme concentration
- Enzyme Active site, Substrate interaction
- Competitive inhibition of enzyme action

Lab 10 topics overview:

Molecular modeling: amino acid, peptide
Pre-lab questions
Enzyme activity – effect of enzyme concentration
-amylase concentrations; rates of starch breakdown
-Use of colorimetric assays for start and end-products (iodine, optional – if there is time: Benedict's)

Lab Materials needed:

gloves, goggles, paper towels
Molecular modeling kits
Enzymatic digestion of starch:
- plastic bulb pipettes, test tubes, test tube holders, beakers
- stock starch solution (in a beaker preferably), glass stir rod
- stock amylase solutions (10%, 1%)
- water bath at 37 ^{o}C
- colorimetric assays:
  - -iodine, spot plates
  - -optional (if time permits): Benedict's solution, hot plate, 100 mL beakers

Lab 10

Modeling:

-using the molecular models

1) make two amino acids (only the backbones (leave the variable portion, the 'R' groups, empty)

2) perform a dehydration synthesis to make a dipeptide

Enzyme activity

Experiment Objective: . To observe the effects of different concentrations of amylase on its the rate of starch hydrolysis. To use colorimetric assays verify starch digestion to its end-product.

Pre-lab Ques:

-What is the importance of enzymes in chemical reactions? How does catalytic rate relate to the concept of activation energy?

_____

-In this experiment,

-which molecule contains the active site? _____

-which molecule is the substrate? _____

-How is amylase digesting starch? (What part of the molecule is the enzyme acting on?)

_____

-What colorimetric assay will be used to verify the presence of starch at the start of the experiment?

_____

-If amylase digests starch in steps, what is the

disaccharide product ? _____

monomer end-product? _____

-What colorimetric test will indicates the completion of starch digestion

-by giving a negative result? _____

-by giving a positive for the end-product? _____

-How will increasing enzyme concentration affect the rate of reaction? _____

-Every enzyme functions at an optimal pH and temperature.

-If you were using salivary amylase as the enzyme for starch digestion, what is its optimal pH?

_____

-What is the optimal temperature for biological enzymes? _____

Method:

-Test tubes containing enzyme at different concentrations and substrate will be prepared separately and placed in a hot water bath. Once the solutions have equilibrated to a constant temperature you will add enzyme (amylase) and substrate (starch) and measure the reaction progress at defined time intervals (every 30 sec) by colorimetric assay (iodine)

-Using a bulb pipette, prepare a total of 4 test tubes (use a wax pencil to label the tubes)

-2 test tubes will contain 4 mL each of starch

Note: starch tends to sediment on standing so cover swirl the solution first with a glass rod before taking your samples.

-2 test tubes will contain either

1 mL 10% amylase

or

1 mL 1% amylase

- Place all 4 test tubes in a 37 ^{o}C water bath for 5 min so they can all equilibrate at the constant temperature

-While waiting for the temperature to equilibrate, prepare spot plates by placing 1 drop of iodine into the wells. You will be adding the enzyme-substrate complex test samples to these wells at 30 sec intervals (2 wells total per time interval, one for each enzyme concentration.). Determine how you're going to organize the time samples and label them, as necessary.

-At the end of 5 min, remove test tubes from the water bath and quickly combine substrate and enzyme. (Pour one starch sample into the 10% amylase tube; pour the other starch sample into the 1% amylase tube)

-IMMEDIATELY after mixing the enzyme and substrate, perform a colorimetric test for starch using iodine.

- using the bulb pipette, remove ONE drop of enzyme-substrate mix and add it to the drop of iodine in the spot plate. This will be your Time 0 or baseline reading (before enzyme begins to act on the starch).

Record the data in the table below. Use a + for starch presence, - for negative result for starch)

Repeat the tests every 30 sec until you have a negative result.

(-If time permits, verify that starch has been digested by using Benedict's solution to give + result for glucose)

	Amylase concentration	
Time (min:sec)	10%	1%
0:00		
0:30		
1:00		
1:30		
2:00		
2:30		
3:00		
3:30		
4:00		
4:30		
5:00		
5:30		
6:00		
6:30		
7:00		
7:30		
8:00		
8:30		
9:00		
9:30		
10:00		

Conclusion: How did enzyme affect the rate of enzymatic reaction?

