CELL BIOLOGY

Course Description: This course is designed to actively engage you in understanding basic cellular biology. There will be activities to allow you to identify and label cellular structures and describe the processes for cellular and organismal function. Topics include biomolecules, cellular architecture, gene regulation, catabolism, protein structure and function, membrane structure and function, transport, enzymes, cellular trafficking, cytoskeleton, cell communication/signal transduction, regulation of cell proliferation and cancer. Laboratory will emphasize basic techniques common to the overlapping fields of cell biology, biochemistry, and molecular biology. Critical thinking and analytical skills are practiced through evaluation of primary literature.

LEARNING OUTCOMES

- Develop a sound understanding of the complexities of the cell and the growth properties of normal cells
- Identify and evaluate the significance of complex protein structures
- Develop an understanding of the origins and functions of subcellular compartments
- Assess the fundamental differences between prokaryotic and eukaryotic cells
- Evaluate the molecular mechanisms involved in DNA replication and gene expression
- Appraise the role of the cell membrane in cellular behavior and function
- Organize the processes of how molecules can be transported into and within the cell
- Value the important roles of the cytoskeleton and associated molecules in cellular dynamics

LECTURE SYLLABUS

(Tentative)

Assessment Exam 1: September 30, 2013

Tidbit: What does it mean to be Living?
Chapters 1-4; 13&14
Don’t forget to assess the “How we know” for each chapter
Quizzes and In-class assessment questions will be derived from End-of-Chapter Questions

1. What is cell biology?
   a. Introduction to the cell
      i. Gain an overview of cells and their origin and evolution.
      ii. Learn how microscopy is used to study cells (see Panel 1-1).
      iii. Review the sizes of cells and the limits of resolution of various kinds of microscopy.
      iv. Appreciate the molecular composition of the cytoplasm
      v. Distinguish genes and genomes and how each is important to cellular function.

2. What is the chemistry of life?
   a. Chemical Components of Cells
      i. Examine the features of weak and covalent chemical bonds, and the energy associated with each.
      ii. Describe the properties of water and how they influence cellular events (Panel 2-2)
      iii. Distinguish polar and nonpolar covalent bonds (Panel 2-1).
      iv. Review the four kinds of organic molecules in cells and their structures (Panels 2-3 to 2-6).
      v. Understand the importance of polymers and macromolecules.
      vi. Appreciate the importance of free energy considerations for cellular reactions.
b. Energy and Catalysis
   i. Learn to quantify free energy changes and relate them to chemical equilibrium (Panel 3-1).
   ii. Distinguish $\Delta G$ and $\Delta G^\circ$ and understand what each means for chemical reactions.
   iii. Consider how oxidation and reduction reactions are used by the cell.
   iv. Review general enzymatic properties and the concept of activation energy.
   v. Appreciate $K_m$ and its use in understanding molecular interactions in a cell.
   vi. Describe how and why ATP is used in cells.
   vii. Understand the significance for cellular energetics of coupled chemical reactions.

c. Protein Structure and Function
   i. Review peptide bond formation and the orientation of polypeptides.
   ii. Understand how weak interactions determine protein folding and conformation.
   iii. Examine the common structural motifs of proteins and their significance.
   iv. Appreciate protein binding and how it is measured quantitatively
   v. Distinguish the four levels of protein structure and their molecular basis.
   vi. Outline the process of gel electrophoresis and western blotting and their applications.
   vii. Describe how cells can regulate protein activity and provide specific examples of each.

3. How do cells generate energy?
   a. Cellular Energetics
      i. Review the basic organizing principles of metabolism, including the critical position of glycolysis.
      ii. Appreciate how free energy changes are used to organize glycolytic reactions (Panel 13-1).
      iii. Examine gluconeogenesis and fermentation.
      iv. Outline beta-oxidation and fatty acid metabolism.
      v. Recognize the contributions of CAC and electron transport to the production of ATP (Panel 13-2).
   b. Energy Generation
      i. Describe the structural organization of the mitochondrion, including its membranes.
      ii. Review REDOX potentials and the relationship between them and free energy changes (Panel 14-1).
      iii. Outline the composition of the electron transport chain, including the REDOX potentials of each component.
      iv. Describe the significance of ubiquinone, cytochrome c, and O2 to electron transfer.
      v. Relate electron transfer to proton pumping and ATP production.

