DEVELOPMENTAL BIOLOGY 4054/5054

BRING THIS COURSE PACKET TO ALL LECTURES-ESPECIALLY TO THE COMPUTER LAB!!

Note in 2009 we will be meeting (starting second class) in NC 3010 Science Computer Lab

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COURSE DATES

CHECK THE COURSE WEB SITE. An additional extra credit exercise (Development biology reading) will be handed in February (date given in class) and a required exercise on fertilization (“Research in fertilization”) will be due in mid April (again, exact date given in class). Graduate student paper due week before finals. Note we meet during quiet week (I will minimize lecture material, there will be a review and no papers are due).

Fill in DUE DATES for Dev Bio from the Class web sites:

- finish online quiz on review material by short Paper 1 due
- Exam one short Paper 2 due
- Exam 2 short Paper 3 due
- the "Research in fertilization" exercise is due
- Break week is Nov 16-22 2009.
- Graduate student paper due week before finals (any time that week; you can also hand it in earlier)
- FINALS WEEK is May 11 2009.

Note we meet during quiet week (I will minimize lecture material, there will be a review).

INSTRUCTOR INFORMATION:

Dr. Bradley J. Stith. Office: 3402 NC, tele. 303-556-3371. OFFICE HOURS: 1-2 PM on Tuesday Thursday (days of class). 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. For more info on me, the course and lab research, VISIT MY WEB SITE: http://carbon.cudenver.edu/~bstith. Fax: 303 556 4352 (put my name on cover page).

COURSE OBJECTIVES:

1. To understand basic concepts and definitions of modern developmental biology, and then apply these concepts and definitions in new areas of developmental biology
2. To develop critical thinking and study skills
3. As a productive and cooperative member of a study group, learn to use the Internet and other on-line resources as learning and research tools

We will cover these general topics: Roles of gene regulation and cell signaling in Developmental Biology, Gametogenesis, Fertilization, Cleavage and Cell Division Embryology, Gastrulation, Neurulation, Development of Dorsal-ventral axis, Cell movement and Neural crest migration, and Cell-cell interactions. This course does not emphasize embryology (memorizing anatomy of various embryos), but biochemistry of development.

Note that we will meet and I will lecture during quiet week, but the amount of new material presented will be minimized. Quiet week will have one or two review sessions.
Best way to an "A:" **Attend all lectures!!** You will not understand the material unless you see my visual aids, or hear my discussion of the animation of the processes, hear my review of the videos (only some of which are on the web). Simply reading the text or reviewing someone else’s lecture notes **is not sufficient** to understand the complicated figures that we will use.

I believe that note-taking skills are important. Not only do they develop listening and communication skills, I and some “master” teachers believe that lecture attendance, listening to main points, recording a distilled version of what I say, and rephrasing in your own words are an important facets of learning. Due to the value of lecture note taking, I do not provide all lecture notes. Learn to think in lecture, not just mindlessly record details. Listen to get the main point (see following example on why flies can be caught when it is cold). 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? Constantly ask yourself if you understand what I said.

However, to help those who cannot show up to the first few classes, and to provide an example of outlining lecture notes, I provide notes. Copies of these notes will be on on our course web site. Note that these notes do not contain all discussions of figures that we use (I simply cannot reproduce all statements and point at figures).

**TEXT AND SUGGESTED TEXTS**

TEXT: "**Developmental Biology,**" by Scott F. Gilbert, **Eighth edition.** A CD ROM is included (Vade Meacum). **NOTE THAT YOU SHOULD START READING THE FIRST THREE CHAPTERS ASAP** and start using the CD ROM.

I plan on covering chapters 1-10 (note that I skip some sections all chapters, last half of chapter 8, and skip all of chapter 9).

BEST WAY TO AN "A:" ATTEND ALL LECTURES!! You simply cannot read the text on your own and understand this difficult material.

Other books from prior courses: a good UP-TO-DATE General Biology text such as "**Biology**" by Campbell et al. This course in Developmental Biology is summarized in ch. 43 OF "**BIOLOGY**" by Campbell, ch. 57/58 in Raven, ch 20 in Life by Purvis (these chapter numbers change but you get the idea).

I also recommend that you have an UP-TO-DATE Cell Biology text book such as **World of the Cell** by Wayne Becker et al., or the newest edition of **Molecular Biology of the Cell** (Alberts et al.). **Chemistry for Biology Students** by and **Professor Farnsworth's**
Explanations in Biology (by Frank Heppner) may be helpful. Most of these books are from courses that you should already have taken and you may already have a copy of these texts. I can put a copy of each in the library on reserve. If you no longer have your texts, and as these NON-REQUIRED texts are expensive but valuable, you might consider splitting the cost with other students.

For a more in depth review of genetics, consider purchasing "The Cartoon Review of Genetics." For more in depth information on molecular genetics, consider reading “Molecular Biology” by Robert F. Weaver (McGraw-Hill) or "Molecular Biology: made simple and fun" by David P. Clark and Lonnie D. Russell (Cache River Press).

OUR COURSE WEB SITE

The web site will be used to enhance this lecture course. Go to Dr. Stith’s home page (http://carbon.cudenver.edu/~bstith/), then go down to “Developmental Biology” found under Dr. Stith’s teaching section (“Courses Taught by Dr. Stith”). We will use this course web site and the textbook web site to find out more about topics that have not yet appeared in a text, to see a video of a developing embryo, to take quizzes, to review certain lecture material, or to communicate with a fellow student (ask questions, discuss answers to questions, share lecture notes, etc.). As the teacher, I can post clarifications of lecture material, keys to exams, use the built-in calendar, or general announcements on the web bulletin board. There is a CHAT ROOM, in which you can communicate with other students, “study” with other students, or post notices. REMEMBER: to use this CHAT ROOM, you must use proper etiquette in addressing others (no profanity, etc.).

