BIO 1140 Introduction to cell biology
Learning objectives – Winter 2016

Week 1
Introduction to the course (outline, exams, etc…)
(in class) Intro to cell biology – The cell (1 of 2 lectures)
(at home – will not be covered formally in class but **you are responsible** for this material) Microscopy section 2.1a and figure 2.4

Readings:
Purple pages F6-7
Ch. 2.1, 3.1 to 3.4 (1st lecture on cell) and Ch. 2.3 to 2.5, 3.5 (2nd lecture on cell)

Objectives – You should be able to answer these questions

- What is a cell?
- What is it made of? Name the different organelles and recognize the roles/functions for each
- What are the different scales/sizes for cells and organelles?
- Explain the theory of the cell and endosymbiosis
- What are the main groups or types of cells and how are they different?
- Understand the different types of microscopy and their requirements for use in cell biology

Additional readings:
Models to study biology: Purple pages F52-56
Origin and evolution of cells http://www.ncbi.nlm.nih.gov/books/NBK9841/
Universality of cells http://www.ncbi.nlm.nih.gov/books/NBK26864/
Endosymbiosis http://www.ncbi.nlm.nih.gov/pmc/articles/PMC368163/?tool=pmcentrez
Salamanders http://jeb.biologists.org/content/216/3/452.full

Video – Tour of the cell:
https://www.youtube.com/watch?v=1Z9pqST72is&list=TLxSfHo2_yogzBEYECTfFTNVUGO-sbqvAu

Week 2
Finish the cell (2nd of 2 lectures)
Macromolecules and chemistry of the cell (1 lecture)
Quiz # 1 to be completed online

Readings before class –
Ch. 3.1 to 3.3
Purple pages F8 to F36
Video lesson: https://www.youtube.com/watch?v=XmBmghaw7_E

In class we will focus on amino acids and proteins, but you are also responsible for carbohydrates, as well as lipids (prior to membrane lectures) and nucleic acids (prior to transduction lecture).

Objectives – You should be able to answer these questions

- Understand and evaluate the importance of polarity of molecules
- What are the types of chemical bonds and how are they relevant to biology
- Discuss the importance of water in biology
- Know what are the main classes of macromolecules, their structures, and interpret these in relation to their roles in cells

Additional readings:
Purple pages F24 to F43
Electronegativity: https://www.youtube.com/watch?v=XmBmghaw7_E
Electronegativity and chemical bonds: https://www.khanacademy.org/science/organic-chemistry/gen-chem-review/electronegativity-polarity/v/electronegativity-and-chemical-bonds
Chemical components of a cell http://www.ncbi.nlm.nih.gov/books/NBK26883/

Week 3: Cytoskeleton and Cellular interactions/Extracellular matrix (1 lecture)

Quiz # 2 to be completed online

Readings: Ch. 2.3f, 2.3g, 2.5, 8.4, 39.2, 42.6a,b

Objectives – You should be able to answer these questions

- How is the cell's interior organized?
- Compare how each component of the cytoskeleton is formed
- Relate the structure of the cytoskeletal fibers to their roles in the cell
- Associate the different cytoskeletal fibers with their preferred molecular motors and contrast their characteristics with respect to their roles
- What are the main types of cell-to-cell interactions?
- Discuss how cellular motility and mobility are different and how they are accomplished
- Describe what the extracellular matrix is made of, and interpret why it is important to cells

Additional readings:
Microtubules http://www.ncbi.nlm.nih.gov/books/NBK9932/
Microfilaments http://www.ncbi.nlm.nih.gov/books/NBK9908/
Intermediate filaments http://www.ncbi.nlm.nih.gov/books/NBK9834/
Cell-Cell adhesion and communication http://www.ncbi.nlm.nih.gov/books/NBK21599/
Cell matrix adhesion http://www.ncbi.nlm.nih.gov/books/NBK21539/
Microtubule motors and movements http://www.ncbi.nlm.nih.gov/books/NBK9833/
Motor proteins http://www.ncbi.nlm.nih.gov/books/NBK21710/
Extracellular matrix: http://www.ncbi.nlm.nih.gov/books/NBK26810/

Membranes (1st of 2 lectures)
Readings: F40-43, Ch. 5.1 to 5.3

Objectives – You should be able to answer these questions

- Discuss the role of membrane, and in particular the plasma membrane, in a cell.
- Understand and explain the fluid mosaic model. Include the membrane's properties in the discussion.
- What is the membrane made of? Describe and organize the different molecules involved and link them to the membrane's properties.

