GENERAL CELL BIOLOGY (BIOL. 3611)

The prerequisite is one year of general biology AND one year of general chemistry. If you have not finished this coursework, you should not be taking this Cell Biology course.

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The 57th tip of the "57 Tips for getting an A" section of this packet has the Dept and University Deadlines and requirements…make sure that you look at these…

OFFICE HOURS: 1-2 PM on Tuesday Thursday (days of class) at NC 3402. Office hours will not be held on days that classes do not meet (e.g., Spring Break). **Feel free to stop in at any time, or call and make an appointment.**

Required TEXTS: The World of the Cell, 7th edition, **AND the accompanying Solutions Manual**. Recommended: **Introduction to Chemistry for Biology Students**. Note that some students say that this course packet is as valuable as the text.

COURSE CD: The lecture notes are on the class CD with other ancillary material. These notes are not sufficient for full understanding; as often there is only one word on the slide, but a five min discussion on the topic, **IT IS CRUCIAL TO ATTEND LECTURE (also impt when I discuss TEXT FIGURES).** These NOTES ARE OFFERED AS AN AID; the notes are not meant to be complete and sufficient; attendance in lecture and your taking of your own notes is crucial!! These notes are a back up to the notes that you take in lecture! One word on the slide often translates into a five minute discussion. Often I make last minute updates to the lecture slides that are not in the notes on the CD (which were sent to the bookstore weeks before the class).

OUR COURSE WEB SITE: Use the files on the course CD, but some students prefer to use the our course web site. To get to the Cell Biology 3611 course web site, type in this URL (address): http://carbon.cudenver.edu/~bstith/. This is my home page; go down from the top a bit and find "Courses Taught by Dr. Stith." Then click on Cell Biology 3611 (or go directly to http://carbon.cudenver.edu/~bstith/cellbio.htm) for exam keys and animations. Animations, web links to sites covering the same material as we do, announcements, exams keys and a copy of this course packet are on the course web site. Our textbook also maintains a web site: www.awlonline.com/becker. Here you will find many of the animations used in the lecture hall or on the course web site.

TEST INFO: Tests will emphasize material from this course packet and from lectures; our textbook is used as a backup and review of material presented in lecture. As noted above, **if you do not go to lecture, you will do poorly (you cannot just read the text or lecture notes).**

Tests will include multiple choice, short essay and fill-in-the-blank questions (see extra credit homework for examples). There will be three lecture exams (100 points each), and one comprehensive final (100 points). Of the three lecture exams, **I will drop the lowest lecture exam** grade but the final exam cannot be dropped (thus, a total of 300 points for the semester from 2 lecture exams and one final). **At the end of the semester, I will add any extra points obtained from the extra credit homework** questions to the total of the best two lecture exams and the final. Typically, I use a cut off at 88-90% for A, 79% and above for B, etc. See the web site for a sample exam.

SOMETHING TO THINK ABOUT: A study in the Chronicle of Higher Education (Sept. 14, 2001, page B17) reported that learning-oriented college students were more inclined to explore possibilities and relationships rather than work only with known facts, and they were more attentive in lecture. In contrast, grade oriented students focus on making a grade, read only material that will be tested, view other class reading as an inconvenient waste of time, performed less well on exams, had poorer study habits and were twice as likely to report having cheated repeatedly.

SAMPLE CALCULATION OF A FINAL GRADE:
LECTURE EXAM 1: 57 PTS OUT OF 100. –**drop this lowest exam grade**
LECTURE EXAM 2: 78 PTS OUT OF 100
LECTURE EXAM 3: 79 PTS OUT OF 100.
comprehensive FINAL: 77 PTS OUT OF 100 (cannot be dropped)
DROP LOWEST OF LECTURE EXAMS 1-3 (i.e., DROP the 57)
ADD IN EXTRA CREDIT (MAX OF about 10-14 PTS; say you got 10 pts);
TOTAL points: 78+79+77 + 10 = 244 OUT OF 300 POSSIBLE; **THIS IS 81% OR "B"**
Yet the student essentially got Cs on the exam- the EXTRA CREDIT and dropping one lecture exam HELPS: note that this student averaged ONLY 71% on the three lecture EXAMS!!

FOR EXTRA CREDIT, FIRST HOMEWORK SET due by Feb 3 2009 (QUES. 1, all parts)!!

SYLLABUS

Note that this is **a flexible schedule and is subject to change** --however I will do my best not to change any exam dates. Typically, I end lecture material 5-7 days before the exam date.
Feb 24 **EXAM 1** (typically over chapt. 1- 5 or 6) (week 6)
March 16-20 spring break (week 9)
March 26 **EXAM 2** (week 10)
April 16 **EXAM 3** (week 14)

FINAL exam week May 11-16 2009: comprehensive final, about 40-60% on new material since exam 3, and rest of the final will be on the old material on exams 1-3. I am told later when the final is within finals week.

My Teaching Philosophy

Biology is part memorization and part application of concepts and facts. To perform well on exams, memorize facts, understand concepts and, most importantly, practice application of facts and concepts in new ways.

For example, an "memorization" question: bacteria are about what size? (answer: about 1 μm). A tougher application question: if I want to filter out bacteria from water from a mountain stream, what size filter would I use? (answer: a filter with pores smaller than about 1 μm). Another: viruses destroy cells and if you touch this lesion, you can pick up the virus. How many cells have to be destroyed before you can see the lesion with the naked eye (need to know the size of the average cell and the resolution of the naked eye; i.e., it's too late when you can see the lesion)?

We will discuss a fact or concept in one lecture, and we will apply it later. This is why it is so important to keep up with the class (don't put off studying until just before the exam; to encourage keeping up, I ask questions in lecture and have extra credit homework). I try to minimize or eliminate those facts that are not used again and again (the text tends to emphasize all topics or even ignore certain basics). SOMETIMES A STUDENT WILL SAY THAT THIS IS WORTHLESS INFORMATION (or "I don't need to know this detail") AND NOT LEARN IT. THEN I WILL SAY LATER: "OK, NOW LET'S USE THAT INFO FROM PRIOR LECTURE." AND THE STUDENT WILL BE FURTHER BEHIND. The newspaper articles at the end of this packet show that I have selected lecture topics because they are used in medicine…although they may seem to be esoteric.

A goal in this course is to learn how to think like a biologist; to develop the ability to attack a question about which you have very little specific knowledge. I have chosen those concepts that provide the basis of understanding most cell processes; we will apply these concepts over and over**. It is important for the student to realize that an apparently esoteric or weird concept (e.g., math of membrane transport) can be applied to seemingly unconnected areas.** For example, cystic fibrosis, diabetes and kidney stones involve malfunctioning membrane transport systems. We make ATP (possibly the most important reaction in the body) by use of active transport and facilitated diffusion. **The best biologists are able to apply facts or concepts from one lecture in a later discussion that seems totally unrelated.**

This goal and the way I teach Biology has benefited students; From a past student of mine: "I took you for developmental biology, cell signaling, and advanced cell biology**...Well, I am 3 weeks into my first semester of medical school at Ross University and** I wanted to tell you how amazing those three classes I took with you were. I am about 1-3 months ahead of my fellow classmates b/c of those three classes. It has made my transition into medical school much easier. **I am even having my mom send me all of your lecture CDs you gave us to help me study" (January 2006). An Oct 2007 email from a student of mine now at UC medical school: "I did get into medical school!!! Today in class, one of our professors asked if anyone knew what Notch was.** It was nice to be the only person of 157 people to know what notch was and answer the question. **My answer could have been better, but I got the point across!!** I'm really glad I took all of your classes!!! **We actually use the same book by Alberts. They just skim the surface of these topics leaving some people lost.** However, I feel very well prepared for this block b/c of your classes!!!"

This is a quote from "Connections" by James Burke:"A Scottish mechanic once made a minor adjustment to a steam pump and triggered the whole Industrial Revolution. A nineteenth - century weatherman developed a cloud-making device that just happened to reveal to Ernest Rutherford, a physicist he knew, that the atom could be split. Thanks to a guy working on hydraulic pressure in Italian Renaissance water gardens we have the combustion engine. A silk

loom and the 1890 U.S. census gave birth to the computer. Gaslight and the American War of Independence were responsible for raincoats. Glassmaking and English clay made possible transatlantic navigation...The process does not fall neatly into categories such as those we are taught in school. For example, most of the elements contributing to the historical development of transportation had nothing to do with vehicles. So there are no rules ...Things almost never turn out as expected. When the telephone was invented, people thought it would only be used for broadcasting. Radio was intended for use exclusively onboard ships. A few decades ago, the head of IBM said America would never need more than four or five computers." Some in Congress want to drastically cut back on research funding (especially those that they believe are worthless); they say that we should only fund certain specific categories, such as cancer research. What do you think this would do to progress?

See my home page about **the nature of research.** "Barnett Rosenberg wasn't trying to cure cancer...wasn't working on cancer (or)....on any disease-related problem (or)....with human cells. All he was trying to do was to test a hypothesis about what would happen when dividing bacteria were placed in a strong electric field. Yet he may have saved the lives of more cancer patients than most of the cancer researchers in the world put together." ..."a very important (idea)...is that **in science there is no such thing as useless information.**" (see web: http://www.asbmb.org/Page.aspx?id=1916).