I will show you how to access our 2 class web sites in the North Classroom science computer lab (we will meet at a computer lab instead of the lecture hall). To use the web, you can use your own computer at home or work, but remember that you can also use the computers on campus. Computer labs are in North classrooms 3010 (the science computer lab, located between the Biology and Chemistry departmental offices), 2206, 1208 and 1206 are typically available Monday through Thursday, 8 am to 9 pm. On Friday, from 9 am to 4 pm, on Saturday, 10 am to 5 pm, and on Sunday, from noon to 8 pm. Depending upon the day, Room 2206 is sometimes open an hour earlier or later. This schedule is subject to change.

If you use your own computer at home or work, then you can dial into the computer on campus for access to the Web (or for email). Instructions for this process are available from the Help desk in the computer labs at or at CINS offices (telephone: 303-556-6100). To dial in from your home or work computer, you will use these telephone numbers: 303-592-7911 or 303-228-9004.

OTHER WEB SITES OF NOTABLE VALUE:

1. The web site for our textbook (lots of animations!!) is:
http://8e.devbio.com/

2. Dr. Stith's web site that has information on research (phospholipase C, fertilization, etc.)—see also the page for Cell Biology 3611 for cell signaling animations:
http://carbon.cudenver.edu/~bstith/
3. SEARCHING FOR THE LATEST PAPERS ON A CERTAIN TOPIC: USING "PubMed" …If you have a topic, you can get abstracts of scientific journal articles at this site: http://www.ncbi.nlm.nih.gov/PubMed/

See my home page for information on how to use Pub Med. Go to the PubMed site, and then type in some key words. If you are not specific and have only a few key words, you will get thousands of references. To reduce the size of the list of references, try for review papers or try for the most recent papers (see “advanced used” of PubMed on the web site). For example, instead of "embryo," type in "embryonic eye development" or other very specific statements (what stage of development? What species? Do you have any certain authors?).

Note that this literature search service is free. Print out the abstract, and if the paper looks good, look it up in our library or at the UCHSC library (telephone: 303-315-7460; located at 9th and Colorado Blvd). Reviewing current literature may be required for your "Short Papers" since the current literature found on PubMed will be more up-to-date than your text. However, the papers found by this method are still slightly out of date since PubMed is about 3 months behind, and the papers take up to about 10 months to be published. Most likely, the data in the recent paper were collected about two years ago!! Thus, as compared to the text or published papers, you might get more up to data information on the web! Thus, I require you to check for pertinent web sites in your three papers. Note that web sites are NOT critically reviewed (whereas published papers and texts are). Something found on a web site may be totally incorrect! Use your critical thinking skills!

4. For a course on DB see http://www.ucalgary.ca/UofC/eduweb/virtualembryo/db_tutorial.html


6. A web site that helps you find any Biology info on the web: http://biology.neehow.org/

8. A web site discussing fertilization and the work by D. Kline: http://www.kent.edu/biology/kline.htm

9. Society for Developmental Biology (has many links to other DB sites): http://sdb.bio.purdue.edu/

10. A web page of a DB teacher and researcher--lots of valuable links!!: http://orion.it.luc.edu/~wwasser/index.html


12. Another course in DB online (note that it has related web sites, old exams-which may not be valuable for our course-, movies, how to study, etc…):
http://www.utexas.edu/courses/zoo321/

13. A review of recombinant DNA technology (good for the review questions!!)  

14. The virtual embryo:  
http://www.acs.ucalgary.ca/~browder/index.html

15. A web site all about sea urchin embryos:  
http://www.stanford.edu/group/Urchin/contents.html

16. General search engine to check out web sites (note that you sometimes do not have to 
type in http://): www.google.com

17. CLONE USING A COW AS HOST, SEE:  

**UNIVERSITY POLICIES**

CHECK UNIVERSITY SCHEDULE AT:  
http://carbon.cudenver.edu/catalog/

If repeating this course, it must be completed in its entirety. There will be no 
exceptions to this departmental policy.

Snowy day policy: some class days might coincide with large snow fall. 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.

Exams 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 approximately 8 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.

Keep track of the drop deadline (tenth week of the semester).

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 even most of the course. No incompletes will be granted after the start of quiet 
week without a doctor’s note.

The following college policy on the awarding of Incomplete grades (IW/IF) was approved by the faculty,  
and was formerly printed in the Schedule of Courses. The CLAS Course Completion agreement is 
available in the CLAS Advising Office.

**Incomplete Grades (IW/IF):** Incomplete grades (IW or IF) are not granted for low 
academic performance. To be eligible for an Incomplete grade, students must (1) 
successfully complete 75 percent of the course, (2) have special circumstances 
verification may be required) that preclude the student from attending class and
completing graded assignments, and (3) make arrangements to complete missing assignments with the original instructor. A CLAS Course Completion agreement is strongly suggested.

Incomplete grades of "IW" (incomplete withdrawal) and "IF" (incomplete failure) are faculty discretionary grades. They are to be used sparingly, and for non-academic reasons. Specifically, the administration of incomplete grades signify special circumstances beyond the student’s control that preclude completing a small portion of the course, for which a final grade cannot be assigned. CLAS policies stipulate that an incomplete grade may be awarded only if the following conditions are met:

1. Student must have successfully completed 75% of course.
2. Student has special circumstances that preclude the completion of graded assignment(s). An incomplete grade is never to be given to a student who is unable to meet course requirements because of a course overload, undesirable grades, or conflicting external obligations.
3. The missed assignments are to be completed with the original instructor.
4. The course grade is to be determined using the original grade combined with missed assignments.

Students who must retake the course are not eligible for an incomplete grade.

Students with poor academic performance are not eligible for an incomplete grade.

Student making up an incomplete grade should not re-register for the course.

When an instructor determines that an incomplete grade is justifiable, students are encouraged to submit a CLAS Course Completion Agreement, which is available from the CLAS Advising Office. This contract documents completed and missing assignments, current course grade, and conditions necessary to obtain a letter grade for the course. If this contract has not been fulfilled within one calendar year (12 months), the grade will be converted automatically either into a "W" (from an "IW") or "F" (from an "IF"). The "IF" grade does not mean that the student is necessarily failing at the time it is issued, but it does mean that the student is required to complete the course.