Assessment Exam II: October 28, 2013
Tidbit: How does the environment influence transcription?
Tidbit: The Journey Down the one-way street.
Chapters 5-10
Don’t forget to assess the “How we know” for each chapter
Quizzes and In-class assessment questions will be derived from End-of-Chapter Questions

1. Describe the Central Dogma of Cellular Biology and identify locations in the eukaryotic cell in which these processes occur.
   a. DNA and Chromosomes
      i. Explain basic DNA structure and the importance of polynucleotide polarity.
      ii. Understand the relationship between chromatin and chromosomes.
   b. DNA Replication and Repair
      i. Outline the process of DNA replication in detail.
      ii. Appreciate the consequences of DNA mutations and describe each kind using correct terminology.
      iii. Provide an overview of DNA repair mechanisms.
   c. Transcription and Translation
      i. Understand the relationship among DNA polarity, RNA polarity, and polypeptide polarity.
ii. Describe the composition and significance of a promoter.
iii. Review basic transcription mechanisms, including the proteins involved.
iv. Learn the significance of RNA processing and outline the steps involved.
v. Explain the dynamics among the ribosome, tRNA and mRNA during translation.
vi. Appreciate the design and use of the genetic code.

2. **Evaluate how differential gene expression leads to different cell types.**
   a. Control of Gene Expression
      i. Recognize the importance of gene expression for cellular differentiation and dynamics.
      ii. Explain the five ways in which gene expression is controlled (Figs.7-40 and 8-3)
   i. iii. Provide detailed examples of how gene expression is controlled in eukaryotes.
      iv. Outline the process by which proteins are targeted for degradation.
   b. Diversity: The Spice of Life
      i. Describe the cause of point mutations and the gene response.
      ii. Demonstrate the tailoring of proteins to a specific organism through gene duplication and divergence.
      iii. Discuss exonization
   iv. Demonstrate gene sharing

3. **Detail a procedure for identifying how specific genes mediates production of a protein.**
   a. Manipulating Genes
      i. Understand the theory and practice of electrophoresis.
      ii. Explain the process of nucleic acid hybridization.
      iii. Distinguish cDNA and genomic libraries and their utility.
      iv. Outline the process of PCR.
   v. Understand the process of making transgenic mice and of the yeast two-hybrid system, as discussed in class.

**Assessment Exam III: November 13, 2013**
Tidbit: How long can you hold your breath?
Chapters 11, 12, &15
Don’t forget to assess the “How we know” for each chapter
Quizzes and In-class assessment questions will be derived from End-of-Chapter Questions

1. **How are cell compartments built?**
   a. Membrane Structure
      i. Describe the composition and functional significance of lipid bilayers.
      ii. Distinguish different classes of membrane phospholipids.
      iii. Understand the significance of membrane fluidity and what determines it.
   iv. Appreciate the molecular basis of membrane asymmetry.
   v. Examine membrane protein structure and relate to the diversity of functions,
   vi. Review the experimental techniques used to study membrane structure and function.
   vii. Describe the glycocalyx and the significance of glycoproteins and glycolipids.
   b. Membrane Transport
      i. Distinguish the different types of membrane transport and their molecular basis.
      ii. Predict which compounds can cross the lipid bilayer by passive transport.
      iii. Appreciate the differences between and similarities of carriers and channels.
      iv. Outline in detail the function of the Na+/K+ pump and its significance.
      v. Review the structure and function of neurons.
      vi. Describe the organization of ion channels and the experimental techniques used to study them.

2. **How do proteins know where to go in the cell?**
   a. Cellular Transport
      i. Provide an overview of the organelles within a cell (see table 15-1).
      ii. Recognize the topological relationships among cellular compartments and the cell membrane.
      iii. Describe the importance of signal sequences and review selected examples in detail.
iv. Outline the importance of the ER for protein synthesis and protein transport.
v. Understand the functions of the ER and the Golgi apparatus and their coordinated activities.
vi. Appreciate the significance of vesicular transport and its regulation.

