Maximum score: 50 points

1. Purines are adenine and guanine, pyrimidines are cytosine and thymine. Purines are two fused rings, pyrimidines are a single ring. (2 points: 1 point for each part)

2. 0.5 points per correct box

3. 6.5 points total
   a. Maximum 1.5 points for this section
      i. RR, rr (0.5 points)
      ii. Rr (0.5 points)
      iii. Incomplete dominance (0.5 points)
   b. Maximum 3 points for this section
      i. 0.5 points per correct answer
         1 - 25%
         2 - 25%
         3 - 25%
         4 - 25%
      ii. Meiosis, Prophase I (1 point)
   c. 16 (2 points)

4. Autosomal dominant, autosomal recessive (1 point)

5. Maximum 2 points for this section
   a. Autosomal dominant, autosomal recessive, sex-linked dominant (1 point)
   b. Autosomal dominant, 0.5 OR autosomal recessive, 0.5 OR sex-linked dominant, 0.5 (1 point)

6. A - 3’ end, 5’ end (1 point)
7. C - “Intron trapping” describes the process that exploits the existence of the intron-exon splicing to find new genes (1 point)

8. Maximum 3 points for this section
   a. 2 points for this section

   ![Diagram of DNA replication]

   b. iii (1 point)

9. Maximum 5 points for this section
   a. The top strand (1 point)
   b. 5’ UCGAACUACA 3’ (1 point)
   c. Before the transcription start site (1 point)
   d. It affects both the mRNA transcript and the protein. The transcript has a different sequence so the protein transcribed will be different. (1 point)
   e. It is a frameshift mutation (1 point - give 0.5 points for insertion)

10. Maximum 3 points for this section
    a. ddNTPs (dideoxynucleotide triphosphates) (1 point)
    b. ddNTPs are missing a 3’ OH in addition to the already missing 2’ OH (1 point)
    c. The chain being produced when sequencing terminates early because the concentration of ddNTPs is too high. This results in an incomplete sequence. (1 point)

11. C, E, B, A, D (1 point)

12. Maximum 5 points for this section
    a. The promoter (1 point)
    b. TATA box (1 point)
    c. Bacteria: sigma factors. Eukaryotes: transcription factors (2 points)
    d. i, iii, iv (1 point)

13. Klinefelter’s Syndrome (XXY) (1 point)

14. Maximum 3 points for this section
    a. Chain elongation and codon recognition and translation termination (1 point)
b. Bonding of tRNA to amino acid (1 point)
c. Transcription would never initiate (1 point)

15. Maximum 4 points for this section
   a. Operator, promoter, and genes (1.5 points)
   b. Gene expression decreases as tryptophan binds the repressor (1 point)
      i. Repressible (0.5 points)
   c. 0.5 points for each correct answer:
      i. Yes
      ii. Yes

16. Cas9 binds to the guide RNA and to the target DNA sequence and also cuts the strands of the DNA. (1 point: 0.5 points per part—binding is one part, cutting is the other part)

17. Maximum 3 points for this section
   a. Forgot ampicillin resistance gene (1 point)
   b. Forgot an origin of replication (1 point)
   c. Forgot restriction enzyme sites (1 point)

18. B (1 point)
19. A (1 point)
20. C (1 point)

21. Height, weight, neural tube defects, spina bifida, anencephaly, hip dysplasia, etc (1 point for each correct answer up to maximum 3 points)