Upon completion of the missing course work, a Change of Record Form should be completed by the original instructor to change the "IW" or "IF" to a letter grade. The original incomplete grade remains on the student’s transcript even after a letter grade is assigned. Grades of incomplete cannot be retroactively added after the semester ends.

### 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. It is the responsibility of the student to verify their schedule prior to any official dates to add or drop 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.

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**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.


• 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.

“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. In laboratory courses, the next step in resolving a grievance after meeting with the teaching assistant may involve a discussion with the faculty member in charge of the laboratory course. 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.”

**IMPORTANT NOTES CONCERNING EXAMS and GRADES**

1. There will be an online quiz reviewing General Biology material relating to this course, 3 short papers, two lecture exams and a comprehensive final. These exams and final are 100 points each and will be given during in our classroom. I typically give out A’s to about 20-30% of the class (warning: this is a comparatively low number). For graduate students, there is an additional requirement of a 15 page paper.

2. The FINAL EXAM will be comprehensive. About 50% will cover new material (material not covered by prior exams) and 50% will cover old material.

3. Review these notes and suggestions at numerous times during the semester (before paper due, before and after exam); this rereading will pay off.

4. **EXAMS WILL HAVE MULTIPLE-CHOICE, TRUE-FALSE, FILL-IN-THE-BLANK OR SHORT ESSAY ANSWERS.**

5. **YOUR FINAL GRADE WILL BE DUE TO:**
   - 2 LECTURE EXAMS (200 points)
   - comprehensive FINAL (100 pts)
   - Three SHORT PAPERS based on the categories of newspaper articles (10 pts each; 30 pts total); see next page for information on papers
   - ONLINE QUIZ on review of general biology material (see web site for the course) (35 pts)
   - Homework (found in this packet): “RESEARCH IN FERTILIZATION: USING WEB VIDEOS” (25 pts)
   - For graduate students, a full paper (50 pts)

   Thus, for undergraduates, there will be 380 pts, for graduate students, 430 pts.

6. **REGRADING THE EXAMS:**
   For the comprehensive final, I recommend that you emphasize figures, videos and animations used in the class as an efficient review method. Of course, go over old lecture notes but emphasize old exams (I often take questions from prior exams and put them into the comprehensive final).

   After you get an exam back, the first thing to do is to check the exam key-try to understand the reason why you missed a question (did you read too much into it, didn't know enough details, misread question, missed the point in lecture). Exams and keys will be posted TO OUR WEB SITE.
If you wish a regrade: first, check the key, then write a detailed explanation explaining why you think that the question was not graded properly (and stable this to the exam) and give it to me. I reserve the right to go over the entire exam to correct any grading errors in your favor, or not in your favor.

**For Graduate Students in DB 5054**

Those taking the course for graduate credit will have (in addition to other course requirements) a 15 page paper (typed, single spaced) due the week before finals. Use these sections: Introduction (short summary of topic), Discussion (present ideas, use references for all statements; e.g., Thorson et al., 1995 and list the title, volume and page numbers in the end of the paper) and conclusion. I will look for your input or criticism or YOUR final conclusions (at which you have arrived after reading the material). The subject matter should be approved by Dr. Stith and can be from the newspaper articles found in this course packet (do not use the same article or topic for both the short paper and for this long 15 page paper) or some other concept/idea from lecture or the text. I have to approve the topic to ensure that it is related to developmental biology and the material presented in this course. For this long paper, I expect you to place clear illustrations in the text and to use ALL sources of information (e.g., web, Pubmed, original literature, textbooks, etc.). To let me know that you tried all sources, let me know about key words that you searched the web with and if the web did not have any pertinent references.

**SHORT PAPERS**

The newspaper articles in this course packet, taken from the *Denver Post* or the *Rocky Mountain News*, have been collected over the past years (most of the topics are not yet found in textbooks). Read the newspaper articles in this course packet and pick one article from each of the 3 sections noted below. You will use the internet and other sources to write a short paper (typed, single spaced) for each article. The 2-3 page short papers may have an appendix of illustrations (limit appendix to two additional pages).

Each of the three short papers will be worth 10 points, for a total of 30 points. The papers will be due approximately every 2-3 weeks, starting about Mid-February. Articles are arranged into three categories.

For **paper One**, pick one newspaper article from the “Cloning” section

For **paper Two**, pick an article from the section on “Fertilization: Fertility, Abortion, Egg, Sperm, In vitro fertilization.

For **paper Three**, pick an article from “Embryology” (includes sex determination, birth defects).

The **format** is as follows (USE THESE 3 HEADINGS):

A. **INTRODUCTION** (summarize or abstract the article)-one-half page. being able to summarize a lot of information succinctly is difficult and takes practice and time.

B. **DISCUSSION**. This section will be at least **1 and a ½ to 2 pages** and you will explain terms and scientific procedures used in the article. Using critical thinking skills, evaluate statements that you have read, evaluate the science behind statements, form an opinion on statements made in the articles. Expand upon the science presented in the
article (explain terms, etc.) and USE THE WEB TO EXAMINE the article (use key words, names and organizations to search the web for more UP-TO-DATE information).

**Does the scientist quoted have a web site?** Go beyond the articles to make a prediction about the future. Note that this section expands upon the basic science presented in the newspaper article, and some of the section is your opinion about the science presented in the article. Note that we use web sites since they offer an encyclopedic summary of various scientific topics, because they are often more up to date than our text, but because the web sites are unrefered, we need to use strong critical thinking skills in evaluating their accuracy and truth.

C. **SUMMARY.** Summary of conclusions and your PERSONAL OPINION of what you read (the article and other sources). USE CRITICAL THINKING SKILLS **One-half page.**

D. **BIBLIOGRAPHY.** At least **One-half page (not counted in total pages noted above).** For references in the text of these short papers (and with the graduate student’s long page); cite them as Smith et al., 1995 or Smith and Thomas, 1996. Then in the bibliography, use this format: Smith, J., Thomas, R. (1996) Title goes here. Journal Name vol: page. If the reference is a web site, list a name for the web site in the text of the paper (e.g., Geron, 1999) and give the URL (address of the web site) and WHEN YOU ACCESSED THE SITE in the bibliography.