Thus, I developed my philosophy on course subject matter: as a biologist involved in research, I find that modern biology requires a basic knowledge and application of math, physics and chemistry. You never know what fact you will apply in research. As you will note during this course, I do not expect total comprehension of all the difficult topics (e.g., you do not have to know derivation of equations- you do have to know the assumptions used in the derivations), however, by simply introducing these difficult but important topics you will eventually receive a "pay off." While it would be easier to teach a less demanding course, introducing these tough but crucial topics provides for a more rewarding course (many of my past students have come back to tell me that they were the "only ones" who knew about certain questions/topics when they took the DAT, the MCAT or the next level cell biology course).

I believe that note-taking is an important skill to be perfected (it has many benefits but most importantly, it develops your ability to think like a biologist and to learn the language of biology).

I believe that I should introduce a topic in lecture, provide a few of the infinite number of examples related to the topic, answer any questions students might have, and then it is up to the student to put in time studying the topic. Like a foreign language, I can summarize and explain "rules" but the student has to practice the "use of the topic" (like going to the language lab, you have to answer text questions, lecture questions, course packet questions, etc.).

I also believe that an important method of teaching is through laboratory research. If you are interested, please talk to me about this. I have had many undergraduate researchers in my lab, and they have been authors on papers and presenters at meetings in San Francisco, New Orleans, and Washington, DC. Research or travel has been paid for by National Science Foundation and the Undergraduate Research Opportunity grants. Over just the last 6 years, these students (among others) used their work in my lab to go on to great careers:

RYAN BATES (now working at Anschutz Medical Campus, Univ CO Denver)

KULAN BATABAYAR (just finished a Ph.D. at A. Einstein in New York, just left for Cambridge England on a PostDoctoral fellowship)

TIMOTHY SILVERSTEIN (now in Ph.D. program at Mount Sinai New York)

THOMAS MORRISON (received Ph.D. at UNC, Chapel Hill, now working in their virus center)
JASON STAFFORD (now in a Ph.D. program at UT SW; four Nobel laureates are on that campus)
WILLIAM HOLLAND (received a BS, MS in our department, Ph.D. at University of Utah, now a PostDoctoral Fellow at UT SW)
JEFFERY TAYLOR JUERGENS (now in a Ph.D. program in Pharmacology at Univ CO Denver -AMC campus)

Brief Summary of HOW TO GET AN "A" IN THIS COURSE

An "A" student will successfully combine memorization and understanding of topics and will be able to apply them to new situations. The "A" student will use clear thinking and logic in lecture exams.

- **TAPE RECORD LECTURE**
- **FORM STUDY GROUPS**
- **USE FREE TUTORING SERVICE (see point 44 below)**
- **ATTENDING LECTURE**
- **ANSWER EXTRA CREDIT QUESTIONS that I assign (see this packet), and END OF CHAPTER QUESTIONS IN TEXTBOOK**
- **WORK ON THE COURSE A LITTLE BIT EACH DAY (DO NOT STUDY ONLY THE NIGHT OR TWO BEFORE THE EXAM)**
- Reading the pertinent newspaper articles on topics discussed in lecture-see this packet.
- Looking at the animation and web sites noted on our course web page, and CD.
- Reading this packet thoroughly (ESPECIALLY BEFORE AND AFTER THE FIRST EXAM).

57 TIPS: Expanded Tips on getting an A:

PLEASE READ THIS AGAIN A FEW WEEKS INTO THE SEMESTER; IT WILL ANSWER MANY QUESTIONS THAT ARISE LATER IN THE COURSE. **Esp impt: reread it just before and after you get your first exam back.** It may be valuable for other courses so I encourage you use it as a general guide to studying.

1. **Attend all lectures (sound familiar?)**; lecture and text do not always coincide (use the book as a backup to lecture; I find that many students who only read the text have more misunderstandings and make more mistakes on exams). LECTURE attendance is very important as lecture material does not always coincide or agree with the text. Some lecture material is not in the text. There is too much material in the book so I will draw upon my experience in cell biology to pull out only the material which keeps coming up again and again in present-day cell biology. MATERIAL FOR EXAMS WILL COME FROM LECTURE, FROM THIS COURSE PACKET AND FROM THE TEXT.

2. Complete or use **extra credit questions found in this course packet for studying.** You will get the practice required for the use of our equations and test taking practice. If all extra credit homework is handed in, you will be given up to 10-14 extra points (added to your final point total at the end of the semester; they are NOT ADDED TO AN INDIVIDUAL EXAM). If you hand in half the questions, you will get about 7 points. Questions will be assigned at one lecture and the answers will be typically due the following lecture. One purpose of the homework is to encourage everyone to keep up with the material in the class (as concepts build upon each other) as the homework is typically due between exam days. Students have said that the best results are obtained from these homework questions if they form groups to

determine and discuss the answers (but turn in your own original answers). If you have questions about your answers, come in and see me. I recommend that **you copy your homework before handing it in since the unclaimed homework tend to build up into a huge pile**. Late homework will not be accepted without a Doctor's note. You can FAX me the homework questions if you cannot attend the class (303 556-4352; make sure that you put my name on the cover sheet). Do not send me the homework in an email attachment. Staple multiple pages together. Do not write your answers on the actual question page from the course packet but put answers on other paper. Since I cannot read some students handwriting, print your name clearly and include your student number at the top of the first page.

3. For certain tough material, I recommend looking through the questions at the end of the text chapters, and then look at the answers found in the required Solutions Manual.

4. I have attached **newspaper articles** at the end of this packet. These articles show that the concepts chosen to empathize in lecture can be applied in surprising ways. The articles show how the basic concepts/facts are applied (typically, in medicine). Read them; scan through them and retain one summary idea (e.g. know that a certain amino acid called…is important in a disease called…). You don't have to spend a lot of time on this, but this may be one of the most valuable learning experiences of this course. There will be a few points on each exam on the articles pertinent for each exam's material.

5. Tape record lectures!! This can result in a miracle improvement! (by the way, listen to the lecture playback with headphones to improve sound quality and enable you to hear me speak over background noise- don't use the recorder's cheap speakers).

6. Join a study group and use our Free tutoring service. Remember the movie *The Paper Chase*? Form a study group. I can help form these groups by announcing their meeting time and location.

7. If you have a problem and cannot make an exam, REMEMBER you can drop one LECTURE exam (you cannot drop the comprehensive final).

8. However, it is a big mistake to simply skip exam-many students have done this then regretted it later. Some were unexpectedly unable to make a future exam, or said that a particular test's material was easier than another.

9. Do Not Make Any Erasures On Your Scantron Sheet.

10. I will assign A/A-'s to students with points totaling ABOUT 90% (270 to 300 points) and above, B/B-'s are above about 80%, and C's above 68-70%. Typically, over 50% of the students obtain an A/A- or B/B-. However, only about 25% receive an A.

11. After each exam, the key, and grade listing will be posted on our course web site (see my home page; www.cudenver.edu/~bstith).

12. Asking for a correction in grading: be sure to check the key posted to the web **before** coming in to ask for more points. Write up your request for correction, explain why the points were taken off when they should not have been, attach this note to the exam and Scantron sheet. For exams handed back in for grading correction, I reserve the right to review grading throughout the whole exam. **GRADE CORRECTIONS FOR EXAMS MUST BE DONE LESS THAN 2 WEEKS AFTER THE EXAMS ARE HANDED BACK.**

13. Tips for the comprehensive final:

a) final is the same format as the other three lecture exams.

b) 40-60% of the exam will be review material from lecture exams. Study preceding lecture exams: I put some questions from the three lecture exams on the final (I may reword them).

c) **An efficient way to study: use the textbook illustrations.**

d) For the final and other exams, lecture notes are most important in studying. For the comprehensive final, next in importance: go over selected sections of text (sections that cover more difficult material).

14. If one part of a T F question is incorrect and another part is correct, the answer is FALSE. Although most students know this, to record an answer of True, **you would mark the A column on the Scantron sheet, false would be the B column.** There will be a few students at the first exam who do not read this and will ask how to record True or false answers on the Scantron form.
15. Give numerical answers in correct units. Show all work in calculations (start with equation with symbols, then fill in numbers, show work to obtain final answer).
16. Take a calculator to the exam
17. If I ask for 3 reasons in an short essay, answer by putting a number next to each of the 3 answers (instead of the grader having to guess which are the answers, having to pick and choose among various statements).
18. Start answers to essay questions by restating the question clearly ("the reason that protons move out of the intermembrane space is because...."). Often, the grader has to search for the correct answer in two paragraphs of writing that does not relate to the question. In other words, if I asked whether the sun rises in the morning, I would get answers such as "the sun is big and yellow, I awake at 6 am, my windows face east..."
19. Write neatly so the grader can clearly see and read your answer.
20. Some students answer the question too fast. Ask yourself: does my answer *sound* correct or do I really understand the question, why would he ask that? One student worked too fast and did not check their answer: they wrote "we can see cells and a typical animal cell". Related to this; some students said "I made careless mistakes...worked too fast...didn't think critically…"
21. Some students incorrectly used material from other courses to answer questions. Emphasize our definitions and presentation of material. Problems on exams arise when students use the Lewis definition of a base versus the one used by most biologists, use different categories for amino acids (instead of our listing of charged amino acids, using acidic and basic), use different definitions (we define solubility always in reference to only water), use different derivation or assumptions than what we use for Δ G, use different units for the R value, etc. The point is: as much of cell biology involves the application of physics, chemistry and math to biological problems, and since I present information in a way that is most useful to cell biologists (not necessarily physicists or chemists), you should emphasize the information presented in lecture when answering test questions. So when our cell biology text categorizes the amino acids in a manner different from your chemistry course, you have to the “biological” version. Related to this; students who have taken many chemistry courses often "tune out" in some lectures because they "already know" the material. This has resulted in many problems; some students that "tuned out" have said, in effect, that "I guess that I didn't really understand

the concept as well as I thought and I should have paid more attention to how biologists develop and apply the concept."

