1. What is the central motif (dogma) in biology (and specifically molecular biology)?
2. What did Ernst Haeckel propose about the cell nucleus in 1866?
3. In 1869 Friedrich Miescher isolates “nuclein” (later known as DNA) from the nuclei of leukocytes. What did he discover about DNA at this time?
4. Who in 1928 found evidence for the transfer of a “transforming principle” between bacterial cells? (Hint: This was the experiment with 3S virulent and 2R non-virulent streptococcus pneumonia strains injected into mice).
5. Define transformation as it pertains to molecular biology.
6. In 1944 Avery, MacLeod, and McCarty demonstrated that DNA was the substance that causes bacterial cell transformation. Please describe their experiment—be sure to tell what organism they used.
7. Who definitively proved in 1952 that DNA was the transforming material?
8. What organisms did Hershey and Chase use?
9. In the Hershey and Chase experiment, what part of the bacteriophage virus was labeled by radioactive P32 and what part was labeled by S35?
10. In what year did Watson and Crick publish their DNA structure?
11. Who in 1958 provided evidence to support the theory of semiconservative replication?
12. What is semiconservative replication?
13. Describe the Meselson and Stahl experiment proving semiconservative replication—including what organism did they use?
14. If Generation 0 is incubated in $^{15}$N (heavy) media, and then Generations 1, 2, and 3 are all incubated in $^{14}$N (light) media: What density gradient banding pattern DNA is found in Generation 1? What DNA density gradient banding patterns are found in Generation 2 and 3?
15. Who discovered that $[A] = [T]$ and $[C] = [G]$ in DNA? Note that brackets [ ] indicate concentration.
16. What two people provided X-ray crystallography data about DNA that helped Watson and Crick create their structure of DNA?
17. Who in 1963 demonstrated the manner of replication in a bacterial chromosome through autoradiography?
18. What radioactive material is commonly used in autoradiography?
19. What is usually tritiated to track transcription? What is usually tritiated to track replication?

20. In what year did M. Schnös and R. B. Inman demonstrate bidirectional replication in bacteria?

21. What is the difference between a nucleotide and a nucleoside?

22. Which nucleotides are the purines?

23. Which nucleotides are the pyrimidines?

24. Be able to recognize and distinguish the structures of the five different nitrogenous bases.

25. What three components make up a nucleotide?

26. In a nucleotide, why do you think the carbons in the ribose are numbered with a prime symbol? Ex: 1’, 2’, 3’, 4’?

27. What is the difference between Ribose (in RNA) and Deoxyribose (in DNA)? Which specific carbon is this difference found?

28. What bond forms between a 3’ carbon’s hydroxyl group and a 5’ carbon’s phosphate group in the sugar phosphate backbone of DNA or RNA?

29. What is meant by antiparallelism when talking about DNA structure?

30. How many hydrogen bonds are formed between cytosine and guanine? How many hydrogen bonds form between thymine and adenine?

31. What are the three forms of DNA discussed in class and which is the most common?

32. Which DNA form is a left handed helix?

33. How long is 1 angstrom in centimeters?

34. In the B-Form of DNA (also known as the Watson and Crick form), how many base pairs are there per each turn in the DNA’s double helix structure? How many angstroms are there per turn in the DNA? How many angstroms are there between each base pair?

35. Describe the Major and Minor grooves in the B-Form of DNA.

36. What is theta replication?

37. Describe the term replication fork.

38. In DNA replication, what is the function of gyrase?

39. What follows gyrase and causes unwinding of the parent helix?

40. What is the purpose of single-strand binding proteins in DNA replication?

41. What enzyme lays down the RNA primer? What is the importance of the primer?

42. What enzyme primarily adds nucleotides to synthesize the new complementary strand of DNA from the original parent strand in DNA replication? What direction does this enzyme work?

43. What enzyme in replication comes back and removes the RNA primer and replaces it with DNA?

44. What is the difference between the leading and the lagging strand in DNA replication?

45. What is another name for the DNA segments/fragments on the lagging strand?
46. What enzyme connects the sugar phosphate backbone (forms covalent phosphodiester bonds) of the lagging strand and areas where the RNA primer was replaced with DNA nucleotides?

47. What enzyme does the drug Ciprofloxacin target and inhibit in a bacterial cell? (Hint: this inhibition prevents the bacteria from replicating its DNA).

48. Are diphosphate nucleotides or triphosphate nucleotides used as precursors during DNA and RNA replication and transcription? Why?

49. List the precursor nucleotides used in DNA replication. List the precursor nucleotides used in transcription (Hint: think RNA).

50. What are the differences in DNA replication between prokaryotes and eukaryotes? (Hint: think about the origin of replication and DNA polymerases). What are the particular functions of the four DNA polymerases found in eukaryotes?

51. Is mRNA transcribed from the sense (coding) or the antisense (template) strand of DNA? Which direction (5’-3’ or 3’-5’) does each of these strands run?

52. How is the mRNA different from the sense (coding) strand?

53. Define polycistronic and monocistronic.

54. If an mRNA is polycistronic is it prokaryotic or eukaryotic?

55. In a prokaryotic cell, translation can be coupled with transcription. Describe what this means. Why doesn’t this occur in a eukaryotic cell?

56. How many different RNA polymerases does a prokaryotic cell have? How many different RNA polymerases does a eukaryotic cell have?