**Final Notes on short papers:**
1. **At the beginning** of the introduction, state the title, author, source (Post or News?) and date of the article that you have chosen.
2. Emphasize developmental biology material in your paper. For example, go into how tamoxifen works, what does P53 do in the cell, what is a telomere and how does it limit cell division? Some papers have emphasized how many people get skin cancer, how to treat skin cancer, use of sunscreen lotions, what number of sunscreen lotion to use; this is not Developmental Biology. In other words, the better papers will relate to the lecture or text material.
3. Make sure that you use the web to check for web sites of the Scientists quoted in the article (**use the author's name as a keyword** in a search with www.google.com or http://www.hotbot.com/), about the subject matter that relates to Developmental Biology (P53, gene therapy, telomeres, taxoifen, mitosis), or even the organization noted (does the lab or foundation or university have a web site that updates and summarizes the work?). CLIP OUT SOME WEB ARTWORK AND INCLUDE IN YOUR REPORT (the illustrations do not count toward the 4 pages). Another reason for using the web is that some of the newspaper articles are old but the web reports the latest information. It turns out that gene therapy, for example, has not fulfilled the promise stated in a 1991 article. I **would like for you to note even unsuccessful searchers on the web** (what keywords were not found, etc.).
4. Make sure that you list a reference for each discussion (I could not find the source of many statements in the papers).

**CRITICAL THINKING SKILLS**
As you read the newspaper articles, as you read the web site information, remember to read using critical thinking skills. Do you really believe what the newspaper writer (often, someone with little biology background) is postulating? Robert Park, professor of Physics at Univ of Maryland, has written a book called: *Voodoo Science: the road from foolishness to fraud* (2002). He states 7 warning signs for bogus science:

1. The discoverer pitches the claim directly to the media.
2. The discoverer says that a powerful establishment is trying to suppress his or her work.
3. The scientific effect involved is always at the very limit of detection (Loch Ness monster or space shit photos are very blurry).
4. Evidence for a discovery is anecdotal (you need hard data).
5. The discoverer says a belief is credible because it has endured for centuries (the “ancient folk cure” existed since middle ages).
6. The discoverer has worked in isolation.
7. The discoverer must propose new laws of nature to explain an observation.

To fully understand the articles, even test questions, use CRITICAL THINKING SKILLS. These skills will enable you to evaluate what you read. 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). The most common example of critical thinking is asking yourself “Did the author present sufficient data to make the conclusion that they did” and whether the writer is trying to sell you something (this does not make the conclusions incorrect but ….).

In addition to points listed above, there are other "critical thinking" questions to ask yourself while reading a newspaper article, studying or even taking an exam:

1. What is the purpose of paragraph or exam question?
2. Identify the Central problem (clarify question you are asking)
3. Is the author's reasoning based on real data or evidence? Does the author make inferences that go beyond what the data support? Is the author biased?
4. Is there the correct use of key words and phrases?
5. Assumptions; what assumptions are used for reasoning? are they appropriate?
6. Implications, consequences and conclusions; where does this lead?

**STUDY SKILLS**

Memorization is very important in college biology, but it is not sufficient; you must understand the concepts and integrate them into the flow of ideas. Some students believe that the more time spent memorizing will always result in a higher grade. The amount of time spent studying is important but good study skills are more important. There are free courses on study techniques (see Center for Learning Assistance).

Application of concepts and ideas is important.

Learn to think in lecture, not just record details. Listen to get the main point (see following example on why flies can be caught when it is cold). 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?
Questions will involve all levels of thinking:
1. **Simple memorization.** Questions requiring more than one step are confusing
2. 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?**
3. Using intellectual skills and abilities, the students **bring together apparently unconnected ideas or concepts.** Application of basic concepts to new, apparently unrelated problems.

Note that the course will have questions from 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.

Often students will think that they know a concept but actually, they don't. The first time many students test themselves is during the first exam; they then find out that they did not clearly understand the concept. The poorer students does not "self assess" or check that they understand the concept before taking the exam. After the exam, the poorer students says "I thought I understood that yet I got it wrong on the exam." 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). 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).

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 agreed with her 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 a lot of lecture time on the concept of temperature altering the rate of an enzyme-catalyzed chemical reaction. As an example, here are the concepts associated with this topic:

- the rate of enzyme-catalyzed reactions speeds up as temperature is raised from zero, peaks then declines again.
- a diagram of the rate of a reaction in the body versus the temperature is bell-shaped 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.; and the second: if the temperature is raised to too high a value (often about 60 deg. C), then enzymes are destroyed 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 in 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.

Write out the concepts and the flow of the concepts completely and clearly. Have a fellow student evaluate it (examples from General Biology: what is the one main function of the electron transport chain? how does it do this? How is pH applied? How is the concept of diffusion of ions across membranes applied?).

The more mature student will try to define concepts and details from the course and integrate them. For example, in Cell Biology, I discuss membrane proteins and how they are connected to proteins outside of the plasma membrane. This topic is covered at least three times in the course, but I use the same illustration. The active thinking student recalls the multiple times that the same topic has been discussed. The active student is able to integrate the discussions of the same topic covered from different approaches. The immature thinker will attempt to memorize a list of disjointed facts.

The active thinker will evaluate all information taken in 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? What impact would this answer have? (this relates to the elements of thought).

The good student will look up lecture topics in our text, in web sites (e.g., for our text or other DB texts) or in ancillary texts (such as Chemistry for Biology Students, Prof. Farnsworth's explanations...).

A goal in this course is to learn how to think like a Biologist. To be able to attack a problem that requires specific knowledge that you may not have. However, understanding the basic concepts of Biology or the “foundation,” the Biologist usually can forge a good answer. The answer may not be correct but it 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.