Assessment Exam IV: December 9, 2013
Tidbit: The dynamics of life
Tidbit: Don’t kill the messenger
Tidbit: These cells go round and round
Chapters 16-18, 20
Don’t forget to assess the “How we know” for each chapter
Quizzes and In-class assessment questions will be derived from End-of-Chapter Questions

1. **How do cells integrate and process information?**
   a. **Cell Communication**
      i. Review the diversity of signaling molecules (see handout).
      ii. Appreciate the different types of receptors and their significance.
      iii. Examine cell-surface receptors and outline specific examples of their function.
      iv. Understand G-protein structure and its importance to cell signaling.
      v. Describe what second messengers are and how they work

2. **How do cells move and change shape?**
   a. **Cytoskeleton**
      i. Distinguish the three types of protein filaments that comprise the cytoskeleton.
      ii. Outline the regulation of subunit interactions and regulation of associations.
      iii. Review the molecular structure of the filaments, their subunits, and how assembly is controlled.
      iv. Explain the significance of motor proteins and the control of their activity.
      v. Describe selected examples of other proteins that associate with the filaments.

3. **How do cells duplicate?**
   a. **Cell Cycle**
      i. Provide an overview of the cell cycle and describe key events associated with each stage.
      ii. Consider the molecular basis of cell cycle control, including a detailed examination of cyclins and Cdns.
      iii. Describe the importance of the proteins p21, p53, Ras and Rb for the cell cycle.
      iv. Outline the molecular details of the M-phase, including organelle fragmentation, spindle fiber formation and chromatin separation.
      v. Understand the significance of apoptosis and the cellular events associated with it.

4. **What happens when cell biology “fails”?**
   a. **Tissue Organization: Can’t we all just get along**
      i. Appreciate the significance of the extracellular matrix to tissue organization.
      ii. Review the different tissue types found in multicellular organisms.
      iii. Relate tissue organization to the cytoskeleton.
      iv. Describe the function and structure of desmosomes and gap junctions.
      v. Understand how tissues renew themselves.
      vi. Relate various cell cycle and cell signaling events to the development of cancer.

**Laboratory Schedule**

Lab 1. Sept. 9&10
   A. Introduction to Cell Biology Course
   B. Guidelines for Reading and Writing a Scientific Paper (The roadmap to how Cell Biology Reports will be written)
   C. Journal Review (Intro)
Lab 2. Sept. 16&17
   A. Lab Calculations
   B. Journal Review (M&M;R)
   C. Homework (Interpretation of Data)

Lab 3. Sept. 23&24
   A. Lab Calculations revisited
   B. Lab Quiz (Lab Calculations)
   C. Pippettes
   D. Journal Review (Assessment)

Lab 4. Sept. 30& Oct. 1
   A. Lab Report Due
   B. Pippetting
   C. Creation of a Standard Curve
   D. Journal Review (Intro)

Lab 5. Oct. 7&8
   A. Pipetting revisited
   B. Lab Quiz (Pipettes and Pipetting)
   C. Solution Preparation
   D. Journal Review (M&M;R)
   E. Homework (Interpretation of Data)

Lab 6. Oct 14&15
   A. Lab Report Due
   B. Cell Fractionation: Isolation of Mitochondria from Cauliflower
   C. Journal Review (Assessment)

Lab 7. Oct. 21&22
   A. Cell Fractionation: Assay of Mitochondrial Enzyme Activity
   B. Lab Quiz (Cell Fractionation)
   C. Journal Review (Intro)

Lab 8. Oct. 28&29
   A. Lab Report Due (Cell Fractionation)
   B. Enzymes: Biofuel Enzyme Kit Workshop
   C. Journal Review (M&M, R)
   D. Homework (Interpretation of Data)

Lab 9. Nov. 4&5
   A. Lab Quiz (Enzyme Kinetics)
   B. Enzyme Kinetics
C. Journal Review (Assessment)

Lab 10. Nov. 11&12
   A. Lab Report Due (Enzymes & Enzyme Kinetics)
   B. Protein Fractionation: Purification of IgG from Human Serum
   C. Journal Review (Intro)