Week 11

Lecture:

Ch 17- Nucleic Acids and Protein synthesis
- Components of Nucleic acids (nitrogenous bases, pentose sugars)
- Nucleosides and Nucleotides
- Nucleic acid primary structure
- DNA
  - -double helix
  - -complementary base pairs
  - -replication
- RNA
  - -types of RNA: rRNA, tRNA, mRNA
- Protein Synthesis
  - -Transcription: DNA to mRNA
  - -Translation
- Genetic Code and Protein synthesis
  - -triplet code
  - -codons in mRNA
- Mutations: defined

Lab 11 topics overview:

Introduction to binocular (or monocular) light microscope use for observation of cell nucleus
- -proper handling
- -microscope parts
- -cleaning lens objectives and slides
- -proper focusing techniques

Identifying microscope parts
Microscope reversal, field of view, depth of field; ('e', thread slides)
Cell nucleus: Prepared slide (simple squamous epithelium)
Cell nucleus: Wet mount (cheek smear) preparation, histological staining to visualize the nucleus
Practice microscope drill for in class Assignment 5, next week: focusing to 100x (blood smear slide)

Lab Materials needed:

light microscopes, dissecting microscopes
lens cleaner, lens paper, immersion oil, Kimwipes
slides: letter 'e', three-color threads; simple squamous epithelium; blood smear
Wet mount (cheek smear) preparation:
- gloves, goggles
- toothpicks, clean slides, cover slips
- methylene blue
- microscopes

Lab 11

Typical lab microscopes

Two type of microscopes are the 'workhorses' of everyday lab work: they differ in their **magnification** and **working distance** capabilities.

-**light microscope**: relatively higher magnification but shorter working distance

-**dissecting scope**: lower magnification but has a long working distance.

Visualizing individual cells typically requires high magnification so the light microscope is most useful.

-What is the total magnification capability of our light microscopes?: How did you calculate the answer?

Some tissue specimens are very large; e.g.,spinal cord sections. To see the entire section at once, a dissecting scope is useful. The dissecting scope is also used when an object is bulky rather than flat.

Objectives: Identification of parts on the binocular (or monocular) light microscope

- Microscopes are in the cabinets

-Always carry scopes upright, holding by handle and supporting the base; when stored, the cords should be wrapped around the base

Identify the microscope parts:

-arm and base

-light switch

-oculars (eyepieces) *

-many scopes will have a pointer in one ocular.

-what is the ocular magnification?

-body tube

-revolving nosepiece with four objectives (second source of **magnification**)

Note: each time you turn to another objective it must snap into place.

4x – scanning

10x – lower power

40x – high power

100x – oil immersion lens (when used with immersion oil, you gain increased **resolution**. The objective is meant to come into contact with the oil. NEVER allow any other objective to contact immersion oil.

-stage with aperture; stage brackets (or clips)
-control knobs for X-axis and Y-axis stage direction movements
-condenser iris (aperture) diaphragm and lever
-regulates contrast and resolution, especially important at high magnifications
-closing down the diaphragm aperture
- 1) increases **depth of field**, **resolution**, **contrast.** 2) decreases light intensity
-opening the diaphragm aperture
- 1) decreases depth of field, resolution, contrast; 2) increases light intensity
-focus knobs
- coarse knob: used first, to bring objects into focus with 4x, 10x objectives
-fine focus knob: used ONLY at 40x or higher. Trying to focus a specimen at scanning or low power with the fine focus knob with jam the scope.

*Ocular adjustments: The oculars on your binocular microscopes are adjustable for two-eye viewing:
- the ocular barrels swing so you can adjust the distance between the barrels, allowing you to look at specimens comfortably with both eyes open (called 'inter-pupillary distance' adjustment

(Some microscopes also have the ability to compensate for vision differences between two eyes. This is called a 'diopter adjustment ring' – a adjustable ring located on one ocular barrel. If your microscope has one do the following: Determine which barrel contains the adjustment ring (e.g., right). Then focus a specimen using ONLY the other left eye with the stage. Then you view only with the right eye turning diopter adjustment ring until you can see clearly with both.. You can now view any slide without further ocular adjustments.)