Examples of Concepts Used Again and Again; Topics You should Already Know (taken from General Introductory Biology)

The most important basic concepts are the helix, pH, chemical bonding (both weak and strong bonds), solubility, scientific notation, levels of protein structure, denaturation, spontaneity of reactions, chemical reactions and mechanism of action of enzymes (SEE the summary set of vocabulary words that you should already know). Certain molecules keep coming up again and again: glucose and glyceraldehyde phosphate (which is 1/2 glucose) are two. Glucose or similar monosaccharides are found attached to proteins, lipids and make up polysaccharides, DNA and RNA. Only four types of biomolecules make up all the parts of the whole body. In developmental biology, Pax6 comes up again and again (in situ hybridization, eye development, induction, transcription factor binding to enhancer region, etc.)---when studying, be aware of a topic that keeps coming up and make your own succinct summary. A good
**test question** is to summarize the many times we discussed a certain topic over different parts of the course.

However, we couple these basic concepts with certain basic facts; cell structure or cell anatomy, the reactions of photosynthesis and respiration, the steps of the cell cycle, the viral life cycle, the basic steps of DNA, mRNA and protein synthesis. These and other facts come together with concepts to form the basis of the various important areas of cell biology: membrane transport, metabolism, Mendel's laws of genetics, molecular genetics, gene regulation, mitosis and meiosis, natural selection, chemiosmosis, and the electron transport chain.

Do not fall behind; it is especially important to keep up the first few weeks of class. With so much material, you will not be able to catch up and this could result in a very poor result on the comprehensive final. All-night cramming to catch up usually doesn't work. A RECENT STUDY HAS SHOWN THAT THE STUDENT'S FINAL GRADE RELATES TO THE NUMBER OF TIMES THE STUDENT ACCESSES THE COURSE WEB SITE DURING THE FIRST TWO WEEKS OF THE SEMESTER!!

Biology is a combination of details and broad concepts; you must know both. One common freshman student comment is that there are too many details; yet without details one cannot understand the concept that they illustrate. Science is full of details (do you inject 3.2 mls or 2.3 mls of anesthetic?). Students should develop memorization skills (use of vocabulary lists, flash cards, group studying). One reason we go into glucose structure in General Introductory Biology is to illustrate that memorization of complex structure can be made easier through mnemonics.

For multiple choice questions: read the WHOLE problem and all of the possible answers. Don't stop at the first answer that you think is correct, there may be an answer that is MORE correct or there may be several true answers that do not pertain to the question. Past student errors and suggestions include: (a) reading too much into the question than what is there (the question was just not that hard) (b) your first guess is most often correct (c) misunderstanding simple English [e.g., a student forgot the difference between switching (two objects) versus the transfer (of one object)] (d) many students miss questions that upon second reading seem so simple-they say "I should have read the question more slowly and carefully."

Another problem I find with short essay answers is that the answer is poorly phrased. Start off by repeating the question ("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..."

**ATTEND LECTURES** because (a) exam and quiz material is drawn from the lectures (b) book covers topics that I do not discuss in lecture, and I cover topics that the book doesn't (c) text book is very valuable but it should be used as a back up for the lecture course. Use the text since people learn best when they see two different discussions of the same material.
Lectures are primary for exams—read only the parts of the book that back up the lecture (the book simply covers too much). If you can't attend a particular lecture, make sure that you arrange with one or more than one student to copy their notes later. Poorer students said "I studied the book not the lecture. I didn't go to lecture."

If you miss a lecture, get a tape of the lecture and notes from a fellow student. You can look at my overheads (which are sketchy) but you will get more information from a lecture tape. Note that cassette tapes can be swiftly copied at the Book store (electronics section).

A VALUABLE HINT: **Use a tape recorder to tape all lectures.** Whether you are a freshman or upperclassman, a student's comprehension and (often) grades shoot up after they begin to use a tape recorder. You will not become a copying machine; you can listen to lectures and see the overall picture (why we are talking about this topic and what is the meat of the topic). Use the tapes for a review. One student said that the tapes were the single most important reason that he improved his grade.

Good note-taking consists of a) listening for what is important b) summarizing what I say in a shorthand (use broken English). Poorer students attempt to write down everything from the overhead notes; they lose the main point in the detail. Do not do this; be selective as to what you write down. Often, for sake of clarity, I will repeat statements on the overhead; don't write these statements down if you have already done so before. The outline of lecture notes and/or use of a tape recorder will help you listen and understand lecture topics. Always ask yourself "Do I need to write this down?"

Monitor your progress in class. Don't wait until the last minute if you are doing poorly. Be aware of drop deadlines and know the procedure for dropping. Poorer students said "I waited too long to....get a tutor.....to drop..... to ask questions."

Get practice taking exams. Often students will know the correct answer but still miss the question because of how they responded to the question. Part of learning is to understand the phrasing of the question and to respond with a logical answer; this takes practice. The "survey" found in our class web site is a good way to practice!

It is not enough to memorize material for an exam to achieve a good grade; you must perform well on the exam. Answering test questions correctly is also due to an understanding of basic English grammar and logic. Some students missed a question because they didn't understand the function of a semicolon or understand commonly used words. Practice taking exams—find out why you missed a question and correct it.

To help your general understanding, look at the concept maps found in the Student Study guide for Campbell's text on Biology. Most importantly: make your own.

Many students put an answer down and say that it doesn't sound correct. They do not explore this thought, go on to the next question, and end up with an incorrect answer. You must think—think again, and then recheck. One of the skills we teach is critical thinking: why did the question state "all?" "only?" "sometimes?" 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?

I suggest that you take a look at Emotional Intelligence by Daniel Goleman and an article in Time (Oct. 2, 1995): the central trait for "being smart and successful:" 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 (PERHAPS THE MOST IMPORTANT) 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).

The student who drops out is often as intelligent as the student who stays (conclusion of study performed by two Boulder sociologists), but the student who stays is more confident ("I know that I can make it"). Initially, Einstein did poorly in math

There are tutors and information on improving your study, note-taking and test-taking skills at the Center for Learning Assistance (tele. 556-2802; located in the NC 2004). I took a study skills course when I was a sophomore and it helped me organize my studying and improved my grade point average. The Student Advocacy Center (call 556-2324; NC 2024) helps with general problems and study skills. They also have Peer Advocates- students who have gone what you are going through and offer specific advice about this course.

