1. DNA Template strand: 5’-CAGCGACAT-3’
   (1) Please write down the sequence of sense strand, anti-codon strand, mRNA and peptide chain encoded from mRNA for this DNA template strand. (6%)
   (A) sense strand: 5’-ATGTCGCTG-3’
   (B) anti-codon strand: 5’-CAGCGACAU-3’
   (C) mRNA: 5’-AUGUCGCUU-3’
   (D) peptide chain: 5’-met-Ser-Leu-3’

   (2) What are Chargaff’s ratios? Why were they important in discovering the structure of DNA? (4%) 
   Ans: Erwin Chargaff found that regardless of the source of a DNA sample, the relative amounts of the four bases conformed to a rule. The rule was that the amount of adenine in a DNA sample always equaled the amount of thymine and that the amount of cytosine always equaled the amount of guanine. He also observed that the amount of A+T together is independent of the amount of C+G and that while the A+T/G+C ratio was the same for all of the tissues in a particular species, it varied from species to species. An understanding of these rules, especially the pairing relationship, helped Watson and Crick to figure out DNA structure and convinced them of its correctness. The model that they built was built to be compatible with the pairing rules and included two polynucleotide chains that were complementary to each other in a way that reflected Chargaff's pairing rules. They realized that this complementarity in the structure could explain DNA's ability to replicate, since the sequence of bases in each chain could specify the bases that appeared opposite them in the other chain. Thus, both chains in a DNA double helix, carry the same, albeit complementary instructions.

2. A red blood cell with an internal concentration equivalent to 0.15 M NaCl is placed in a solution with a concentration of 0.35 M NaCl. What happens to the red blood cell? What term describes the solution relative to the red blood cell? What relative term describes the interior concentration of the red blood cell relative to the surrounding solution? If the concentration of the solution surrounding the red blood cell were changed to 0.15 M NaCl, what term would describe this environment relative to the cell? (5%) 
   Ans: The red blood cell loses water to the surroundings and shrinks or crentates. The solution is hypertonic relative to the red blood cell. Hypotonic. Isotonic.

3. In a dihybrid cross between individuals heterozygous for both traits, how many different genotypes are possible in the F1 generation? Assuming that both traits show dominance, how many different phenotypes are possible? (5%) 
   Ans: There are nine possible genotypes and four possible phenotypes in a dihybrid cross between individuals heterozygous for both traits.
4. List two extracellular organelles responsible for cell movement. How are they similar and different? (5%)
Ans: Cilia and flagellae are responsible for cell movement. In cross section, cilia and flagellae are structurally identical. The organization of the microtubules of which they are composed is essentially identical. The major difference in their structure is that cilia are generally shorter and much more numerous. While a cell will have at most only a couple of the longer flagellae, the shorter cilia often cover the whole cell surface or significant portions of the surface. Flagellae achieve cell motion by pushing against the medium in which the cell finds itself, thus propelling the cell forward. Cilia beat back and forth in unison and produce motion. They can be seen beating in waves across the cell surface and look much like a breeze blowing across a field of wheat.

5. What would happen if the different tRNAs in cells could bind to just any amino acid? How does the specificity of tRNA for particular amino acids maintain the integrity of the genetic information? (5%)
Ans: If the different tRNAs in cells could bind to just any amino acid, the specificity required of tRNAs and their attached amino acids would be compromised. Very few proteins would possess the correct primary structure and they would thus not function properly. The specificity of tRNAs for particular amino acids assures that the amino acid corresponding to the anticodon (codon) will be placed only in those positions within a growing protein where it belongs. It is this rigid correspondence between the anticodon and the attached amino acid that maintains the integrity of the genetic information.

6. Molecular biologists can connect pieces of DNA from two different organisms to make recombinant DNA. What are the steps in this process? (5%)
Ans: If the DNAs from the two different organisms are treated with the same restriction endonuclease, they will be cut at the same recognition site and will possess the same sticky ends. If the two types of DNA are mixed, their sticky ends will pair with each other, hooking together the two foreign pieces of DNA. The association can be made permanent by treating the recombinant DNA with the enzyme DNA ligase, which will connect the two foreign pieces of DNA covalently.