Lab 11. Nov. 18&19
   A. Lab Quiz (Protein Fractionation)
   B. Protein Fractionation: Sodium Dodecyl sulfate – Polyacrylamide Gel Electrophoresis
   C. Journal Review (M&M, R)
   D. Homework (Interpretation of Data)

Lab 12. Nov. 25&26
   A. Protein Fractionation: Western Blotting
   B. Journal Review (Assessment)

Lab 13. Dec. 2&3
   A. Lab Report Due (Protein Fractionation)
   B. Lab Quiz (Microscopy)
   C. Microscopy
   D. Journal Review (Assessment)

Lab 14. Dec. 9&10
   A. Lab Quiz (Cell Culture)
   B. Cell Culture: Determining the Density of Cell Cultures
   C. Lab Report Due (Microscopy & Cell Culture)

TA Contact Information:
Nikhil Menon: nmenon@islander.tamu.edu
Whitney Roberson: wroberson@islander.tamu.edu

Major Course Requirements

Tentative Evaluation: Your final grade will be based on the percentage you earn out of the total possible points, weighted as specified below. Individual extra credit is not possible, but bonus points may be built into exams or other assignments. Statistical manipulations, if used (at the Instructor’s discretion), will be performed only once, at the end of the semester. A 10-point grading scale will be used:

A = 90 - 100 %
B = 80 - 89.9 %
C = 70 - 79.9 %
D = 60 - 69.9 %
F = 0 - 59.9 %
Components of Course Grade (Tentative)

I. Lecture (70 %)
   - 4 Exams @ 100 pts = 400
   - Comprehensive Final Exam = 200
   - Quizzes = 100

II. Laboratory (30 %)
   - Lab Reports = 180
   - Journal Review Assignments = 120
   - Lab Quizzes = 150

The time schedule may require adjustment. Should this be the case, the assignments and weighting may change slightly. Additional assignments may or may not be provided at the Instructor’s discretion. Such assignments might include homeworks, group projects, reading assignments, quizzes, seminar attendance, etc. Regardless of any such changes, the lecture and laboratory weighting of your grade shall remain at 70 % and 30 %, respectively. For example, if you make 90 % of total points available for the lecture and 80 % of total points available for the laboratory portion, then your grade would be calculated as:

\[(0.9 \times 70) + (0.8 \times 30) = (63) + (24) = 87/100 \text{ possible} = B\]

An assignment will likely be due during the last week of class.

Every attempt will be made to follow the time and evaluation schedules shown here. It is the student’s duty to attend each class session, review Blackboard and to be aware of all assignments, deadlines, changes.

Exams can consist of any of the following mixture of multiple choice, matching, fill-in the blank, short answer, labeling, calculations and essay questions, with heavy emphasis on short answer. Some will require analysis and interpretation of data or experimental design to assess critical thinking skills. Some questions will be derived from laboratory activities. The Final Exam (Wednesday, Dec. 18 from 8:00 - 10:30 AM) will contain material from each of your Assessment Exams.

Quizzes may be given at any time in class. There will be no makeups. Homeworks and other assignments may be given in class. The other assignments may include data interpretation, experimental design, calculations, opinion papers, research article summaries, etc. They will generally be due at the start of lecture class the following week. You are encouraged to get together and work on them as a group. However, unless specified otherwise, the assignments must be turned in individually and be written in your own words, NOT COPIED. An assignment grade of ZERO will be given if the work is not in your own words.

Readings, Resources & Supplies


BlackBoard: Course-associated site for posting notes, readings, labs, data, etc.

Recommended or Supplemental Reading:
- Supplemental readings will be posted on the Blackboard course site.

Text-Associated Website: http://garlandscience.com/index.jsf
List of Supplies

- You must have access to a computer and internet.
- For the Lecture:
  - Index cards (3x5)
  - Qwizdom Q4 student remote
    - There are a limited supply of remotes that you can borrow for the semester from SOAR
    - Go to the following website and follow instructions for borrowing:
      http://titlev.tamucc.edu/lendingprograms/qwizdom.html
- For the Laboratory:
  - You will need a laboratory notebook, index cards (3x5), “sharpie”, calculator, laboratory coat, and safety glasses.
  - Students will have to printout lab manuals that will be made available on Blackboard

Suggestions

If you are having trouble in this class don’t hesitate to communicate with me or take advantage of SOAR. A Supplemental Instructor will be available to assist.