There are books in the library and private courses (e.g., one student recommended a tape called "Where there's a will, there's an A" by American Education Publisher, Paoli Corp. Center, 15 Industrial Blvd., Paoli, PA 19301; the Academic Center may have this tape available). For returning students: "Going Back to School-college survival strategies for adult students;" $13; Frank J. Bruno.

Read "Becoming a Master Student" (College Survival; 1800-528-8323); especially important are chapt. 1-6. The most important section of this book: take the "Self-Test" to find where your study skills are weakest. Review "When Reading Is Tough" (tips for active reading). I believe that these tips are crucial for reading Biology text books. Tips for returning students is also a discussion topic. "Science course” tips are reviewed along with a section on overcoming test anxiety. There are many older students who are returning to classes. They are intelligent but sometimes their study skills are rusty. It takes up to a year for many returning students to redevelop study skills. If you are Pre-Med, 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.

Learn each item that you miss on each exam. Many students never look up what they missed on exams due to the belief that section is over. However, the concepts will come up again and again and will be built upon. For example, in General Introductory Biology, pH is introduced early and referred to again to explain the basis of the
chemiosmotic theory. The term helix comes up again and again in reference to proteins and nucleic acids. In addition, the final is comprehensive—it will cover the whole course.

ANOTHER great hint to obtain better grades: Remember the movie the Paper Chase? **Form a study group.** One year, there were 3 study groups; one that met on campus, one that met at the Tech Center and one that met in Boulder. There were 3 to 13 people per group and they all reported that meeting and going over material helped a great deal. I can help form these groups by announcing their meeting time and location.
Use of our “Blackboard” web site for Developmental Biology

Welcome to the computer lab! We will log into our Blackboard web site (A NEW VERSION WAS JUST RELEASED SO WE MAY HAVE TO MODIFY THE INSTRUCTIONS) and explore the bulletin board, online quiz questions, and other features of the web site. Check off the following steps as you go:

1. From the desktop of your computer, click on the icon for the internet: either Netscape Communicator (or new version) or Microsoft Internet Explorer. GO TO MY HOME PAGE: http://carbon.cudenver.edu/~bstith/

Take a look at some of the ANIMATIONS AND VIDEOS that are on my home page (for example, look in the paragraph under "Cell Division," click on "PI Turnover" for an animation). Make sure that you know how to view the three major types of video/animations on all home computers and Science lab computers. The 3 major types of video/animations are: avi which requires a Microsoft player found on all Windows based computers, mov file requires Quicktime player (found on all Macs and most all Windows computers) and swf which requires the very common Shockwave player. If you do not have the Shockwave plug in needed for the animations, see the bottom of my home page for a link that will enable you to download the plug in. Also, in our Blackboard web site, go to “External Links” and find the links to the Shockwave or Quicktime players so that you can download the players. Finally, you can also go to this web site to download all players: http://carbon.cudenver.edu/~bstith/plugins.htm

2. Go down my home page just a bit from the top until you come to:

“Courses taught by Dr. Stith

Developmental Biology 4054/5054. Once you know your user name and password, Go to the CU Online web page, go to the upper right corner, under "Course Login" and click on Blackboard Login. To go to the CU Online web page, click here.

..........................course packet for Dev. Biol.”

If you click where it says “click here” you are sent to the CU Online home page—DON’T DO THIS YET.
If you click on “course packet for Dev. Biol.,” you will go to a shortened version of our course packet (the one you bought in the Bookstore). Let’s first click on “Course packet for Dev. Biol.” and take a look.

NOW go to the CU Online log in site by clicking on “click here.” You will then see the CU Online home page; go to the upper right hand corner, under COURSE LOGIN and click on BLACKBOARD LOGIN. This takes you to a welcome page; click on the log in line on the left side. You can also bookmark this page on your own computer. Use your
student number for both the username and password (later, you will change the password from your student number).

Once into the Blackboard site, look for new announcements, and then enter the Developmental Biology course site (click on link under “My Courses” at the far upper right).

Read the ANNOUNCEMENTS (located under the photo of students working in the lab) on the first page for our Dev. Biol. course.

3. Check YOUR EMAIL ADDRESS—it could be the university email address that all students have or a one that you use at home or work—whichever one that you check the most often (SO I CAN CONTACT YOU). To do enter your email address, click on “Tools” which is located on the end of the list of places to go on the left side of your computer screen. Then click on “Personal Information” then “Edit Personal Information.” Put in your email address in the appropriate spot.

ONCE INTO THE SITE, CHANGE YOUR PASSWORD from the student number. To change your password, go to: Tools, Personal Information, Change Password.”

3. On this Blackboard web page called “Tools,” you will note the link to the “Manual.” If you have any questions as to the use of our Blackboard web site (quiz taking, for example) look at this manual. Other sites on this page include the Calendar function (where you can keep track of dates, enter dates for exams in other courses etc-CHECK COURSE DEADLINES), and a way of checking your grade (along with class average).

4. Look at the list on the left side of your computer screen. Go through the titles on the left; Course Information, Staff Information, Course Documents, External links (to the web) etc. Go through each page and see what is there.

5. Under “Assignments,” there is a “Survey.” Click on this and take the survey (it is not worth any points, but it illustrates the kind of questions you will find on the online quiz that is worth 35 pts). Once you know about the kinds of questions there will be for online quizzes, you can take the actual online quiz. DON’T DO THIS NOW! The online quizzes will have a time limit (e.g., 60 min for 35 questions) and will be available over a set period of time.

6. Under “Communication,” you will find:

   **Send E-mail**

   **Discussion Board** (this is like a bulletin board, we will post answers to terms here so that everyone can see them)

   **Virtual Classroom** (although not popular with students in the past, I can have real time discussions here)
SEND ME AN EMAIL by clicking on the first on the list. In the future, you may want to send someone else in the class an email. (note: you cannot receive an email through the Blackboard site; you must go to your own email program such as Outlook or Eudora).