7. (1) What is the polymerase chain reaction (PCR)? (5%)
(2) What are the primers in PCR and why are they needed? (5%)
Ans: Using the polymerase chain reaction or PCR, specific sequences of DNA can be targeted from the entire genome and amplified, copied billions of times, without first cutting with restriction enzymes or cloning. It is possible to make billions of copies of a sequence of DNA nucleotides that may be present initially in very few copies. What must one know before performing PCR? One must know what the target DNA is, that is, which part of the total DNA one wishes to copy. One must also know the nucleotide sequences of about 20 bases on either side of the target DNA, its flanking sequences.

8. Why does the FBI use 13 different VNTR (variable number tandem repeats) regions instead of just 1 VNTR region in identifying criminals with DNA evidence? (5%)
Ans: Often, it is not possible to identify a person with certainty using just one VNTR region. For example, some VNTR patterns can be found in 1 of every 25 people in the general population. The more VNTR regions that are compared, the more likely it is that the DNA at a crime scene came from a particular suspect with the same VNTR patterns.
II. 選擇題(50%)，共25題，每題2分：

C 1. Which of the following structures is typical of the genetic material, DNA?
   (A) cubicle helix     (B) triple helix     (C) double helix     (D) alpha helix     (E) c and d

C 2. Which of the following is an RNA nucleotide?
   (A) phosphate - deoxyribose - thymine
   (B) phosphate - deoxyribose - adenine
   (C) phosphate - ribose – cytosine
   (D) phosphate – cytosine - guanine
   (E) phosphate - ribose - thymine

B 3. Which type of RNA possesses an anticodon?
   (A) mRNA             (B) tRNA              (C) rRNA
   (D) all of them have anticodons     (E) none of them have anticodons

A 4. The division of cytoplasm in eukaryotic cells is:
   (A) cytokinesis     (B) cytolysis     (C) cytoplasmic streaming
   (D) cytofusion      (E) cytocryro

E 5. The function of mitosis is for:
   (A) growth and repair       (B) production of gametes       (C) production of a zygote
   (D) asexual reproduction    (E) both a and d

E 6. What is considered to be the beginning of modern biology?
   (A) Naming of “cells” by Robert Hooke
   (B) Distinction between animate and inanimate objects
   (C) Mendel's discovery of the laws of inheritance
   (D) Linnaean classification system
   (E) Darwin's The Origin of Species

A 7. What is the mechanism for change in species?
   (A) natural selection         (B) artificial selection       (C) reproduction
   (D) acquisition of traits     (E) food supply

B 8. In which phase of mitosis do the two sister chromatids separate?
   (A) prophase     (B) anaphase     (C) telophase     (D) metaphase     (E) prophase II

E 9. Which of the following pairs are unrelated?
   (A) nucleus: heredity
   (B) endoplasmic reticulum: transport
   (C) mitochondrion: cellular respiration
   (D) food vesicles: endocytosis
   (E) smooth endoplasmic reticulum: ribosomes
10. What microtubule-containing structures organize the cytoskeleton prior to mitosis in animal cells?
   (A) basal bodies  (B) centrioles  (C) chromosomes  (D) rough ER  (E) mitochondria

A

11. Which word below describes an organism that has two genetic factors (alleles) identical for a particular trait?
   (A) homozygous  (B) heterozygous  (C) heterogametic  (D) homogametic  (E) a and d

C

12. What is the name for a cluster of genes in a bacterium, including protein coding genes and all of the regulatory DNA involved in controlling their expression?
   (A) operator  (B) repressor  (C) operon  (D) structural gene  (E) gene cluster

B

13. Sickle cell anemia is caused by the substitution of one base for another resulting in a single amino acid variation in the coding for a hemoglobin molecule. What type of mutation would this be called?
   (A) frame shift  (B) point  (C) lethal  (D) transforming  (E) backward

B

14. Positions within the genome where DNA nucleotides of 2 or more individuals differ, i.e., where different nucleotides occupy the same position are called __________.
   (A) polypeptide protein parts (PPP’s)  (B) single nucleotide polymorphisms (SNP’s)  (C) snipets  (D) unique nucleotide differentiators (UND’s)  (E) palindromes