Additional readings:
Membrane structure: http://www.ncbi.nlm.nih.gov/books/NBK9898/
http://www.ncbi.nlm.nih.gov/books/NBK26871/
Videos: Cell membranes https://www.youtube.com/watch?v=y31DlJ6uGgE

Week 4: Membranes and Transport (2nd of 2 lectures)
Readings: Ch. 5.3-5.6

Objectives – You should be able to answer these questions

- Compare the different types of transport across the membrane and give examples for each.
- How are membrane dynamics important for transport?
- How is membrane potential formed and what is it useful for in a cell?

Additional readings:

Transport https://www.youtube.com/watch?v=svAAiKsJa-Y
ATP pumps http://www.ncbi.nlm.nih.gov/books/NBK21481/
Transport proteins http://www.ncbi.nlm.nih.gov/books/NBK21502/
Membrane potential http://www.ncbi.nlm.nih.gov/books/NBK21627/

2nd lecture; Catch-up and review for midterm 1
Midterm covers all material until this lecture

Midterm exam I Saturday February 6th (Objectives from Lectures 1 to 8)

Week 5: Mitochondria

Energetics (1 Lecture)

Readings: Ch. 4.1 to 4.4, 6.1, 6.2, 6.5, 7.1-7.2

Objectives – You should be able to answer these questions

- Explain what is the role of mitochondria in a cell with regards to energy production
- Understand the importance of calcium
  - Availability, Storage
  - Cellular functions
- Understand key concepts of cellular energetics in relation to mitochondria
- What is mitophagy and how/why does it occur?

Additional readings:
Protein synthesis in mitochondria http://www.ncbi.nlm.nih.gov/books/NBK21652/
Mitochondria http://www.ncbi.nlm.nih.gov/books/NBK9896/
Calcium paper (on BB)
http://javeriana.edu.co/Facultades/Ciencias/neurobioquimica/libros/celular/programacell_archivos/Calcium%20Signalling%20and%20regulation%20of%20cell%20function.pdf

Apoptosis (1 Lecture)
Readings: Ch. 8.5h, 42.7f, and Document on blackboard – Regulation of programmed cell death

Objectives – You should be able to answer these questions

- Describe and differentiate the two cell-death mechanisms and explain the role of mitochondria and calcium in each

Additional readings:
Cell death http://www.ncbi.nlm.nih.gov/books/NBK9922/

Week 6: Reading week – no class

Week 7: Signal Transduction (2.5 lectures)

Readings: Ch. 5.7, 43.1-43.2, Fig. 38.2 (p 920)

Objectives – You should be able to answer these questions

- Explain and give examples of cellular communication and its role
- Define the 3 steps of cell communication
- Know and differentiate the 6 paths of communication
- Identify and differentiate the 6 messenger classes and their characteristics
- Know and recognize the 4 different classes of receptors
- Define what is cellular signalling and transduction
- Identify and compare the basic signalling pathways:
  - Intracellular
  - Ion channels
  - Enzymatic receptors (Particularly RTK/Tyr-k)
  - GPCR (cAMP and IP3 Pathways)
- Describe in detail an example of a cellular response with its signal transduction cascade
- Recognize and describe the mechanisms (6) that can terminate a cellular response

Additional readings:
Cell signalling http://www.ncbi.nlm.nih.gov/books/NBK26813/#A2745
Cellular receptor classes http://www.ncbi.nlm.nih.gov/books/NBK26813/#A2766
GPCR http://www.ncbi.nlm.nih.gov/books/NBK26912/
Enzyme receptors http://www.ncbi.nlm.nih.gov/books/NBK26822/#A2847
http://www.ncbi.nlm.nih.gov/books/NBK26822/
Signalling https://www.youtube.com/watch?v=FkkK5lTmBYQ

Week 8: Transcription (DNA to RNA) (2 lectures)