7. Note that there is a direct link to the **Discussion Board and the Virtual Classroom** also listed on the left site.- you can go there directly!! The Discussion board is like a bulletin board, you post there for every one to view the message. The virtual classroom allows us all to talk together in real time- we can even make drawings to communicate with each other. We will not use “Group Pages”

8. Go to the “**Discussion Board**” and reply to my first message “**HELLO. Introduce yourself**” Click on the forum entitled "**HELLO. Introduce Yourself**" and then click on "**Add New Thread**." Tell everyone in the class a bit about yourself (remember to click "submit" when you are done typing). We will send messages to the **second forum** on the list in just a bit.

9. Next, look at the list of words from General Biology (this is on the next page). I will assign certain terms to each team; look on the web (we do this to make sure everyone can explore the web) for answers. That is, go a web site such as those noted in the section of this course packet entitled: **OTHER WEB SITES OF NOTABLE VALUE.** One of the best search engines is: **www.google.com** for scientific references and an abstract of a paper check: **www.ncbi.nlm.nih.gov/PubMed/**

and type in the word you want to define. The search engines noted above will search the web for the word. Go to the web page and find a definition or description of the term. You can gather info from multiple sites by cut and paste to a Word file.

Then post the term to the definition/description (AT LEAST ONE PARAGRAPH!! ATTACH ILLUSTRATIONS IN A WORD FILE) to the **Discussion Board** by clicking on the second forum listed and cut and paste info: **Review of General Biology terms**

Post your terms and concepts here; other students will use this to study by...(you may have to do more than just this to review Gen. Biol for the upcoming online quiz).

13. After this computer lab, I will make the first online quiz available. After studying all the terms in the list by viewing the many **Discussion Board** postings, and, if you feel it is necessary, studying your General Biology text for more information, take the quiz.
TOPICS THAT YOU SHOULD ALREADY KNOW FROM GENERAL BIOLOGY

This list will form the basis of an Online quiz that you all will have to pass to complete this course in Developmental Biology. At the computer lab, we will break up into groups and your group will be assigned a specific list of terms (from those below). You will use the web to define and explain the term or process. Then you will post the information to our Bulletin Board. You should know the definition of the terms and the procedures listed below. Note that early chapters of our text Developmental Biology (by Gilbert) is basically a review of General Biology applied to Developmental Biology. You can use your text, the web, or other sources (your old General Biology text; see Biology by N. Campbell) to review these topics.

Name the parts of the following structures and the functions of the structure:
1. Microtubule
2. Microfilament
3. Intermediate filament
4. DNA structure (explain the difference between a nucleotide and a nucleoside)
5. messenger RNA

Explain these processes or answer these questions:
6. What are the four major biological macromolecules and their monomers?
7. What are the 4 levels of protein structure. Explain what type of bond is important in each.
8. DNA replication (steps..)
9. translation (steps…)
10. transcription (steps…)
11. cell cycle (phases and events during each phase)
12. mitosis (characteristics of phases) Diagram (see our Fig. 1.3) Mitosis...know characteristics of phases....

Official listing of events during the phases of mitosis (i.e., know this list for quizzes/exams):
Note that before mitosis begins, chromosomes replicate to produce enough DNA for two daughter cells. But remember the number of chromosomes in a cell does not yet double-the two "chromosomes" stay bound together and are called sister chromatids.

Prophase
Mitotic spindle begins to form
Nucleoli disappear
Chromosomes begin to condense (get shorter and fatter)
Note the presence of two strands of DNA, attached at the center; these are sister chromatids

Prometaphase
Nuclear envelope disappears
Mitotic spindle formation becomes complete

**Metaphase**
Chromosomes line up along the center

**Anaphase**
Sister chromosomes separate, forming the daughter chromosomes. NOW, WE SEE TWICE THE NORMAL NUMBER OF CHROMOSOMES (ENOUGH FOR TWO DAUGHTER CELLS)

**Telophase**
Daughter chromosomes reach the poles or ends of the cell
Nuclear envelope starts reforming

**Cell Division**
13. In what cells does mitosis take place?
14. Where does meiosis take place?
15. cyclin
16. cdc2
17. meiosis
18. cytokinesis
19. cell culture
20. contact inhibition
21. kinase versus phosphatase
22. tyrosine kinase (especially in reference to hormone receptors)
23. phospholipase C and the inositol phosphate (or PI turnover) path
24. Gap junctions (they can regulate cell division)
25. Extracellular matrix (they can regulate cell division)
26. Signal transduction (for example, how a growth factor induces cell division)
27. Map kinase path

**Mendelian Genetics**
28. monohybrid and dihybrid cross
29. genotype
30. phenotype
31. crossing over

**Molecular Biology (see chapter 19 in Campbell's "Biology" or other Gen Bio text)**
32. plasmid
33. transduction
34. general transformation
35. transfection
36. recombinant DNA
37. gene cloning
38. operon (inducible, repressible)
39. promoter region on DNA
40. operator region on DNA
41. repressor
42. restriction enzyme
43. cDNA,
44. reverse transcriptase
45. DNA ligase
46. vector

**Embryology** (for example, Campbell's chapter 47-emphasize frog embryo pictures as they are the easiest to understand):
47. Fertilization
48. Cleavage
49. Blastomeres
50. Blastula
51. Gastrulation (how do the cells move?)
52. Neurulation (formation of neural tube that becomes the brain, spinal cord)
53. Germ layers: ectoderm (epidermis, nervous system), endoderm (lining of GI tract, organs) and the mesoderm (several organs, connective tissue, blood cells)
54. protostomes
55. deuterostomes
56. fate maps

(useweb)
RESEARCH IN FERTILIZATION: USING WEB VIDEOS

An electronic laboratory experience

This worksheet will be used later in the semester when we cover Fertilization. Work in groups to answer the questions noted below. Your group will discuss the questions but I want you to hand in your own effort (don't photocopy the group's answers but write out your own version). In your “lab report,” there should be at least 4 graphs (with multiple points in each graph); one graph of the surface contraction wave, one graph of the calcium wave, one graph of gravitational rotation and one of cleavage furrow formation. On each of the four figures, you should graph results from multiple species using different videos from different web sites. All information you need is already available either here, or on the web.