22. Some **multiple choice questions may have more than one answer <u>and you have to mark all answers for the question on the Scantron form.</u>** For practice, here are two questions of this type from a past exam:

How does the SER play a role in glucose metabolism (more than one answer possible)?

a. makes glycogen from glucose
b. removes a phosphate that is attached to glucose
c. transports glucose to the blood stream
d. acts as a kinase
e. acts as a phosphatase

Which proteins will have a signal sequence when they are first made (more than one answer possible)?

a. insulin
b. enzymes in the gut
c. enzymes found in the lysosome
d. enzymes found in the Golgi
e. enzymes found in Glycolysis

23. Even though you may understand the material, some students do poorly on exams because of poor vocabulary and grammatical skills. For these reasons, it is important to practice answering questions (see end of textbook chapter questions and extra credit homework). Test-taking and communication skills (especially writing/critical reading skills) are very important. In fact, our senior-level seminar courses center in on the practice of communication skills. This question confused some students: "an antibody localizes a molecule that gives off light." Some students asked what "localize" meant, and some students wondered if the phrase "that gives off light" referred to the antibody (if the phrase did, it would be a misplaced modifier). In another question, a few students answered incorrectly because they confused the meanings of "switching two objects" with the "transfer of one object." In another case, the student missed a question because they did not understand the function of a semicolon. Some students did not know what I meant by a "twisted ladder" when I used the term in lecture (referring to DNA structure) and then in an exam.
24. There are many older students who are returning to classes. Sometimes, their study skills are rusty. It takes up to a year for many returning students to redevelop study skills. If you are Pre-health professions, this means that your grades will not be the best during this first year--you may consider taking a course pass-fail or even just sitting in on the course to give yourself time to perfect your study skills. The book <u>Becoming a Master Student</u> has a chapter on problems faced by returning students (its on reserve).
25. Many students describe in detail how hard they work--how many hours were spent studying for an exam--yet they still did poorly. While there is a general relationship between how long you study and your grade, it is not a law. HOW you study, and how you perform in an exam situation are most important. Length of time spent studying does not guarantee an A. In addition to studying skills, one needs to know how to take a test

(see elsewhere; test taking skills). There are free seminars on study and test-taking skills. One student spent 35 hours studying for each Introductory General Biology exam yet still got a "C." When he subsequently took my General Cell Biology course (a harder course than GB), he said that he studied less than 10 hours yet he got one of the highest A's. His study and test-taking skills had improved.

26. Learn each item that you miss on each exam and understand why you missed it. Many students never look up what they missed on exams due to the belief that that section is over. However, the concepts will come up again and again and will be built upon. In addition, the final is comprehensive-it will cover the whole course.
27. If you miss a lecture, get a tape of the lecture and their written notes from a fellow student- not just my published lecture slides.
28. Some students said that they missed questions on my exam because they read the question with the idea that I would try something tricky to throw them off track (using a play on words or something very subtle instead of a straight forward examination of a main point in lecture). They said that they "read too much into the question."
29. THINKING SKILLS: One of the skills we teach is critical thinking. Many students put an answer down and say that it doesn't sound correct. They do not explore this thought, and continue taking the rest of the exam; this may result in an incorrect answer. You must think, think again, and then recheck. Why did the question state "all?" "only?" "sometimes?" If the answer doesn't sound correct, re-evaluate your answer. Continually ask questions of yourself when reviewing notes and the text. Why did Dr. Stith say that? That statement doesn't seem to fit into the discussion-what did I miss? What did he (or the text) mean by that? Why did he develop this concept with that fact? What is the connection between these two facts?

From: **Emotional Intelligence** by Daniel Goleman and article in **Time** (Oct. 2, 1995): the central trait for "being smart:" IQ and brain power may not be as important as being able to regulate "emotion in a way that enhances living." In short, being able to put off instant reward for long term reward, being able to handle anger, frustration, loneliness and to use worry/stress to focus the mind not cloud it (i.e., hard for depressed or angry students to study), and being an optimist to overcome obstacles that will cause others to give up. Another characteristic of those with high EQ (emotional quotient): being able to work with others (form study groups).

Levels of thinking and testing:

A. First level: Thinking at the level of "simple memorization." Questions should require only one step to answer or are simple regurgitation. The student who thinks at this level is confused by questions that require more than one step in obtaining the answer. Things are right or wrong. There is only one definition. An answer by the prof of "I don't know" is unacceptable. Ambiguity is unacceptable. This student does not use evidence to back up their thinking.

B. Second level: understanding and applying concepts. Student actively uses intellectual abilities and skills to analyze concepts. Test yourself; do you really know all implications of the concept and how to use it? Often, the student reads about or hears the concept in lecture and assumes that they know it but on a test they find out that they do not. Practice testing yourself; make up questions about concepts. However, alternate definitions or "exceptions to

the rule" can still be irritating. Often, people thinking at this level do not consider alternative explanations, and believe that all opinions are equally valid.
C. Third level: Using intellectual skills and abilities, the students bring together apparently unconnected ideas or concepts. Application of basic concepts to new, apparently unrelated problems. These are the toughest questions. The student can address ambiguity, offer best answer in context, bring into play many factors in their answer. **Memorizing lecture notes does not help to *apply* apparently unrelated concepts; develop your thinking skills.** For all of us, higher level thinking takes practice.

Note that the course will have questions from all of these categories; that is, there will be some simple questions that require memorization and regurgitation. Other questions will involve more than one step and require careful thinking; obviously, these questions require higher level thinking skills. Practice answering all three types will be important for medical school, dental and graduate school exams. Use the skills to identify assumptions that you may have as you enter this course (biology is easy; college is as easy as high school; I do not have to improve my logical thinking skills). As you go through the list below, remember to apply them to some form of writing (use sample exam questions). "Critical thinking" questions to ask while in lecture or reading:

A. What is the purpose of the exam question, lecture notes sentence or paragraph?

B. Identify Central problem (clarify question you are asking)

C. Point of view; any bias on the part of the author?

D. Is the author's reasoning based on data or evidence? make inferences that go beyond data support?

E. Concepts and ideas; are the concepts clear and relevant? correct use of key words and phrases?

F. Assumptions; what assumptions are used for reasoning? are they appropriate?

G. Implications, consequences and conclusions; where does this lead?

30. Related to these critical thinking skills is the ability to listen intelligently and critically in lecture. Learn to think in lecture, not just record details. Listen to get the main point. Ask yourself, why did the prof say that? Did it follow from the last part of the discussion? Can you see the connection between this topic and the last? Did the prof say something that seemed to contradict what he said last lecture?
31. Often students will think that they know a concept but, actually, they don't. **The first time many students test themselves is during the exam; they then find out that they did not clearly understand the concept.** So, constantly test yourself. You can do this by presenting the idea to a fellow student (JOIN A STUDY GROUP). Try to answer the questions that I present in lecture (write them down to practice them later). You can test yourself with the homework/extra credit, the questions in the student study guide or at the end of textbook chapters. Ask yourself questions about the concept (pretend that these are questions that will be on the exam). When making up questions, look at the concept from different angles (don't just make up a regurgitation question). The poorer students does not "self assess" or check that they understand the concept before taking the exam. After the exam, the poorer students say "I thought I understood the concept yet I got it wrong on the exam."

32. An important story to remember: a student came up to me after the first exam and complained that I tested only details, not concepts. She pointed to a question and said that she listened to the lecture tape after the exam and that the answer to the question was found in only one sentence of the lecture. The question was "Why is it easier to catch flies when they are cold?" On the basis that this answer was only mentioned, she said that I tested only on unimportant details. I noted that detail is important in Biology. Concepts are based on supporting details or facts. However, the question that she missed was a concept question. I spent 20 or more minutes of lecture time on the concept of temperature altering the rate of an enzyme-catalyzed chemical reaction. We discussed that the rate of enzyme-catalyzed reactions speeds up as temperature is raised from zero, peaks then declines again. I presented a diagram showing the rate of a reaction in the body versus the temperature- the bell-shaped curve was due to two factors. The first factor was important for the increase from lower temperatures; the rate of any chemical reaction (inside the body or outside) increases as the temperature increases. Second: if the temperature is raised to too high a value (often about 60 deg. C), then enzymes are denatured (weak bonds broken) and the chemical reactions responsible for movement slow down. Peak rate of the chemical reaction is usually body temperature. The enzymes of the organism work best at this temperature (peak rate of reaction). Since movement is due to a series of chemical reactions, movement may speed up with higher temperatures. We mentioned various applications of this concept; this is why flies are harder to catch in the summer, and why snakes like to lie to streets (to warm up so that they can move faster). We discussed the advantage of keeping the body temperature constant and high versus allowing the body temperature to cool down. The student did not understand the concept of temperature and chemical reactions in the body.
33. The more mature student will try to define concepts and details from the course and integrate them. The immature thinker will attempt to memorize a list of disjointed facts.
34. The active thinker will evaluate all information to see whether they understand the concept. The active thinker pushes each idea. The active thinker constantly asks "What would the consequences of that statement be?" What implications are there? What else could you say about that? **How could I apply this fact?** What impact would this answer have?
35. The good student will look up topics in ancillary texts (such as Chemistry for Biology Students).
36. Use the **Solutions Manual** for our Text (the paperback answer guide is also a required text) only after you have attempted to answer the question! Test yourself BEFORE you get into the exam itself. If you do not buy the Answer Guide, you will not get the review and experience answering questions found in the Guide.
37. A major goal in this course is to learn how to think like a biologist. To be able to attack a problem about which you have no prior knowledge (or at least, very little specific knowledge of details), and by using the basic concepts outlined in this course. The answer may not be correct but the formation of the answer would involve knowing and applying the basic concepts of biology. A quote that I often repeat in this course is: "Mother Nature likes certain things." Certain concepts come up again and again (that is, they are used again and again) and this makes them important.