<u>Viewing 'e' and 'three-color-thread' slides.</u>

1) The purpose of the 'e' slide is to show that the microscope **inverts** the image. It also demonstrates the loss of **'field of view' (FOV**) with increasing magnifications.

-In the space below, draw the appearance of the 'e' 1) without the microscope (on a white paper) and 2) at 10x on the microscope.

-In the space below, draw the appearance of the 'e' at 4x and at 40x. Your FOV decrease at the higher magnification.

2) The purpose of the 'three-color-thread' slide is to demonstrate changes in **depth of field (DOF)** that occur at different magnifications. DOF decreases with increasing magnification; i.e., you cannot simultaneously focus the full thickness of a specimen That is why most histological sections are cut very thin (e.g., 10-15 micrometers)

-Compare the thread image seen at 10x and at 100X. If you can see all three colored threads in high resolution then there is high DOF. DOF is low you can only see one thread in focus at a time. (Remember to clean slide and objectives with lens cleanser and paper.)

Microscope preparation and focusing to 100x (oil) with a prepared slide (simple squamous epithelium)

Method:

-Plug in the microscope and turn on the light switch

-Using the lens cleaning fluid and paper, clean off the slide to be used, the objectives, and the eyepieces

- Take the prepared slide and clean it with the cleaning fluid and paper

-Mount the slide on the stage, making sure it is secure between the stage brackets or slips

-Scan the slide at 4X. Once you have found a cell of interest, center it using the horizontal and/or vertical stage control knobs and focus using the coarse focus knob.

-Turn to the 10X objective and re-focus using the coarse focus knob. Keep the cell centered by readjusting the X, Y stage control knobs.

-Turn to the 40X objective. Only now should you use the fine focus knob. Re-focus and re-center the cell.

-Practice using the condenser iris condenser (aperture) diaphragm. Notice the changing appearance when the aperture is open and closed. In the best of condensers closing down the aperture can give a three-dimensional appearance to a viewed object.

-When you have the best resolution and light adjustment, rotate the nosepiece so it is halfway between the 40x and 100x objectives. The space allows you to apply a small drop of immersion oil directly onto the slide.

-Rotate the 100x objective into place and adjust for maximum resolution with the fine focus lens. (You shouldn't have to do more than turn it a hair)

-CLEANUP: After viewing at 100X oil, use lens cleaning paper and cleaner to clean oil from the all glass surfaces (objective, slide)

-NEVER leave oil on slides or objectives and NEVER submerge non-100X objectives in oil. The oil hardens to leave a milky residue which makes subsequent clarity impossible.

Preparing a wet mount preparation (cheek smear) for microscope viewing, histological staining to visualize the cell nucleus

Most routine histology (tissue) stains will darkly stain the nucleus of a cell. You will learn that a cell contains many **organelles** in the cytosol (outside the nucleus) but these

are visible only at very high magnifications (usually seen in electron microscope). In your wet mount preparation and stain procedures you will see the cell's boundary (plasma membrane), the clear cytoplasmic, a the darkly stained membrane-bound nucleus.

The histological stain **methylene blue** is used because the **DNA and RNA** inside the cell nucleus effectively reacts with the dye, making the cell nucleus visible.

Method:
-With a toothpick, GENTLY scrape the inside of your cheek. You will be scraping away cells from a multi-cellular tissue lining the cheek (buccal cavity).
-GENTLY swipe a clean slide with your tissue sample. Try not to crush the cells.
-With a pipette, place a small drop of histological stain (methylene blue) to the slide. (Don't flood the slide with stain.)
-To coverslip your preparation, touch the edge of the glass to the slide (not over your sample). Holding it first at a 45^{o} angle, slowly lower the cover slip over the liquid (with forceps or by hand) until it meets the slide. Take care not to create bubbles.
-Place the slide on the microscope at view it at sucessively higher magnifications (4x to 100x oil).