Readings: F37-39, Ch. 13.1-13.2, Ch. 14

Objectives – You should be able to answer these questions

- Understand, describe and demonstrate the steps involved in transcribing DNA to mRNA
- Be familiar with the elements comprised in a transcription initiation complex and its role
- Explain and demonstrate RNA maturation and splicing
- Compare and contrast RNA transcription in prokaryotes vs eukaryotes
- Know, describe and/or compare the different elements of control for gene expression in prokaryotes vs eukaryotes
  - Activators, Enhancers
  - Repressors
  - Alternative splicing
  - Operons

Additional readings:
Transcription http://www.ncbi.nlm.nih.gov/books/NBK26887/
http://www.ncbi.nlm.nih.gov/books/NBK26829/
Initiation complex http://www.ncbi.nlm.nih.gov/books/NBK26887/#_A994_
Transcription video: http://www.dnalc.org/resources/3d/13-transcription-advanced.html
Post-transcriptional regulation http://www.ncbi.nlm.nih.gov/books/NBK26890/

Week 9: Regulation of transcription and Translation
Readings: Ch. 13.3 to 14.3c

Objectives – You should be able to answer these questions

- Know the components and roles of a ribosome
- Understand and demonstrate the different steps involved in translation
- Using the codon table, be able to obtain the mRNA and amino acid sequence corresponding to a given DNA strand
- Define and explain, using an example, the different genetic point-mutations and possible mutagens

Additional readings:
Translation http://www.ncbi.nlm.nih.gov/books/NBK26829/
http://www.ncbi.nlm.nih.gov/books/NBK26841/
http://www.ncbi.nlm.nih.gov/books/NBK21653/

Week 10: Translation and protein sorting (1 Lecture)

Objectives – You should be able to answer these questions

- Discuss/Compare the possible scenarios for protein sorting following translation
- Relate vesicular transport to the cytoskeletal elements and motor proteins previously discussed
- Analyse a cascade of events from a messenger molecule to a nuclear response, including protein secretion

Additional readings:
Protein transport from ER to Golgi http://www.ncbi.nlm.nih.gov/books/NBK26941/
Exocytosis http://www.ncbi.nlm.nih.gov/books/NBK26892/
Translation video https://www.youtube.com/watch?v=5bLEDd-PSTQ
Vesicular traffic https://www.youtube.com/watch?v=rvfvRgk0MfA

Catch-up Review prep for midterm II (1 Lecture)
Midterm 2 covers material from Lectures 9 to 18

Week 11: DNA replication (2 lectures)

Readings: F37-39, Ch. 12
Objectives – You should be able to answer these questions

- Understand the structure and organisation of DNA (including nucleotides etc.)
- Understand and demonstrate the steps involved in DNA replication
- Understand the structure and organisation of RNA
- Explain the DNA protection and correction mechanisms

Additional readings:
Replication http://www.ncbi.nlm.nih.gov/books/NBK26850/
Replication Video: https://www.youtube.com/watch?v=27TxKoFU2Nw

Week 12-13: Cell-cycle regulation (2 lectures)

Readings: Ch. 8
Objectives – You should be able to answer these questions

- Describe and compare the role of the different phases of the cell cycle, including the various molecular checkpoints
- Explain how the cell cycle is regulated
- Understand and discuss the relationship between the cell cycle's regulation and the cell's mechanisms for survival vs death

Additional readings:
Cell cycle http://www.ncbi.nlm.nih.gov/books/NBK21466/
Checkpoints http://www.ncbi.nlm.nih.gov/books/NBK21719/
Regulation http://www.ncbi.nlm.nih.gov/books/NBK21497/
Cell cycle control http://www.ncbi.nlm.nih.gov/books/NBK26824/
Cell cycle video https://www.youtube.com/watch?v=FMIOiW3V9Vo

Week 14: Catch-up, Review, prep for final

The final exam is cumulative and the entire course material will be covered in the exam – be prepared for integrative questions (i.e., a question may touch upon more than one topic, so you can show you understand how the material relates together).

Final exam dates to be confirmed
Check with faculty, if necessary, to see if you are eligible to a supplemental/deferred exam (Final Grade of E)