38. Since I include fill-in-the-blank/short essay questions, the answer will be counted wrong if the spelling is incorrect.
39. I will briefly discuss derivation of ΔG and the Nernst Equation- you will not have to memorize the derivations but you will have to know the equation, how to use it (with practice questions), and **the assumptions used in the derivation**.
40. Know the experimental evidence for statements I make in class. I will ask for the evidence for certain theories on the exams. This is especially true for the Cell Division exam.
41. **For Exam 1** (note that the cutoff for material for exam one varies slightly from year to year), see **pertinent extra credit homework questions** (some of these were taken from old exams) and understand these concepts: Modern cell biology arose from what fields? Know the techniques and parts of the E.M. and light microscope, fluorescence microscopy, freeze fracture, centrifugation. Know distance units and measurements for various cell parts, eukaryotic versus prokaryotic, strong vs. weak bonds, water chemistry, biological macromolecules, amino acids, functional groups, protein structure (4 levels and bonds involved), glucose, structure of triglyceride, sphingolipids, molecular aging, thermodynamics, known equations for change in standard free energy and K_{eq}, assumptions of the equations. Go over textbook questions (see below).
42. **For exam number two (cut off varies)**: IN ADDITION TO homework QUESTIONS, go over the pertinent sections of the textbook (including section on Nernst and Goldman equations) and answer questions at the end of the appropriate chapters (esp. on bioenergetics and membrane transport). The lecture outline for membrane transport is in this booklet. In addition, there is a paper on our web site: the article by Alan Koch (from American Zoologist) on passive flux equations is very difficult--read it for a general review but you do not have to know it in depth. Know the Carboxypeptidase A mechanism. This exam is typically the hardest of the semester because it emphasizes mathematical biology (less straight memorization and more concepts and their application). For this exam, list what goes into and what comes out of the 6 equations that we emphasized (Δ G', Δ Go, Nernst equation, ΔG_{inward}, J_{net}).
43. Some problems require math commonly used in science: (practice and know how to do these operations on your calculator! You may have to know how to perform the antilog operation. For more help; see http://www.chem.tamu.edu/class/fyp/mathrev/mr-log.html.

    a. $\log(a*b) = \log a + \log b$

    b. $\log(a/b) = \log a - \log b$

    c. $\log (a^3) = 3 * \log a$

    d. if $y = \log_A X$, then $X = A^y$ (from web site above: $\log_{10}100 = 2$ is equivalent to $10^2 = 100$ where 10 is the base, 2 is the logarithm (i.e., the exponent or power) and 100 is the number)

    e. $e = 2.718$; $\log_e x = 2.303 \log10\ x$

44. For all exams and especially the final, *emphasize* lecture slides, this booklet, past exams, and homework questions. If you feel weak on certain topics, and want to review certain topics more completely, reread the text, go over the any animations on the web site or with the text CD.
45. Tutor's are available along (SOME SESSIONS ARE FREE) with information on techniques of studying, a test file, taking lecture notes, and taking exams. Test anxiety workshops are also available. Go to the Center for Learning Assistance (North Classroom 2006; 303.556.2802)- see: http://carbon.cudenver.edu/cla/
46. There are also tapes available in the library covering basic chemical principles (and of course biology topics).
47. Another book that I recommend is "**Becoming a Master Student**;" it includes a section on testing yourself to find any poor study skills, and one on the older, returning student.
48. ARE YOU HAVING TROUBLE WITH STRESS MANAGEMENT? RELATIONSHIP ISSUES? CAMPUS ADJUSTMENT? DEPRESSION? ANXIETY? Immediate, free advice and professional counseling are available at **UC Denver Student Counseling Center, NC 4036 303-556-4372**. See: http://thunder1.cudenver.edu/CLAS/faculty/emtionalIssues.html.
49. If you are not a biology major, this course will be very difficult as you will be competing against more motivated students. About 75% of our students are "pre-health profession."
50. Due to differences in material and your background (some students think the exam that emphasizes chemistry is the easiest, others think that it is the hardest), tests may vary in their difficulty. I try to make all tests the same level of difficulty but this is difficult as the material on exams varies in difficulty. If one test is easier for you, don't assume the others will be (and vice versa).
51. **IMPORTANT**: The major purpose of our cell bio text is to provide repetition of major concepts and practice problems. From the 3rd chapter, and using our required Answer Guide text, know questions 1, 2, 3 (except how to calculate binding energy), 5, 7 (but not 4,6,8). Also questions from the end of chapt. 5 (thermodynamics chapter), and chapt. 6 (especially question 7). Some questions at the end of chapt. 7 and 13 are especially important. Some of the other questions are ridiculously difficult. If you do not practice the concepts by answering these text questions (don't just look up answers first but test yourself) or the homework questions, I guarantee that you will miss similar questions on the exam. If you just read the answers to book questions, when you are faced with a similar question on an exam you will forget certain crucial steps or use the wrong units. Like a foreign language, you have to practice use of equations or concepts. IF YOU ANSWER THESE QUESTIONS, YOU WON'T HAVE TO GO TO EXTRA EFFORT TO MEMORIZE EQUATIONS; YOU'LL KNOW THEM THROUGH PRACTICE.
52. Read the class web site (see first page of handout for URL); there are some discussions (delta G derivation), articles on topics from class and animations.
53. Write out the various equations; list what goes in and what comes out (remember proper units!!).Write out the concept completely and clearly and have a fellow student evaluate it (what is the one main function of the electron transport chain? how does it do this? - you don't have to know the individual steps). See REVIEW OF EQUATIONS TO KNOW FOR CELL BIOLOGY in this packet.
54. Functional groups you may have to know (draw them to the right):

a. acetyl
b. aldehyde
c. carboxyl
d. amide
e. amino
f. acyl (note acetyl is a type of acyl where R=methyl group)
g. aromatic
h. aliphatic
i. sulfhydral
j. carbonyl
k. imino
l. hydroxyl
m. (note that carbon has four bonds, nitrogen three, nitrogen is positively charged with four bonds, sulfur has two, hydrogen one, oxygen two)

55. List of some degradative enzymes we will cover or note:
    a. RNase
    b. trypsin
    c. papain
    d. pepsin
    e. carboxypeptidase
    f. subtilisin
    g. dehydrogenase
56. **Complete the GENERAL INTRODUCTORY BIOLOGY INFORMATION THAT YOU SHOULD ALREADY KNOW** (as this cell biology course builds upon info from general biology class)--this is the first question in the set of questions found in the extra credit homework. It will be due a couple of weeks into the class--**Start Working On It Now**.
    READ CHAPT. 2-8 IN CAMPBELL'S BIOLOGY (one text for General Biology). Better yet, if there is time: read chapt. 1-11 -this is especially important for returning students who took Gen Biology years ago. In General Cell Biology, we will cover this same material only in more depth.
57. **Know deadlines and rules:**

Spring 2009 CLAS Academic Policies

The following policies pertain to all students and are strictly adhered to by the College of Liberal Arts and Sciences (CLAS).

- Every student MUST check and verify their schedule prior to the published drop/add deadlines. Failure to verify a schedule is not sufficient reason to justify a late add or drop later in the semester. It is the student's responsibility to make sure that their schedule is correct prior to the appropriate deadlines.
- CLAS students must use their email.cudenver.edu email address. Email is the official method of communication for all University of Colorado Denver business. All email correspondence will take place using your UCDHSC email address. Go to http://www.cudenver.edu/registrar to update and/or change your email address.

- Students **are NOT automatically added** to a course off a wait list after wait lists are dropped. If a student is told by a faculty member that they will be added off the wait list, ***it is the responsibility of the student to complete the proper paperwork to add a course.***
- Students are ***not automatically notified*** if they are added to a class from a wait-list. Again, it is the responsibility of the student to verify their schedule prior to any official dates to drop or add courses.
- Students must complete and submit a drop/add form to make any schedule changes. ***Students are not automatically dropped from a class if they never attended, stopped attending or do not make tuition payments.***
- Late adds will be approved ***only*** when circumstances surrounding the late add are beyond the student's control and can be documented independently. This will require a petition and documentation from the student. Late adds will only be approved if the student has not taken any exams, quizzes, or has not completed any other graded assignments. Independent verification of this from the professor of record will be required. Please note that the signature of a faculty member on an add form does not guarantee that a late add petition will be approved. Petitions are available in NC 4011.
- Late drops will be approved ***only*** when circumstances surrounding the late drop have arisen ***after*** the published drop deadlines, are beyond the student's control, and can be documented independently. This will require a petition and documentation from the student. Pre-existing circumstances (circumstances that existed prior to the published drop deadlines) regarding illness, work, family, or other confounding issues will not be considered adequate reason to drop or withdraw from courses after the published University and/or College drop deadlines. Please note that the signature of a faculty member does not guarantee that a late drop petition will be approved. Petitions are available in NC 4011.
- **Undergraduate students wishing to graduate in spring of 2009** must meet with their academic advisor by the end of the drop/add period to obtain a graduation application. This application must be completed and submitted by 5 PM on **February 4, 2009**. You can obtain an application ONLY after meeting with your academic advisor. **There are no exceptions to this policy or date.**
- **Graduate students wishing to graduate in spring semester 2009** must complete their Intent to Graduate form and have a Request for Admissions to Candidacy on file with the CLAS Dean's office no later than 5 PM, **February 4, 2009.**
- Students are responsible for completing financial arrangements with financial aid, family, scholarships, etc. to pay their tuition. Students will be responsible for all tuition and fees for courses they do not officially drop using proper drop/add procedures and forms.