The exercise mimics the research experience (YOU have to discover how to overcome obstacles). It not only reviews fertilization processes, THIS EXERCISE TESTS YOUR DRIVE, INGENUITY, INITIATIVE AND PERSEVERANCE! BE CLEVER TO OVERCOME CHALLENGES! Like real research, it has a variety of possible correct answers, you must overcome problems, develop methods and come up with the answers independently (e.g., how to record the rate of movement on your computer monitor; find videos on web, how to graph rate, etc.). This exercise tests you - just like real research.

Recommended steps: (1) define problems (what you need to do), (2) how to address problems; brainstorm solutions (3) evaluate collected data (you have to answer the question of “how to do this?”).

Fight procrastination (will continue to ask me questions that they should answer); jump right in, avoid excuses. Independent thinkers will proceed faster.

Search for web sites showing videos of fertilization waves of calcium, surface waves and then on cleavage furrow formation. First, start with your textbook, those web sites that are listed in “course Documents” or external links in our Blackboard web site and at Dr. Stith’s home page web site. Then, use a web search engine (www.google.com may be the best) and pick your keywords carefully. On the lab report that you hand in, you should retype questions noted here on these pages, including the question number. Also on the lab report:
1. List your group members (I recommend that you work together in groups but you need to type out and hand in your own report).
2. First paragraph: Describe what you see in the videos of the surface contraction waves and the calcium wave at fertilization (in question 4, you will graph out results). From the web and other sources, you should find and discuss at least six different videos involving at least three different species. For each video, record the species examined, the web site address and where the sperm entered the egg.

In addition, see if you can find a research paper with a description of the calcium wave such that you can find the rate (pictures showing the movement of the wave with a time stamp on each picture).

3. How is the intracellular calcium wave recorded? What sensor is used for calcium (see textbook)? For Dr. Stith’s web videos, the surface contraction wave is recorded with microscope attached to a camera but this is not sufficient for the measurement of intracellular calcium.
4. Graph the surface contraction wave and the calcium wave from *Xenopus*. Using web videos, graph the distance traveled by the waves versus time to calculate how fast the surface contraction and calcium waves travel in *Xenopus*. For example, *Xenopus* eggs are 1.25 mm wide. Check your text or lecture notes for sizes of other species. Obtain points and graph them on your graph paper (what is on the X axis? Y axis?). Try right clicking on the video and, after right clicking, stepping through frame by frame; use an acetate over the monitor screen. Obtain as many rates as you can (how many different *Xenopus* videos can you find for the surface contraction wave? For the calcium wave?).

5. Report in a table, the rates for the surface contraction wave and the calcium wave in *Xenopus*. For all videos of the two waves, I want a number for the average rate for the wave in CORRECT units. In your table, you should have a couple of surface contraction wave averages and a couple of calcium wave numbers. Compare the numbers. Does one cause the other—would you expect them to be different or the same?

6. With the graph(s) from question 4, you can determine whether the wave speeds up or slows down as it travels across the cell. If a straight line means constant speed, EXPLAIN HOW A SLOWING OF THE WAVE would change the straight line. Comment on whether the rate increases or decreases during the surface contraction or calcium wave travel. Why would it change?

7. What causes the surface contraction wave? Hint: a cytoskeletal fiber that is located around the edge of the cell is involved. Use web sites and our Developmental Biology text for explanations.

8. Can sperm enter the vegetal pole (versus the pigmented animal pole) of the *Xenopus* egg? Speculate as to why.

9. Next, compare the rate of **calcium** wave obtained in *Xenopus* to those obtained in other species. Graph and calculate rates of the calcium wave (distance/time) for at least two other species (you do not have to compare the rate of surface contraction waves).

10. What causes the initial release of calcium at the sperm binding site (what signals-enzymes, second messengers- are involved)? Summarize various models.

11. After the increase in calcium at the sperm binding site, there is a calcium wave. What causes the increase in intracellular calcium to travel across the egg? That is, what diffuses across the cytoplasm to cause the calcium wave to travel? Is it calcium?

12. What is the immediate role of elevated intracellular calcium at fertilization? What does this lead to?

13. What is the purpose of the calcium wave? In other words, why isn't the egg happy with just a local calcium increase at the sperm binding site? ALSO: if there were no wave, what abnormal event(s) would take place after insemination?
Questions on gravitational rotation:
14. From Dr. Stith's multiple videos on gravitational rotation and from a University of Utah web site (http://courses.biology.utah.edu/gard/development/Html/Images_movies/fertilization.html): how fast does the gravitational rotation take place (what units will you use? the angle change or degrees per sec)? Obtain a multiple points and graph them on your graph paper (what is on the X axis? Y axis?). Obtain at least three determinations of gravitational rotation and then average them.

15. List and compare the average times that the surface contraction, calcium wave and gravitational rotation take place (relative to insemination).

16. Which end of the zygote is heavier? Animal or vegetal pole? What has this to do with gravitational rotation?

17. What causes the gravitational rotation? In your answer, involve cortical granules and the cutting of linkages.

18. What is the purpose of the surface contraction wave? DON'T BE AFRAID OF SPECULATING!

Cleavage furrow
19. Find web videos, then describe the cleavage furrow after fertilization. For example, where on the zygote does the first cleavage furrow begin? When does the first cleavage furrow start (with zero being when insemination or fertilization began)?

20. Quantify the rate of cleavage furrow formation (need graph and average rate in proper units). Does it change its speed? Why would it?

21. What cytoskeletal fiber is responsible for the cleavage furrow?

22. Where is the cytoskeletal fiber located within the cell to produce the furrow? Draw a picture.