Course Policies

ALL E-MAIL COMMUNICATIONS WITH THE INSTRUCTOR OR LAB TA MUST BE MADE THROUGH YOUR OFFICIAL UNIVERSITY E-MAIL (@ISLANDE:r), BY UNIVERSITY RULE.

Attendance/tardiness, Late work and Make-up Exams You are expected to attend all classes and labs in a timely manner. Important new material, as well as schedule changes and quizzes may occur at any time. It is expected that you will take notes, ask/answer questions, and participate in group activities.

LATE WORK will not be accepted, except as below, or unless otherwise specified.
Attendance is the student’s responsibility. You are responsible for the material covered in every lecture, even if it is not in the book, regardless of your attendance. Nothing missed during an unexcused absence can be made up. An excused absence allows us to make alternative arrangements to complete an assignment. Only unavoidable absences are excused. Routine events (holiday travel, non-emergency medical visits, parent-teacher conferences, household or auto repairs) should be scheduled to avoid conflicts with class. An acceptable excuse must be:
- from an appropriate source (doctor, dentist, funeral director) stating the nature of the event
- In writing, on official letterhead, and signed (it will not be returned)
- presented prior to, or within 1 week of, the absence
- It must state the dates for which the excuse applies

There are No make-up examinations: For some scheduled events, you may arrange to take a lecture exam before, but not after, its scheduled time. Quizzes cannot be made-up.

Expectations:
You are responsible for your own education. Participate! Take notes in class as some new information may be presented. Lecture notes from the instructor, when made available, do not represent everything you need to know. Read the book and handouts for further detail not covered in class, and to be prepared for laboratory. If you don’t understand, then please ask, or see the instructor after class. Don’t allow yourself to fall behind. Be diligent and thorough on written assignments and examination answers. If you are not sure of an answer, at least try. For many people, putting anything down on paper clarifies their thinking and helps with recall. Also:
- Be aware of university-imposed deadlines (ie drop dates)
- Be aware of test times and dates, including changes which may be announced in class
Check your exams for clerical errors. The test score is not the end of the learning process. Review tests to determine why you missed an answer. Correcting your mistakes is an effective way to learn material (reflective learning).

Work on all assigned homework problems in a timely manner. Seek tutorial help from classmates or the course/laboratory Instructors.

Keep track of your progress in class.

The following procedures will be enforced:

All major exams are the property of the instructor and may not be removed from class, copied, reproduced or photographed in any way. Violation will result in a grade of “F”

You must be prepared to present a photo ID at all examinations

If you leave an examination room—for any reason—you must hand in your test and you will not be allowed to resume the examination. Attend to personal matters (e.g., rest room visits) before the examination.

Cell Phone/Electronic Device Usage Policy on Disruptive Behavior:

As adult university students, you are expected to act with courtesy and common sense. Disruptive, disrespectful, or abusive language/behavior towards anyone in class (student, staff, faculty) will not be tolerated and could result in permanent removal from class. This includes tardiness to class, talking in class, insubordination, and electronic disturbances (cell phones, ipods, etc). Turn it off. Hazardous materials are used in the laboratory so “play” or reckless behavior will not be allowed. Children are not allowed in class or lab.

Academic Integrity/Plagiarism.

University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in appropriate action at the discretion of the instructor, including failure of the course. Everything should be in your own words.

Dropping a Class

I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. Please consult with me before you decide to drop to be sure it is the best thing to do. Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Be aware of the last day to drop a class with an automatic grade of “W” this term.


Grade Appeals*

As stated in University Rule 13.02.99.C2, Student Grade Appeals, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Rule 13.02.99.C2, Student Grade Appeals, and University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules.
Web site at http://www.tamucc.edu/provost/university_rules/index.html. For assistance and/or guidance in the grade appeal process, students may contact the Office of Student Affairs.

**Disabilities Accommodations**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call or visit Disability Services at (361) 825-5816 in Driftwood 101.

If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.