Find a slide area with individual cells and draw a cell at its best magnification:

Practice for graded 2-min focusing drill- blood cell at 100X (**Assignment 5**, next week)
-Using a blood smear slide, focus a cell at 100X within 2 minutes.
-Note: Timing for the drill will start AFTER you have made the diopter ring and inter-pupillary distance adjustments

Grading rubric:
1. slide and objectives cleaned with lens cleaner and proper cleaning paper
2. slide set securely within brackets
3. correct use of X- and Y- stage knobs to center slide within the stage aperture
4. began viewing at scanning objective
5. focus adjustment at scanning and low power made using coarse focus knob
6. objectives properly 'clicked' into place with each successive objective change
7. proper repositioning of objectives and application of oil
8. proper focus adjust at 100X made with fine focus knob
9. proper use of the condenser iris diaphragm
10. **specimen is centered in the FOV, has adequate light, is in focus at 100X**

Week 12

Lecture: Ch 7 - Preparation for understanding coenzymes in metabolism (Redox reactions & energy relations)
- Oxidation-reduction reactions, Section 7.6
- Oxidation and reduction in biological systems, Section 7.9

Ch 18 – Metabolic Pathways and ATP Production
- Metabolism, Catabolism (Digestion), Anabolism defined
- Catabolism of complex organic molecules
  - -Carbohydrates (polysaccharides to disaccharides to monosaccharides)
  - -Fats (triglyceride to fatty acids and glycerol)
  - -Proteins to amino acids
- Coenzymes in metabolic pathways
  - -NAD+ (oxidized/low energy), NADH (reduced/high energy)
  - -Coenzyme A (CoA)
- Glycolysis: oxidation glucose
  - -pathways for pyruvate
    - -aerobic conditions
    - -anaerobic conditions (lactic acid)
- Citric acid (Tricarboxylic acid or Krebs) cycle
- Electron Transport Chain and Oxidative Phosphorylation

Lab 12 topics overview:

Overview of cell structure/function using models (cell, mitochondrion)
Osmosis & Tonicity: microscope observation of Osmosis using blood cells (microscope, test tube examinations); effects of hypotonic, isotonic, hypertonic solutions (coordinates with Ch 9)

Lab Materials needed:
models: cell, mitochondrion
tissue slides: stratified squamous epithelium
Osmosis:
- gloves, goggles, Kimwipes
- clean slides; cover slips, beakers, bulb pipettes, wax pencils
- ox blood; stock saline solutions (0.9%, 10%), deionized distilled water
- test tubes & rack, test tube holders, parafilm

Assignment 5 (IN CLASS)

Graded Two-Minute Drill for microscope focusing of a blood cell to 100x.
Can be performed at the beginning of class.

LAB 12

Two-Minute Focusing Drill

Name (print) _____

Timing for the drill will start AFTER you have made the diopter ring and inter-pupillary distance adjustments

Grading rubric:

1. slide and objectives cleaned with lens cleaner and proper cleaning paper
2. slide set securely within brackets
3. correct use of X- and Y- stage knobs to center slide within the stage aperture
4. began viewing at scanning objective
5. focus adjustment at scanning and low power made using coarse focus knob
6. objectives properly 'clicked' into place with each successive objective change
7. proper repositioning of objectives and application of oil
8. proper focus adjust at 100X made with fine focus knob
9. proper use of the condenser iris diaphragm
10. **specimen is centered in the FOV, has adequate light, is in focus at 100X**

GRADE: _____

Cell structure and function:

Objective:

Be able to identify the following structures on the cell model. State a function for each structure;

Cell structure	Function
Nucleus	
Nucleolus	
Nuclear envelope & Nuclear pores	
Ribosomes	
Mitochondrion	
Cytosol vs. Cytoplasm	
Cell membrane	

Mitochondrion structure & function

Objective:

-Using the mitochondrion model, identify each region or structure
- outer membrane
- intermembrane space
- inner membrane with cristae (membrane foldings)
- matrix

Mitochondrion events:

