**Supplemental Table 1: Learning outcomes (LOs) used in Cell Biology at Georgia Gwinnett College.** 20 learning outcomes were generated and used to delineate the course content used for individual assessments when using specifications grading.

1) Compare and contrast the structure and function of cytoskeletal filaments and their role in cell division.

2) Describe the process of DNA condensation, knowing how histone proteins (H1, H2A, H2B, H3, and H4) are involved. Describe the differences in the structure of euchromatin and heterochromatin and where/when they are found during the cell cycle.

3) Describe the proteins/enzymes involved in the process of transcription, be able to identify the promoter region, the start site and be able to generate the mRNA from a given DNA strand.

4) Describe the three RNA modifications in eukaryotes and their functions. Describe the process of splicing and explain how alternative splicing can result in multiple mRNAs and therefore different proteins.

5) Describe and identify the role of the ribosome, rRNA, tRNA and mRNA, and aminoacyl tRNA synthetase involved in the process of translation.

6) Delineate the start of a coding sequence, identify location/length of the 5' UTR and 3' UTR, match a tRNA to a codon, and determine the amino acid sequence from a given mRNA strand.

7) Describe the varying types of gene expression regulation in eukaryotes that may activate or prevent transcription. Apply how chromosome structure (at both the DNA and histone level) can be modified to affect gene expression.

8) Describe the role of repressors and activators and other regulatory elements in the regulation of gene expression in prokaryotes and/or eukaryotes.

9) Describe the properties of the plasma membrane that allow molecules to diffuse across the phospholipid bilayer.

10) Compare and contrast the functions of different types of transporters and ion channels, the molecules they move, and the direction of transport for individual molecules (knowing which use passive vs. active transport).

11) Define the electrochemical gradient and understand how transport of Na	extsuperscript{+}, K	extsuperscript{+} and Ca	extsuperscript{2+} are transported to maintain homeostasis in relation to the electrochemical gradient.

12) Explain how different signal sequences regulate the transport of proteins to their proper location in the cell. Describe how proteins with nuclear localization signals are transported into the nucleus and how proteins with mitochondrial signal sequences are transported into the mitochondria.

13) Describe the proteins and events involved in the import of proteins into the ER, compare and contrast the events that result in the generation of a transmembrane protein vs. a secretory protein.

14) Describe the process of vesicle formation (endocytosis and exocytosis) including the proteins and the process that allow vesicle sorting and docking to appropriate locations and describe receptor mediated endocytosis.

15) Describe the four methods of cell communication and explain the major differences between the general signaling pathways of an intracellular receptor and an extracellular receptor.

16) Compare and contrast the structure and function of G-protein coupled receptors (GPCRs) and receptor tyrosine kinases (RTKs), describe the mechanism of action and signaling pathways that are a result in activation of these receptors.
17) Identify where cell-cycle checkpoints are located, describe how Cdks become activated and
describe which cyclins activate the corresponding Cdks and how the activated Cdks regulate cell cycle
checkpoints.

18) Identify the names and functions of the proteins involved in DNA replication, be able to accurately
draw or label bi/unidirectional replication in a replication bubble. Know the various types of
mutations and how DNA polymerase proofreads and the effect of using NHEJ (non-homologous end
joining) vs HRR (homologous recombination repair) on double strand breaks

19) Compare and contrast necrosis and apoptosis, describe the molecular events that regulate
apoptosis. Describe how dysregulation of cell cycle control mechanisms can contribute to the
formation of cancer and how tumor suppressors and oncogenes contribute to tumor formation.

20) Compare and contrast the capabilities, locations and potential therapeutic application of stem
cells when defined as pluripotent, multipotent, or totipotent and compare and contrast the process of
self-renewal and differentiation of stem cells.

Supplemental Table 2: Correlation of number of mastered learning outcomes (LOs) to grade earned
in lecture. The number of learning outcomes mastered correlates to the final grade earned in the
lecture portion of the course.

| Number of Mastered LOs | Grade Earned in Lecture |
|------------------------|-------------------------|
| 20-18                  | A                       |
| 17-16                  | B                       |
| 15-14                  | C                       |
| 13-12                  | D                       |
| Fewer than 12          | F                       |

Supplemental Table 3: Effect of midterm and final exam grades on number of mastered learning
outcomes (LOs). Cumulative midterm and final examinations were given to students that could alter the
final numbers of LOs earned in the course.

| Midterm or Final Exam Grade | Number of LO Gained or Lost as a Result of Exam Grade |
|-----------------------------|------------------------------------------------------|
| A                           | + 1                                                  |
| B                           | + 0.5                                                |
| C                           | -0.5 if lecture grade is A/B, no change if lecture grade is ≤ C. |
| D                           | -1                                                   |
| F                           | -1                                                   |
Supplemental Figure 1: Student Attitudes Towards Grading. Survey questions addressing student attitudes towards the grading scheme and their ability to 1) understand course content, 2) retain course content, 3-9) achieve course learning goals, and 10) increase enthusiasm for cell biology were assessed using a Likert scale with the choices Strongly Disagree (red), Disagree (pink), Neutral (gray), Agree (light purple), and Strongly Agree (dark purple). A) represents students in the Traditional grading scheme and B) represents students in the Specifications grading scheme. Increases in positive responses were found, but the data was not statistically significant.