Students who drop after the published drop/add period will not be eligible for a refund of the COF hours or tuition.

Important Dates

- **January 20, 2009:** First day of Class
- **January 25, 2009:** Last day to be added to a wait list using the SMART system.
- **January 25, 2009**: Last day to add a course using the SMART system.
- **January 27-February 4, 2009:** Students are responsible for verifying an accurate spring 2009 course schedule via the SMART registration system. Students are NOT notified of their wait-list status by the university. All students must check their scheduled prior to February 4, 2009 for accuracy.
- **January 26, 2009: LAST DAY TO DROP WITHOUT DROP CHARGE – THIS**

INCLUDES SECTION CHANGES.

- **January 26, 2009: Wait Lists are dropped.** Any student who was not added to a course automatically from the wait list by this date and time MUST complete a drop/add form to be added to the class. Students are NOT automatically added to the class from the wait list after this date and time. If your name is not on the official student roster, you are not registered for the course.
- **January 27, 2009:** First day instructor may approve request to add a student to a full course with a Schedule Adjustment Form.
- **February 4, 2009 at 5 PM:** Last day to add structured courses without a written petition for a late add. ***This is an absolute deadline and is treated as such.*** This deadline does not apply to independent study, internships, project hours, thesis hours, dissertation hours, and late-starting modular courses.
- **February 4, 2009 at 5 PM:** Last day to drop a spring 2009 course with a tuition adjustment **minus the drop charge** and no transcript notation – this includes section changes. Drops after this date will appear on your transcript. ***This is an absolute deadline and is treated as such.***
- **February 4, 2009 at 5 PM:** Last day to completely withdraw from all spring 2009 courses with a tuition adjustment and no transcript notation. **Drop charge applies.** Drops after this date will appear on your transcript. ***This is an absolute deadline and is treated as such.***
- **February 4, 2009 at 5 PM:** Last day to request pass/fail option for a course.
- **February 4, 2009 at 5 PM:** Last day to request a no credit option for a course.
- **February 4, 2009 at 5 PM:** Last day to register for a Candidate for Degree.
- **February 4, 2009 at 5 PM:** Last day to petition for a reduction in thesis or dissertation hours.
- **February 4, 2009 at 5 PM:** Last day to apply for spring 2009 graduation. You must make an appointment and see your academic advisor before this date to apply for graduation.
- **February 16-25**: Faculty can use the early alert system.
- **April 6, 2009 at 5 PM:** Last day for **non CLAS students** to drop or withdraw from all classes without a petition and special approval from the student's academic Dean. **This is treated as an absolute deadline.**
- **March 23-29, 2009**: Spring Break.
- **April 20, 2009 at 5 PM:** Last day for **CLAS students** to drop or withdraw from all classes without a petition and special approval from the student's academic Dean. Students still need signatures from the faculty and Dean. **This is treated as an absolute deadline.**
- After **April 20, 2009** all schedule changes require a petition. Petitions are available in NC 4011.
- ***No schedule changes will be granted once finals week has started. There are NO exceptions to this policy.***

Disability Accommodations- To be eligible for accommodations, students **must** be registered with the UCDHSC Office of Disability Resources and Services (DRS) (Arts Building, Room 177; 303-556-33450, 303-556-4766 TDD). If a student chooses not to accept the accommodations set forth by the DRS, they MUST complete all assignments and do all course work in the same manner as all other students.

Biology Department Policies:

Grievance procedure: If a student has a grievance with any aspect of a course, the first step is to meet with the instructor during office hours or by appointment to discuss the problem. This discussion should not take place by e-mail. Student and instructor should both maintain a professional, respectful demeanor during this discussion, and make an honest effort to listen carefully and to understand the other's viewpoint. If the grievance cannot be resolved by an honest and sincere dialogue between student and instructor, the student may then make an appointment to discuss the problem with the department chair.

"Incomplete Grades (IW/IF): Students in CLAS classes may be awarded an Incomplete grade, "IW' or 'IF,' only if the following conditions are satisfied: (1) student successfully completes 75% of course, (2) student has special circumstances that precluded the completion of graded assignments, (3) the missed assignments are to be completed with the original instructor, and (4) course grade is determined using original grade combined with missed assignments" (CLAS Faculty Guidebook). Incomplete grades (IW or IF) are not granted for low academic performance. Incompletes cannot be awarded that stipulate: (1) a student may repeat the entire course, (2) repeat or replace existing grades, (3) allow the student an indeterminate period of time to complete a course, or (4) allow the student to repeat the course with a different instructor. The CLAS Course Completion Agreement is available from the CLAS Advising Office, NC 2024. The departmental policy is that incompletes will be granted only when a majority of the course requirements have been completed and only one or two items remain to be completed. Incompletes are not to be given in which the student is to retake the entire course or simply because the student is earning a low grade. There will be no exceptions to this departmental policy. CLAS guidelines governing the administration of an incomplete can be reviewed at:

http://thunder1.cudenver.edu/clas/faculty/policyGrades.html#incomplete

Snowy day policy: some class days might coincide with large snowfall. If classes are not officially canceled (check radio or TV news or 556-8376 or 556-2401), a lecture or exam will be held. If the campus is closed, the exam or lecture will be held next meeting time.

The exam will be taken from students caught cheating and they will receive an F for the test. Further action may be taken. Warning: I have given an F to many students in the past because of cheating on an exam. Make sure that you have read the Student Code of Honor booklet to understand your responsibilities.

REVIEW OF EQUATIONS TO KNOW FOR CELL BIOLOGY:

1). $\Delta G' = (\Delta G'_o$ which is - RT ln Keq) + RT ln (P/R)
This equation is a chemical reaction, this equation calculates what?
what numbers do you put in and what are the units of the outcome?
under what conditions is it used?
explain the symbols in the equation (e.g., what is Keq?):
(for all equations below, answer same questions noted above for #1)

2) There is a different equation for a second type of chemical work: ΔG for diffusion; if we move a uncharged or charged molecule from a region with one concentration to a different region with a different concentration (diffusion). Specifically, we move a molecule **into** a cell, we would use this equation:

$\Delta G_{chemical,\ inward} = RT \ln [(conc.)_{in} / (conc.)_{out}]$

If the molecule is charged, we have to add a ΔG for electrical work. So the total ΔG for the movement of charged sodium into a cell is the sum of chemical (diffusion) and electrical work terms:

$\Delta G_{total,\ inward} = RT \ln ([X]_{in} / [X]_{out}) + zFE_m$
This equation calculates what?

3). We will not plug in numbers into these equations, however, you need to understand what they represent. Explain the terms and symbols in these two equations:
$J_{diffusion} = J_{chemical} + J_{electrical} + J_{convection}$ (which term drops with no osmosis? With glucose?) The book uses $J_{passive\ transport}$ instead of the more common $J_{diffusion}$)

$J_{total} = [J_{diffusion}$ or $J_{passive\ transport}] + J_{activetransport}$

5) Uses and forms of the **Nernst Equation**. How would you derive the Nernst equation from equation #3 above? What are the assumptions? Note we can rearrange the equation:

a) Membrane Potential = $RT/zF \ln [X]_{out}/[X]_{in}$ for potassium (same equation used to estimate equilibrium potential-define this- and to estimate the membrane potential).

b). EMF = $E_m - (RT/zF)(\ln [X]_{out} / [X]_{in})$ (used to determine direction and magnitude of diffusion)

QUESTIONS FOR EXTRA CREDIT HOMEWORK: (most are taken from old exams). Extra credit to be added at the end of the course.