A

15. Using the chart below determine which of the organisms would be considered “living.”

<table>
<thead>
<tr>
<th><strong>Organism I</strong></th>
<th><strong>Organism II</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Composed of one or more cells</td>
<td>a. Composed protein and DNA</td>
</tr>
<tr>
<td>b. Can carry out chemical reactions</td>
<td>b. Can change chemical form</td>
</tr>
<tr>
<td>c. Can grow in size and change in appearance</td>
<td>c. Can grow in size and change in appearance</td>
</tr>
<tr>
<td>d. Maintains a fairly constant internal environment</td>
<td>d. Has a fluctuating internal environment</td>
</tr>
<tr>
<td>e. Has the ability to reproduce offspring similar to self</td>
<td>e. Has the ability to replicate self</td>
</tr>
<tr>
<td>f. Responds to changes in the environment</td>
<td>f. Has no response to changes in the environment</td>
</tr>
</tbody>
</table>

(A) Organism I  (B) Organism II  (C)Both organism I and II  (D)Neither organism I nor II

B

16. “Sticky ends” is a term that describes
   (A) the DNA that is left behind after bacteria have been removed from a culture plate
   (B) the unpaired DNA bases after the DNA has been exposed to a restriction enzyme
   (C) the bacterial strain that ends with the same initials as its corresponding restriction enzyme
   (D) the last sequence of a DNA strand that codes for STOP
   (E) the affinity of a restriction enzyme for a particular sequence on the DNA strand
17. For two organisms to be of the same species, they must be:
   (A) Able to interbreed in nature and produce fertile offspring
   (B) The same color and look similar
   (C) Able to recognize each other’s scent
   (D) Live in a similar climate and environment
   (E) All of the above

18. Some genes are capable of moving from one chromosomal locus to another. There is evidence that this has happened a number of times over the course of evolution. What are such genes called?
   (A) jumping genes     (B) gluons     (C) travelons     (D) transposons     (E) a and d

19. What is recombinant DNA?
   (A) Recombinant DNA is DNA formed by splicing RNA into existing DNA strands
   (B) Recombinant DNA is DNA formed by joining together DNA fragments of different organisms.
   (C) Recombinant DNA is DNA formed by rearranging the sequence of genes on a single strand of existing DNA
   (D) Recombinant DNA is DNA formed from synthetic nucleotides
   (E) Recombinant DNA is DNA formed by replication of an existing DNA strand

20. Dolphins, sharks and the extinct ichthyosaurs all exhibit streamlined shapes that help them move smoothly through the water. Such similar forms in distantly related organisms that live in similar environments are examples of ________ evolution.
   (A) divergent     (B) convergent     (C) co-     (D) punctuated     (E) adaptive

21. A mixture of DNA fragments has been separated using agarose gel electrophoresis. You would expect to find
   (A) the largest size fragments closest to the point of origin
   (B) the smallest size fragments closest to the point of origin
   (C) the most dense fragments farther from the point of origin
   (D) the largest size fragments clumped together into one solid band
   (E) the smallest size fragments fluorescent and the larger size fragments not fluorescent

22. Computers designed to scan large amount of DNA sequence easily identify open reading frames by locating
   (A) a repeating string of nucleotide bases
   (B) the AUG start codon and UGA stop codon
   (C) two equally spaced regions of DNA coding for the same amino acid order
   (D) a comparable DNA sequence published on the internet
   (E) sections of DNA that match the code for a specific gene

23. Mendel’s law of segregation states
   (A) heterozygous parents are equally likely to pass either of their two alleles on to their offspring
(B) alleles of one gene are passed to offspring dependent on gender of parent
(C) two alleles are expressed equally in the offspring
(D) environment affects the expression of alleles for a trait
(E) two unlike alleles are always passed together to the offspring

24. All of the following statements allow scientists to distinguishing eukaryotic from prokaryotic cells EXCEPT:
   (A) Eukaryotes have no membrane-bound organelles
   (B) Prokaryotes have no membrane-bound organelles
   (C) Eukaryotes have no nuclei
   (D) Prokaryotes have no nuclei
   (E) a and c

25. Two pea plants are crossed. One plant has round seeds and the other has wrinkled seeds. ALL of the offspring have round seeds. Which of the following conclusions is NOT correct?
   (A) both parents are homozygous
   (B) round is dominant over wrinkled
   (C) one parent is homozygous, the other is heterozygous
   (D) all of the offspring are heterozygous
   (E) in the F2, the wrinkled trait has a 25% chance of reappearance