57. List the eukaryotic RNA polymerases used in transcription and what type of RNA they produce.

58. What are the four general steps of transcription (in prokaryotes)?

59. If no free hydroxyl group on the 3’ carbon on ribose and no primer are necessary for initiation of transcription, what causes the initiation of transcription in prokaryotes and eukaryotes?

60. In prokaryotes, the RNA polymerase is a holoenzyme that consists of two units. What are the two units? What is the purpose of each unit?

61. In the lac operon model, explain what happens if lactose is present. Explain what happens if lactose is absent.

62. Describe rho-dependent termination and rho-independent termination of prokaryotic transcription.

63. How do each of the three different RNA polymerases terminate transcription in eukaryotes?

64. What are transcription factors in eukaryotic transcription (also known as trans-acting regulatory proteins)? What can transcription factors bind to?

65. There are two sequences in the DNA that help initiate transcription in eukaryotes. These are Promoters and Enhancers (also known as cis-acting nucleotide sequences). What can Enhancers bind to? What is the purpose of Enhancers? What can Promoters bind to?
What is the purpose of Promoters? Is the Enhancer or the Promoter closer to the target gene?

66. In the Promoter region there are three “boxes” that can bind transcription factors called the TATA box, the CAAT box, and the GC box. How do you think they got their names? List these three “boxes” of the Promoter region in order from the farthest to the closest to the transcriptional start site.

67. What are exons? What are introns? Which one is spliced out of eukaryotic pre-mRNA during post-transcriptional modifications? Do prokaryotes have introns?

68. What else happens to eukaryotic mRNA (other than splicing) before it is transported to the cytoplasm?

69. What specific molecule is added to the 5’ end of eukaryotic pre-mRNA during post-transcriptional modification? What is added to the 3’ end? Why do you think these additions are necessary for eukaryotic mRNA?

70. List the post-transcriptional modifications that occur to a eukaryotic tRNA. What shape is tRNA? What specific sequence is found at the 3’ end (where the amino acid attaches to the tRNA)? What unique nucleotide bases are placed in the looped regions?

71. What is unique about rRNA post-transcriptional modifications? Is that activity representative of rRNA’s future function?

72. What is meant when discussing translation by the statement that the genetic code shows degeneracy?

73. Describe the difference between partial and complete degeneracy.

74. What is the wobble idea? Which nucleotide base positions/locations does wobble occur (mention both the anticodon nucleotide and the codon nucleotide)?

75. Ribosomes are labeled/named via the Svedberg unit or their sedimentation rate. The total prokaryotic ribosome is 70S. What numbers are the prokaryotic small and large subunits of the ribosome? (Remember Svedberg units are not additive in ribosomes).

76. The eukaryotic ribosome is 80S. What Svedberg units are the eukaryotic small and large ribosomal subunits?

77. Where is the anticodon located? Where is the codon located?

78. How many nucleotides are in a codon?

79. If you have a polypeptide with 8 amino acids, what is the minimum number of nucleotides that coded for that protein?

80. What enzyme causes a tRNA to become “charged” or form a tRNA complex with an amino acid?

81. What makes up the initiation complex in translation in prokaryotes (be sure to mention initiation factors)?

82. During translation, what is the first amino acid in eukaryotes? What is the first amino acid in prokaryotes?

83. Do all final protein products have a methionine as their first amino acid? Why or why not?
84. What is the codon for methionine (aka the start codon for translation)?
85. During translation, where does the first “charged” tRNA molecule (aka tRNA containing methionine or formyl-methionine) bind in the ribosome (which site)?
86. Where in the full ribosome (which site) does the second amino acid bind with the help of an elongation factor?
87. On the ribosome, what are the full names for the abbreviated P and A sites? When are the P and A sites formed during translation?
88. What enzyme is responsible for the transfer of the amino acid in the P-site to the second amino acid in the A site via peptide bond formation? What is a by-product of peptide bond formation? (Hint: you drink it every day).
89. What bond forms between amino acids?
90. An elongation factor also aids in the translocation step. What happens during translocation? Which direction (3’ to 5’ or 5’ to 3’) does translocation occur (think about the mRNA)?
91. How does translation stop (termination)? Be sure to mention release factors. List the three stop codons. What happens to the ribosome?
92. What are polysomes?
93. Which steps in translation require energy (aka GTP)?
94. Be able to design an mRNA strand given an antisense (template) DNA strand. Be able to assign amino acids to the particular codons in an mRNA strand (think about the direction of the codon and the anticodon. Are they 5’-3’ or 3’-5’? Which directions do they need to be in to be able to complementary bind?)
95. Understand that there are 20 main amino acids and some amino acids share similar properties. List the four major groupings of these 20 amino acids.
96. Distinguish between the amino end and the carboxyl end of a protein (aka a strand of amino acids).
97. Understand general protein structure. The amino acid sequence (known as primary structure) ultimately determines the rest of the structure of the protein. The characteristics of the particular sequence of amino acids determine secondary structure (Alpha helix and Beta-pleated sheets). Tertiary structure is the folding of these structures into a functional protein. If several proteins combine to form a functional protein (such as hemoglobin) this is known as quaternary structure.
98. Realize that each step of gene expression (transcription and translation) is controlled. It isn’t just controlled by simply knowing when to start/initiate transcription and translation of a particular gene. List next to each level of control some of the ways that control is possible. Note those items marked with check mark on slides 46-49 in lecture slide set 19.

   a. Chromosome
   b. Gene (transcriptional control)
c. RNA (post-transcriptional control)
d. Protein (post-translational control)