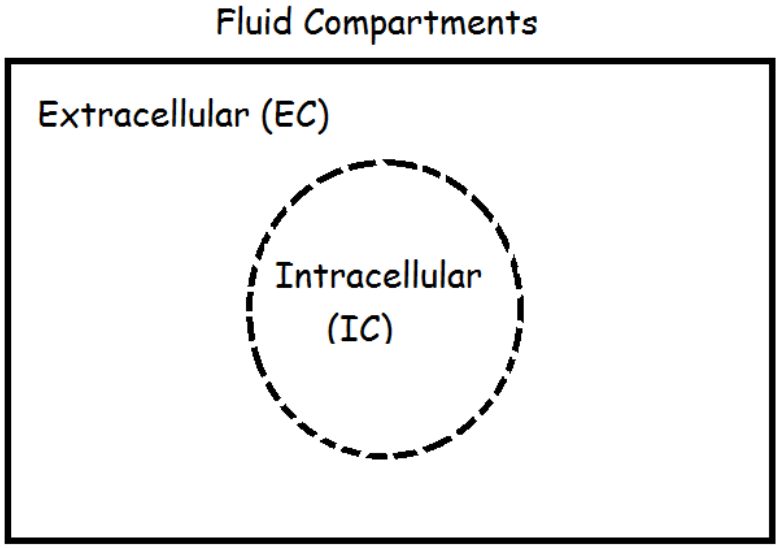
Answer the questions about mitochondrion functioning by filling in the table below.

ATPase synthase is located here	
Glycolysis occurs here	
Krebs cycle pathway takes place here	
Electron transport chain is located here	
A high proton concentration is built up here	
Protons diffuse down their gradient to this region	

Osmosis and Tonicity.
Introduction

We previously learned that the process of **Osmosis** requires a: 1) solvent, 2) selectively permeable membrane, and 3) solute. By definition, osmosis is the movement of solvent (water) across a selectively permeable membrane towards a region of higher solute (e.g, NaCl) concentration. In Lab 9, our selectively permeably membrane was dialysis tubing. In this lab, we will examine the movement of water across the selectively permeable membrane of cells.

The plasma membrane essentially divides the cellular environment into **fluid compartments** with specific fluid/solute compositions existing within the compartment. The diagram below represents the compartments in relation to a boxed environment



Ques:

1) In Lab 6 you prepared solutions of **physiological saline**. This sodium chloride concentration represents the normal value of the body's fluid compartments. Write the normal percentage concentration below and in both fluid compartments of the diagram above.

_____

2) If both fluid compartments contain equal NaCl concentrations AND the cell membrane is selectively permeable to water but not the salt, will there be any net (directional) movement of water across the selectively permeable membrane (will water move either toward the EC space or toward the IC space)? Why not?

The term **'Tonicity'** is used for extracellular solutions with respect to their solute concentration's ability to cause an osmotic flow of water into or out of a cell. In other words, it refers to the ability of a solute to 'pull' water across the membrane. Remember, water follows solute. Fluid movement across the cell membrane therefore changes a cell's volume, either expanding or decreasing it.

Three names are used to describe a solution's tonicity;

		Examples
isotonic solution	iso- ('same')	physiological/normal saline
hypertonic solution	hyper- ('greater')	seawater, 3% NaCl
hypotonic solution	hypo- ('less')	deionized distilled water

The tonicity of a solution implies comparison with a reference standard. The comparison is with the normal solute concentration inside the cell. The normal IC value for sodium chloride is 0.9% NaCl.

Objective: Blood cells (ox blood) will be used to study the effects of hyper-, hypo-, iso- tonic saline solutions on changes in cell volume and/or shape. In one experiment, changes in cell appearance will be viewed directly under the microscope. In a second experiment, the effect of different tonicity solutions on cells will be examined in test tubes.

Microscope examination of osmosis.

This experiment studies cells *in vitro* (in a dish) as opposed to *in vivo* (in the body). Ox blood samples will be subjected to three test fluid conditions: 1) distilled deionized water; 0.9% saline, 10% saline. Each mixture will be placed on a different slide, coverslipped and examined under the microscope.

Scientific reasoning:

Your **Results** will determine if there are changes in cell volume and/or shape: e.g,, does the cell increase, decrease in size or show no change?

On the basis of your results, what is your **Conclusion**: Remember, a conclusion is an explanation of the process underlying the result.

Method:

Prepare slide with ox blood and test substance and examine immediately under the microscope using the high power objective. Record your results and draw conclusion in the table below. (Slides should be prepared one at a time. Don't let them stand before observing.)