1. **GENERAL INTRODUCTORY BIOLOGY INFORMATION THAT YOU SHOULD ALREADY KNOW** (as this cell biology course builds upon information from general biology class). This FIRST question (with its 58 parts) will be due a couple of weeks into the semester; begin completing it AS SOON AS POSSIBLE (typically due 2 weeks or so into the semester)- it is worth points toward your grade!! GREAT WAY TO STUDY FOR the Exams in Cell biology, MCATs OR OTHER GENERAL EXAMS. Use your General Biology or Chemistry text and notes (or even our cell bio text) to define the following for credit:

(1.1) strong bonds: covalent vs. ionic bonds,
(1.2) moles
(1.3) molarity
(1.4) molecular weight
(1.5) Daltons
(1.6) isotopes vs. radioisotopes
(1.7) atomic number
(1.8) $pH=-\log(H^+)$, acid, base, difference between weak vs. strong acids/bases
(1.9) $(OH)x(H)= 10^{-14}$ what does this mean?
(1.10) irreversible vs. reversible chemical reaction
(1.11) Law of Mass action (LeChatlier's law)
(l.12) enthalpy, entropy, how to draw a reaction diagram showing activation energy barrier
(1.13) Buffers: what do they do and how do they work?
(1.14) How ATP is used to make nonspontaneous reactions spontaneous (link up two chemical reactions with phosphorylated common intermediate). Does linking to ATP hydrolysis change the ΔG of a nonspontaneous reaction? Do enzymes alter ΔG?
(1.15) 2 types of covalent bonds (polar and non-polar).
(1.16) hydrophobic molecule (what type of covalent bond is predominate in these molecules?); hydrophilic molecule (what bond is present here?); which is soluble?
(1.17) Explain the 3 types of weak bonds that we emphasize (hydrogen, hydrophobic and weak ionic; e.g., hydrogen bond takes place between what 2 atoms?) How strong are these bonds (e.g., what are the bond energies?)? This info is important as protein shape/conformation, hormone binding to its receptor, substrate to enzyme and protein to protein binding occurs through these weak interactions.
(1.18) Explain the 4 levels of protein structure and the bond(s) involved in stabilizing each.
(1.19) How enzymes work: induced fit model. Discuss how the protein is a very rickety structure (its structure is stabilized by weak bonds) and is easily distorted (this distortion may turn on or off the protein).
(1.20) Define: active site, substrate, product, catalyst.
(1.21) The 3 types of amino acids are… (note that two types are commonly found on the surface of the protein whereas one type of amino acid is typically hidden inside the protein).
(1.22) Denaturation of a protein (what conditions break what bonds? Reveals what type of amino acid on the surface of the protein?).

(1.23) Feedback inhibition: explain this type of allosteric regulation, and compare this to competitive inhibition. Which is used by the body to control of enzymes?. What type of bonds (strong? Weak?) are involved in the binding of the allosteric regulator or competitive inhibitor to an enzyme? Poisons use what kind of bond to lock onto the enzyme?
(1.24) Explain the nature of the 4 classes of biological macromolecules (protein, nucleic acid, lipid, and polysaccharide) and their monomers (e.g. amino acids, etc).
(1.25) Draw the structure of an amino acid in terms of the atoms present, a true fat structure and a phospholipid structure (draw simplified block diagram of structure showing glycerol, phosphate, charged molecule and fatty acids).

Cell structure--describe structure and their function; SEE OUR TEXT CH. 4:
(1.26) microtubule,
(1.27) microfilament,
(1.28) mitochondrion,
(1.29) centrosome, MOC or cell center,
(1.30) chloroplast (is it surrounded by one membrane or two?)
(1.31) nuclear envelope (is it one membrane or two?)
(1.32) plasma membrane is made up of….(how many layers of what molecule?)
(1.33) what is the fluid mosaic model of the membrane?
(1.34) prokaryotic vs eukaryotic cells,
(1.35) ribosome,
(1.36) endoplasmic reticulum (what is the difference between the rough and smooth ER?),
(1.37) Golgi complex,
(1.38) lysosomes,
(1.39) peroxisome,
(1.40) extracellular matrix (list the 3 parts that make it up).

Basic steps of the following processes; proteins/enzymes involved in each:
(1.41) mRNA and protein synthesis (i.e., translation, transcription)
(1.42) mRNA processing, aerobic respiration, fermentation,
(1.43) oxidative phosphorylation vs. substrate-level phosphorylation,
(1.44) glycolysis, Kreb's cycle, electron transport chain, chemiosmosis
signal hypothesis and protein secretion pathway

Define the following terms from the "membrane" lectures/chapter:
(1.45)0osmosis,
(1.46) pure diffusion vs. facilitated diffusion vs. active transport,
(1.47) what kind of molecule (hydrophilic or hydrophobic) can pass through membranes?
(1.48) types of endocytosis,
(1.49) what is a glycolipid (structure)
(1.50) what does the Na-K pump do (move what ions where?),
(1.51) gap junctions,
(1.52) Tight junction.
(1.3)Explain hypotonic, hypertonic, and isotonic.
(1.54) what happens to a red blood cell when it is placed into a hypertonic solution?

(1.55) Cell division: draw the cell cycle (explain what happens in G1, G2, S and M phases),
(1.56) mitosis (explain events of phases: e.g., prophase, prometaphase, etc.),
(1.57) is cytokinesis part of mitosis? What is it?
(1.58) two of the most important proteins in cell division and cancer studies; what are cdk and cyclin? What do they do?
----------end of general review of Introductory Biology information

World of the Cell chapt. 1-3 (these questions are from lecture and out Cell Bio text):

2. The light microscope can see to about _____ whereas the electron microscope can see to about _____ microns. Bacteria are about _____ micron(s), whereas eukaryotic cells are about _____. Microtubules are ____ whereas microfilaments and proteins are _____. Organelles are about _____ and membranes are _____ (use correct units for above).

3. Describe, draw and equate the basic parts of a light and electron microscope:
4. What "microscope" technique would you use to prove the following statement?
THE MITOCHONDRIAL INNER MEMBRANE HAVE LOT OF MEMBRANE PROTEINS, BUT THAT THE LAYERS OF THE OUTER MEMBRANE HAVE LESS.
Explain the method of the technique.
5. The properties of water can be explained by its unusually high number of…
6. If water did not have its unusual properties, how would we be different? (that is, if water had low heat of evaporation, how would our physiology be different?)
7. For the following questions, use these answers: (**note that more than one answer is possible for each question—taken from old cell bio exam** and good practice for this type of question on your upcoming cell bio exams)

A. weak bonds
B. hydrogen bonds
C. disulfide bridges
D. hydrophobic interaction
E. strong ionic bonds
F. weak ionic bonds

a. what weak bond holds 2 layers of phospholipids in membranes together?
b. can be both weak and strong
c. among weakest of covalent bonds
d. 60-100 kcal/mole of bonds
e. links enzymes to substrates
f. bonding involves carbon-hydrogen chains
g. as we discussed in lecture, broken by reduction

8. Draw alpha and then beta glucose (if lecture has not covered all of these yet, look up the structure in your text)

9. Protein structure:
(a) In a typical protein where are the nonpolar amino acids? In a membrane protein, where are they?

(b) Read the *Scientific American* article "Glucose and Aging" that is on our class web site (look under chapter 2-3 material; see "For a copy of the article on GLUCOSE AND AGING, CLICK HERE (it is in pdf format, so you need the pdf reader)." Draw the reactions that occur between a glucose molecule and a protein that end up cross-linking two proteins. Note which functional group of the amino acid initially reacts with glucose. What form of glucose reacts (linear or ring?)? Note that the major text for diabetes relies upon this reaction.

10. Why are animal fats solid at room temperature?

(Chapter 4 summary cell structure material is from General Biology and is tested in question one)

Thermodynamics (this is a way of thinking about the cell and its reactions) chapt. 5

11. If the cell breaks down ATP in making a polysaccharide, what kind of work is this?
12. When is the change in enthalpy the same as the change in internal energy? Look at the web link that explains this…go to our course web site and find the link…
http://carbon.cudenver.edu/~bstith/cellbio.htm see link in third paragraph or just click on:
http://carbon.cudenver.edu/~bstith/derivegibbs.pdf to view the pdf file on derivation of the Gibb's Free Energy equation for chemical reactions.

13. What are the assumptions of the Gibb's free energy equation for chemical work? Biologists have to remember that there are many biological situations where this equation cannot be used…
14. Two Free Energy questions:

a. Given the free energy change **under actual conditions** (-6.2 kcal/mol), and the concentrations of a reactant (1 millimolar) and two products (0.2 mM and 50 micromolar), **calculate the standard free energy change**. Remember that chemists often stop here but that biological systems are typically not in standard conditions (but we often need this calculation to get to nonstandard conditions). First start with writing the equation (with only symbols). Note that units will have to be changed to one type of molarity (micrmolar versus millimolar; remember that 0.2 mM is $2x10^{-4}$).

b. show all work in solving question 5-6, from chapter 5 of our text (it is the one on calculating delta G zero/prime, delta G prime and using the Keq). Remember that delta G prime is the nonstandard condition that represents the cell.

15. If the chemical reaction is not already spontaneous, the body uses what molecule to make the reaction spontaneous (or drive the reaction)?
16. Biologists typically use other forms of the delta G equation; for example, biologists use the for the movement of ions across membranes (bad movement of ions across the kidneys or lungs or cells is associated with a huge number of human diseases). Let's practice the thermodynamics equation for movement across membranes. If $[Na]_{out}$ is 150 mM, $[Na]_{in}$ is 4 mM, and the membrane potential is -60 mV, is inward movement of sodium spontaneous (use our thermodynamics equation)? How much work can this movement of sodium do (or how much work is required to cause the inward movement of sodium?)? For help, see questions and answers in LECTURE slides).