Slide#	Condition
1	drop of ox blood + drop of 0.0% NaCl (deionized distilled water)
2	drop of ox blood + drop of 0.9% NaCl
3	drop of ox blood + drop of 10% NaCl

Informative Title of Table:

Result: cell appearance at 400x total magnification			
Slide #	#1	#2	#3
Name of test fluid in the EC fluid compartment	DDIH2O (0.0% NaCl)	0.09% NaCl	10% NaCl
Tonicity name of test solution			
% water in the EC compartment			
% water in the IC compartment			
Conclusion: Why did the cells change volume and/or shape			

Note that you can describe water as moving down its gradient from a region of higher **water** concentration to a region of lower **water** concentration

Ques: Which of the cells in the photos below is in hypertonic solution? Note; cell shrinkage is called '**crenation'**

Test tube examination of osmosis.

Objective: To study test-tube hemolysis in hypotonic solutions by examining the clarity of a test tube solution.

A blood cell in hypotonic solution may burst (**lyse**) as water moves through the membrane and increases cell volume. **Hemolysis** is the term given when the lysed cell is a red blood cell. Hemolysis is detected in the microscope by a cell's 'disappearance', often leaving only a faint rimmed outline. Hypotonic solution-induced hemolysis can be quickly detected in tests tubes by examining the **clarity** of tube contents. This test depends on the ability to see print clearly when a printed page is placed behind the test tube solution.

Method:

-Label two test tubes with wax pencil as #1, #2.
-In one test tube add 3 mL physiological saline; into the other tube add distilled water
-To each tube, add 1 drop ox blood.
-Cover the tubes with parafilm and gently swirl to mix.
-Holding the tubes vertically, place any printed page behind each tube. Record the clarity of the printed words for each tube

Tube 1 clarity: _____

Tube 2 clarity: _____

Conclusion:

State tube with greater clarity, what that tells you of the tonicity solution the cells were in, and explain why the result occurred. Explain why there was less clarity in the other tube.

Week 13

Lecture and lab are based on the online reference:
https://openstax.org/details/anatomy-and-physiology _

Lecture:

Basics of Anatomy
-Ch 1: Introduction to the Human Body
URL address: https://cnx.org/contents/FPtK1zmh@8.86:Xh_25wmA@7/Structural-Organization-of-the
Section 1.2 Structural Organization of the Human Body
-Levels of structural organization (atom to organism)
-Organ Systems of the Human Body

URL address:
https://cnx.org/contents/FPtK1zmh@8.86:8Q_5pQQo@4/Homeostasis
Section 1.5 Homeostasis
-Negative Feedback
-Positive Feedback

URL address:
https://cnx.org/contents/FPtK1zmh@8.86:F-TuqKAF@4/Anatomical-Terminology :
Section 1.6 Anatomical Terminology
-Anatomical Position
-Regional terms
-Directional terms
-Body Planes
-Body Cavities and Serous Membranes
-Abdominal Regions and Quadrants
-Serous membrane structure
-visceral, parietal membranes, cavity
-pericardium, pleura, peritoneum

Lab 13 topics overview:

Human Body (human body models-torso, limbs)
-Organ Systems
-Anatomical terminology

Lab Materials needed:
torso models; limb models and articulated skeletons

LAB 13

This lab coordinates with Ch 1 of the online reference above.

Objective:

An introduction to basic anatomy. Using a torso model, limb model, skeleton, or yourself, identify the following anatomical directions, positions, regions,, organs, or systems.

- Place your teammate in correct anatomical position.

Note: all anatomical terminology is defined by anatomical position. Left/Right is defined with respect to the subject (not you). Do a handshake if you are unsure left and right. Your right hand will extend toward the subject's right side.

- Point to your teammates right ear.

- Turn your teammate so that you have a
    - lateral view
    - anterior (ventral) view (Note: In bipedal (two-footed) humans, anterior is also ventral, meaning toward the abdomen). In four-footed animals, anterior means toward the head and is therefore not synonymous with ventral.

- posterior (dorsal, towards the back) view

- With respect to directional terminology, the skin _____ to muscle.