Enzymes Chapt. 6 (again, some questions from old exam)

17. T F The purpose of enzymes is to alter the ΔG' of a reaction. Explain.
18. Do you think that synthesizing a complex fatty acid from smaller molecules is spontaneous? Why? What is a synthetic reaction in biology called? A degradative reaction is called.. ?
19. Define the following:

a. a redox reaction,
b. a catalyst; how do catalysts work?
c. Specificity pocket
d. levels of protein structure and bonds that stabilize them
e. we modeled protein structure with a flexible kid's toy; what is the flexibility due to and why is this important?
f. what are the terms for the two shapes of proteins? (hint; a spherical shape is…

20. What are the functions of the important tyrosine, glutamic acid, arginine, and zinc ion in the mechanism of action of carboxypeptidase A (**see lecture slides** for chapter 6)?
21. The temporary transition state is a weird molecule that is located where on the reaction energy diagram (the reaction energy diagram has the molecule's G value on Y axis, reactants/products on are on the X axis)? Draw the example of the weird transition state molecule from the carboxypeptidase reaction.
(I highly recommend: f**or practice, but you do not have to record the answers here, do the questions at the end of the enzyme chapter -chapter 6).**
Concerning enzymes (explain correct answer):
22. T F The body turns on chemical reactions by turning on the enzyme that speeds the chemical reaction. To turn off a chemical reaction, the enzyme for the reaction is turned off.
23. T F The body turns off enzymes through allosteric regulation. The study of medicine involves an attempt to turn off bad chemical reactions in the body through drugs. Drugs are usually competitive inhibitors not allosteric regulators. AZT is an example.
24. Look in your textbook for this answer: What are the two types of enzymatic reactions (e.g., electrophilic substitution vs...). Explain their mechanisms (in particular, the nature of the attacking group of the enzyme).

Membranes, Membrane Transport (Chapt 7, 8 and 13)
25. What types of phospholipids are there? Identify which has what backbone (name the 2 types of backbones).
26. Show and describe 2 methods that demonstrate the fluidity of membranes.
27. Membrane fluidity must be carefully controlled for the cell to survive… (a) What happens to membrane fluidity if the cell is taken to very low temperatures?
(b) or to very high temperatures?
(c) Since abnormal fluidity can prevent membranes from functioning normally, some cells respond by changing the nature of their membranes. Explain how fatty acids components of phospholipids and cholesterol levels are changed in response to high or low temperatures, and why these changes help.

Questions Using Work Equation for Ion Movement and The Nernst Equation:
Work through the problems below before you look at the answers. **See page 17 in this course packet for a summary of the equations that we use in this course.** Since exam 2 is typically

the most difficult, these practice questions are especially important. Note that by answering these questions, you will understand and memorize the **Work Equation for Ion Movement and Nernst equation** (required for exams). **Optional but highly recommended for more practice using these equations: answer Nernst equation and membrane potential questions at the end of chapter 13 (esp. questions: 2, 4, 5).**

For the situation below, ion concentrations are (millimolar):

	outside the cell	inside the cell
Sodium	150 mM	10
Potassium	3	21
Chloride	5	10
Bicarbonate	10	5
Calcium	1	0.0001

The membrane voltage is +60 mV (inside is positive relative to out; this is the opposite of the value in a typical cell but allows us to check our understanding). R= 1.987, F = 23062. All net fluxes are zero (ions are in equilibrium). Temperature is 25 deg. C. Use for below.

28. Show the equation used (using symbols only) and calculate how much work is done when sodium (Na) moves into the cell. How do you know which direction diffusion will push the sodium ion (into the cell or out of the cell)? Hint: remember that the ΔG for chemical reactions gives a positive or negative number and this tells you whether something is going to happen on its own. This movement of sodium does a lot of work for certain cells (instead of ATP).
29. What are the assumptions of the Nernst Equation?
30. Using the above conditions, use the Nernst equation to estimate the membrane potential. Show the equation, give answer in correct units and identify what numbers you would need to estimate the potential.
31. You want to describe the direction and size of the force of diffusion on an ion (which is dependent upon the cell since the cell sets up the concentration gradient and membrane potential). To determine this, you need to find the equilibrium potential for K; show how you would calculate it (what equation would be used?). Explain what this theoretical membrane potential is equal to (hint: in terms of forces represented by arrows, arrows are equal and opposite…). **For help, see question 13- 4 in your textbook and use the answer guide**.
32. Using the conditions noted above (see ion concentrations above), calculate the Electromotive force (EMF) for the potassium ion. Show the equation used, how numbers are plugged in, answer in correct units. Cite the rule (+ number for a + ion means…) and note whether the net force (combination of electrical and chemical/concentration gradient) is directed out of the cell or into the cell.
33. For movement due to pure diffusion, a channel for facilitated diffusion, a carrier for facilitated diffusion, and active transport, fill in the following table (**hint: see similar table in our textbook**):
a. ATP required?
b. driving force(s)?
c. very selective about what moves?
d. slow or fast?
e. shows competitive inhibition?
f. shows saturation kinetics?

g. ΔG positive or negative? Consider the case of no ATP present.
h. involves a membrane protein?

34. The movement of a molecule or ion across a membrane is equal to the total flux (J_{total}); the total flux is equal to the flux due to active transport ($J_{active\ transport}$), plus the flux due to the electrical gradient ($J_{electrical}$), plus the flux due to the chemical gradient ($J_{chemical}$; concentration gradient), plus the flux due to convection ($J_{convection}$; water flow carries along the ion/molecule; important in plant root cells, some kidney cells). Also, the combination of $J_{chemical} + J_{electrical}$ is called "interfusion." Based on this discussion, pure diffusion ($J_{diffusion}$; **Note that the book uses a term called $J_{passive\ transport}$ instead of the more common term $J_{diffusion}$.**) is equal to what three terms? (**hint: convection plus…**).
(b) The J_{total} for glucose across a typical cell membrane (not root cell) is the sum of what symbols noted above (some flux terms are zero, so do not list them)? Remember the figure shown in class showing glucose moving from the gut to the blood stream.
(c) What terms are used in the J_{total} for the movement of sodium across the typical cell membrane?
Remember: there is a summary of all equations on page 17 of this course packet.

35. Explain the two ways that glucose can move across a membrane. Show where each type of movement occurs in a gut cell (and explain why they are used where they are).
36. Explain the steps of how a membrane potential develops. Check the animation on our web site.

Review Questions For Signal Transduction: Messengers and Receptors Ch. 14
37. Explain what cell signaling is.
38. What are the methods that cells use to communicate?
39. Chemical mediators work over what "distances."
40. What are the types of chemical mediators?
41. Explain the cAMP, IP3 and tyrosine kinase paths of cell signaling. Include a discussion of how the receptor can work through an enzymatic mechanism, an ion channel or a nonenzymatic method (e.g., G protein).
42. Briefly compare cell signaling paths of the alpha and beta adrenergic receptors and what these paths cause inside the cell.
43. In the proteins of the map kinase path (part of the growth factor pathway), which are enzymes and which are binding proteins?
44. Explain the difference between kinases and phosphatases; what do they do?
45. How are G proteins turned on and off? What toxin can affect a G protein? How is the cAMP system related to G proteins?
46. Explain ways that intracellular calcium can be increased.
47. Explain how calcium can act as a second messenger (what protein binds calcium?).
48. Use the EMF equation (involving the Nernst equation) to calculate the direction and magnitude of the electrochemical gradient for **calcium** across the plasma membrane of the average cell (use a plasma membrane potential of -60 mV; remember to change it to volts; 1 mM [Ca] outside, 0.0001 mM [Ca] inside).
49. Use ΔGinward to calculate how much work could be done if calcium moved into the cell

(change sign and you find how much work is needed to push calcium out of the cell). Specifically, since there is a calcium pump in the plasma membrane that pumps calcium out, how much energy does the calcium pump need to move one mole of calcium out of the cell?
50. How is calcium kept low?
51. How is calcium concentration measured inside a cell? (hint: cell glows)

Organelles (chapt 9,10, 12)
52. Explain the functions of the SER; show and name the chemical reaction found there (that we discussed in lecture).

53. Some forms of arthritis are thought to be due to a mistake; instead of _____ (name of vesicle) merging with the plasma membrane, a _____ (organelle name) merges with the plasma membrane. Hint: both are products of the Golgi and one involves acid hydrolases). If anti-arthritis drugs such as steroids act by decreasing the frequency of any vesicle/organelle merging with the plasma membrane, what side effects would you expect? Hint: involve the vesicle noted above.

WE CAN USE THE MOVIE "LORENZO'S OIL" TO ILLUSTRATE MANY BASIC PRINCIPLES TAUGHT IN Cell Biology 3611: I recommend but do not require you to watch the movie "Lorenzo's Oil." It is available from video stores (or from me) and shows the process of science. Some of the questions below will be hard to answer (we may not have emphasized or discussed some issues in lecture-look it up in your textbook); make your best attempt. Many answers are found in my web paper on ALD; see "Presentations and Web Papers" section: http://www.cudenver.edu/~bstith. Also, see our text: page 84-85 Box 4A (6th edition of text).

The disease portrayed in the movie is called ALD. In the perioxisome, long chain fatty acids are broken down by ß oxidation (the mitochondria handles shorter chain fatty acid breakdown). One idea for the cause of adrenoleukodystrophy (ALD) is that the oxidase (enzyme) that breaks down fatty acids does not get across the peroxisome membrane. The oxidase enzymes are made in the cytoplasm but a transport or carrier molecule located in the peroxisome membrane is nonfunctional and is unable to carry the oxidase into the lumen of the peroxisome. The carrier protein would be a mutant; it does not have the correct amino acids (different primary structure) and thus may not fold properly (have correct secondary and tertiary structure). The active site of the enzyme may be distorted so that the peroxisomal enzyme can not bind and be moved into the peroxisome lumen. Another idea is that the cause of ALD is that an integral membrane protein that transports the very long chain fatty acids into the peroxisome is not functioning. In this model, the oxidase is fine and is located in the peroxisome, but the substrate never gets to the oxidase.