- On the skeleton, point to the
    - most superior aspect of the body
    - most inferior aspect of the body
- The terms distal/proximal relate to which parts of the body?
    - point to the most distal part of the upper limb
    - point to them proximal part of the lower limb
- On the torso model, identify the two organs: heart and lungs.
- Is the heart (medial or lateral) to the lungs?
- The heart and lung organs are located in the _____ body cavity.
- What organ of the cardiovascular system lies in the mediastinum?
- On the torso model, point to the abdominopelvic cavity.
- On the torso model, locate and name the organ(s) in the
    - dorsal (posterior) body cavity
    - cranial cavity
    - pelvic cavity
- The ventral cavity includes both the _____ cavity and the _____ cavity.
- Name and locate the gonads of a male; a female (the reproductive organ forming sperm or egg)
- The reproductive organs are located in the _____cavity.

- Which major organ system is located in the abdominal cavity?

- Point to and name an organ in the pelvic cavity.
- The kidney is part of the _____ system.
- Locate the following organs on the torso models
    - liver
    - intestines
    - pancreas
    - testes
    - uterus
    - kidney
    - stomach
- The quadrants divide the _____ cavity.
- The liver is located in the _____quadrant.
- The most lateral portion of the stomach is located in the _____quadrant.
- The regions are divided into _____(how many) areas?
- The bladder is located in the _____region.

- Fill in the words to indicate hierarchy of organization of the body from simplest to highest organization level.

  Cells of common function form _____ which in turn form

  _____which in turn form _____

  which work together to maintain homeostasis of the _____

- Name and locate on the models or skeleton the organs belonging to the following Systems (also called organ systems).

  - Cardiovascular system

  - Urinary system

  - Digestive system

  - Skeletal system

  - Nervous system

- Muscular System (also called the Musculoskeletal system). (Does heart muscle belong to this system?

- Identify the following body locations on the models or skeleton.

  - buccal region
  - axilla
  - ocular region
  - brachium
  - carpus
  - inguinal region
  - femoral region
  - ped

Week 14

Lecture:

(online references based on https://openstax.org/details/anatomy-and-physiology
Lecture:
URL address: https://cnx.org/contents/FPtK1zmh@8.86:6iouz0Jo@5/Cell-Growth-and-Division

Ch 3, Section 3.5 Cell Growth and Division
-Cell Cycle
-Interphase
-Structure of chromosomes (compare to chromatin)
-Mitosis and cytokinesis
Cell division: mitosis followed by cytokinesis
-Phases of mitosis
-Prophase, Metaphase, Anaphase, Telophase

Lab 14 topics overview:

Microscopic examination of mitosis (whitefish, onion root tip slides)
End-of-semester review

Lab Materials needed:
mitosis board
mitosis slides: whitefish, onion root tip
compound microscope

LAB 14

Cell cycle:

Mitosis (**nuclear division**) occurs in **somatic** cells, that is in cells other than the reproductive 'germ cells' (gametes of sperm or egg). As you will learn later courses, cells making up some (but not all) tissues demonstrate mitosis. For example, worn or damage cells of the skin or digestive system linings routinely divide; adult brain cells do not.

Mitosis involves **nuclear division**. **Chromosome** number is first duplicated during interphase then divided during mitosis. The end result of mitosis should be the same number and genetic makeup of the chromosomes. If any change has occurred it is called a **mutation.**

Fill in the table information concerning the normal process of **Mitosis**:

# of daughter cells	
Daughter cells are genetically similar?	
Normal somatic chromosome #?	
Normal chromosome # after mitosis?	
Mitosis involves haploid? diploid? chromosomes?	
The abbreviation for haploid is	
The abbreviation of diploid is	
In which part of the Cell Cycle is DNA replicated?	

Objective:

To define the cycle the function of mitosis within the cycle. To observe and sketch the mitosis phases using whitefish and/or onion root tip slides.

Method:

Fill out the table below indicating the order of the mitoses phases and major event that occurs during these phases.

	Mitosis phases in order	**Major event**	**Identifying cell appearance**
1.			
2.			
3.			
4.			

Observe animal and/or plant mitosis slides and sketch each phase in the boxes below.

Whitefish mitosis

1.

2.

3.

4.

Onion root mitosis

1.

2.

3.

4.

End-of-Semester review: Notes

Week 15

FINAL Exams