For whatever reason, fatty acids build up in the body of the child (as measured by levels in the blood). Specifically, the dangerous fatty acids are saturated, very long chain fatty acids that are 24 or 26 carbons in the chain (this is what they mean by "very long;" many fatty acids are shorter with 14, 16, 18, 20 or 22 carbons).

The long chain fatty acids prevent the formation of myelin sheaths around nerve cells. For this reason, nerve cells don't function well.

In the movie, the Odones suggested that synthesis of the very long chain saturated fatty acids can be prevented if the cell switches over to making unsaturated very long chain fatty acids

(which are harmless). Erucic acid is a long chain (C22) fatty acid that is used by enzymes in the ER and elongated to make harmless unsaturated very long chain fatty acid (C24, 26). Thus, if they could increase the amount of erucic acid in the little boy, the enzyme would not make the harmful form but spend all of its time elongating the harmless form from erucic acid. The other substrates (shorter saturated fatty acids) used to make saturated very long chain fatty acids would be competing with erucic acid for the same enzyme.

54. Where are fatty acids made (in this case, elongate shorter fatty acids into very long fatty acids)?
55.What are fatty acids? Draw out the structure; show a kink due to a double bond. What is the functional group that is at one end, and is negatively charged, called?
56. When three fatty acids come together with glycerol, what is the name of the molecule?
57. Draw the molecule noted in the last question, use our block diagram style.
58. What are the 2 major biochemical reactions that occur in the peroxisome? What 2 enzymes are involved in these reactions?
59. What are unsaturated and saturated fatty acids? Why would only very long chain saturated fatty acids be dangerous (not unsaturated, or shorter fatty acids)?
Diet: the first method of treatment (unsuccessful) of Lorenzo was to limit the dietary intact of saturated fatty acids. Certain foods contain a large amount of the molecules and they were avoided. However, faced with a reduction of the fatty acids in the diet, the body simply makes more. Thus, the patient still has an increase in fatty acids and the nerve cells are still affected. So changing to a diet lacking long chain fatty acids did not help since the body simply made large amounts of fatty acids.
60. Draw the diagram of the sink model portrayed in the movie (e.g., level of fatty acids in the blood stream is the level in the sink; explain the two "faucets or spigots" -what they are. Explain what organelle is the drain. Where is the problem (a faucet? Drain?) in Lorenzo's cells?
61. So, treatment of ALD should lower very long chain (C24 and C26) fatty acids in the blood stream. Explain how they were lowered by Competitive Inhibition (describe the type of molecule the inhibitors are). In what organelle do these inhibitors work (peroxisome?).
62. Oleic acid was also used but it was less potent than erucic acid; why? Hint: it is a shorter chain (C18) fatty acid found in olive oil.

Equations that were discussed earlier can now be applied to organelles like the lysosome or the mitochondrion that move protons: ΔG_{inward} (for calculating the amount of work that proton H+ movement across the inner mitochondrial membrane can do) and the EMF equation (the Nernst equation is used to calculate the EMF; EMF tells you the direction and magnitude of the electrochemical diffusion gradient for an ion like H+).
63. Calculate the direction and magnitude of the net passive force across the inner mitochondrial membrane for protons-- use the electromotive force (EMF) equation with proton concentrations inside cytoplasm and outside (matrix). The book choses to use the term pmf or proton motive force (instead of the more general EMF). The Nernst equation is used in the EMF equation. Use the following values for the calculations: pH of 7.8 in the mitochondrial matrix or lumen (you need to change this into concentration: this pH is equal to what [H+]? 1x10-7.8 = 1.585 x 10-8 Molar) and a pH of 7.2 for the cytoplasm, and an Em across the inner mitochondrial membrane of +200 mV. After switching the pH values into actual concentrations, plug in numbers into the

EMF equation. **Important**: remember to go over questions at the end of the pertinent chapters that apply to these equations; you do not have to turn these answers in since they are published in your answer guide.
64. Next, show how much work needs to be done or can be done by allowing protons to move through the ATP synthase. Use the equation for ΔGoutward (remember, inward means from matrix to the cytoplasm/intermembrane space; note that ΔGinward is just the negative of ΔGoutward).
65. Draw a mitochondrion; show (with the numbers noted in the last question) the electrochemical gradient (where is "in?" and where is "out?"). Describe how ATP is made by the electron transport chain (what is the energy from an electron used for? In your answer, note H+ and chemiosmosis (ATP synthase). Note the two types of H+ transport involved.

66. Arthritis may also be caused by antibodies (immune response) to our own GAGs. Explain GAGs, note their structure, and discuss over the counter drugs sold to alleviate this problem.

Ribosomes and Protein synthesis (and a review of protein secretion) ch. 22
67. Review how tRNA is attached to the amino acid, and the 3 parts of protein synthesis.
68. Describe posttranslational import (e..g, how a protein would end up in the mitochondrion).
69. How is the membrane protein reach the plasma membrane?
70. We find that a certain patient has a mutant enzyme that is nonfunctional; the normal form of the enzyme puts mannose-6-phosphate onto proteins. What will happen (biochemically) in the person with the mutant enzyme? What might be symptoms of the disease?
71. List all of the names of peptides (or protein domains) that regulate where a protein ends up (be it in the nucleus, outside the cell or in an organelle).

Review Questions For Microtubules Chapt 15, 16
72. What anticancer drugs have been used to study microtubules?
73. What proteins are associated with cytoskeletal fibers?
74. What are the steps for microtubule formation?
75. What factors regulate the formation or stability of microtubules?
76.What two methods of regulating stability are related to GTP?
77. Explain treadmilling (involve + and minus ends). How would you use radioactive GTP or radioactive tubulin to follow treadmilling?
78. What are the three types of cellular movement?
79. What two molecular motors are associated with microtubules? What direction do they move?
80. What are the important parts of a cilium?
81. How is ciliary motion produced and what is the model called? Show how the cross-section of a bending cilium, taken at a certain location along the length of the cilium, was evidence for this model.
82. Summarize microtubule functions.

Questions For Microfilaments Chapt 15, 16
83. Instead of tubulin, microfilaments are made of... Instead of GTP, microfilaments bind....
84. Describe factors that regulate microfilament stability (and how they affect stability).

85. From lecture, name actin binding proteins, explain their function (see text for help).
86. Name and describe the functions of microfilaments.
87. Describe the "clutch" model for cell crawling.

Extracellular matrix, Cell Adhesion, Cell Junctions ch. 17

88. What three molecules make up the extracellular matrix? Name a function for each and include in your answer which one is connected to a plasma membrane receptor. Name the receptor and the 2 intracellular molecules that connect to the receptor.
89. Name the three intercellular junctions (e.g., gap junctions, etc) and their functions.
90. Discuss diseases that are due to bad collagen in the extracellular matrix—see our cell bio web page and look for this section: "7) Extracellular Matrix and Cell Junctions (ch. 17): To view a site on collagen and human disease, click here. For biochemistry of cadherins, click here. For a site on connexins and human diseases, click here."
91. Summarize how cells adhere to another cell.

Questions For Cell Division And The Cytoskeleton Ch. 19

92. Describe the cell cycle (e.g., what happens in each phase).
93. Based on whether cells can reenter the cell cycle, describe three types of cells.
94. Describe cell shape changes during the cell cycle. Why is this important (hint: do pathologists use this information? How?)?
95. Describe the properties of MPF and what two proteins make up this activity. Regulation of activity is by....
96. Explain these terms and discuss what they do during M phase: kinetochore, polar or spindle microtubules, astral microtubules, kinetochore microtubules, microfilaments.
97. How are chromosomes attached to microtubules?
98. What are the two parts of anaphase? Related to positive and negative ends of microtubules and the centrosome (or microtubule organizing center).
99. Cancer is often due to failure of turmor surpressors like Rb and p53- explain how these two work to stop the cell cycle in G1.

NEWSPAPER ARTICLES ILLUSTRATING THE TOPICS THAT WE COVER IN CELL BIOLOGY 3611 LECTURE.

Newspaper articles illustrating the importance of topics that we cover in lecture. **READ THEM**; I will not assign them in the lecture, but you should read the sections listed below as we cover them in lecture.
The articles are organized by topic and in order of their coverage in lecture. Often, exam one covers the first three sections (1. cell size, 2 and 3).

A question or two on the newspaper articles are typically on the exams; however, the questions are relatively simple; just read through the articles and take a note or two on each article. For example, note that there are two articles on a dangerous amino acid that causes blood vessel damage, and you can reduce meat intake or take B vitamins to lower the levels of this amino acid.

The articles are separated into groups based on different lecture topics (see section topics below and the sections are noted on the articles themselves):

1. Cell Size
2. Articles on Biomolecules and Health (amino acids in health, glucose, lipids)
3. Lipids in Health and Disease (including Ceramide, sphingosine 1 phosphate; triglycerides, steroids)
4. Enzymes
5. Membrane Transport
6. Signal Transduction (kinases, phosphatases, receptors)
7. Collagen
8. Gap Junctions
9. Mitochondria
10. Protein Sorting within the cell
11. Cytoskeleton (microtubules, etc.)
12. Cell Cycle