Question 1

A. (Fundamentals of Life Sciences) Answer the following questions.

(1) Select all the organisms that has a cell nucleus.

A. Influenza virus
B. Budding yeast
C. Coronavirus
D. *Escherichia coli*
E. Human cardiac muscle cell
F. Human red blood cell

(2) Select all the secondary structures of proteins.

A. Alpha Fold
B. Alpha Helix
C. Beta Sheet
D. Gamma Chain
E. Z Form
F. Z-Line

(3) DNA polymerase I isolated from *E. coli* K-12 is thought to be composed of 928 amino acid residues from the DNA sequence. What is the length of the DNA encoding the start codon to the stop codon of this gene?

(4) Gene expression consists of the (a)_____ reaction in which RNA is synthesized from DNA molecules that hold information and the (b)_____ reaction in which protein is synthesized from RNA.
Choose the word that goes in (a), (b) from the following and answer in the form of (a)-X, (b)-Y.

A. Insertion
B. Transposition
C. Translocation
D. Transcription
E. Replication
F. Translation

(5) Select the most appropriate stage of the cell cycle in which DNA is replicated.

A. D phase
B. F phase
C. G phase
D. M phase
E. R phase
F. S phase

(6) Select the best description of endocytosis from the following.

A. The process by which cells take in external substances
B. The process of breaking down unwanted substances in the cell
C. The process by which cells eliminate waste products
D. The process by which cells produce energy
E. The process by which cells fuse with other cells
F. The process of cell death according to the cell's program

（Question 1: continue on next page）

(7) Which of the following substances is most appropriate as a source of energy for living organisms

A. ADP B. AMP C. ATP

D. cAMP E. cAMP F. cAMP

(8) Answer all five major classes of mammalian immunoglobulins (Ig).

(9) Select the most appropriate phenotypic segregation ratio for the second generation of a hybrid in a two-gene hybrid cross in Mendel's laws of inheritance and answer with a symbol.

A. 1 : 1 : 1 : 1 B. 9 : 3 : 3 : 1 C. 4 : 2 : 2 : 1

D. 1 : 3 : 3 : 1 E. 1 : 2 : 2 : 1 F. 0 : 1 : 1 : 0

(10) In the PCR (Polymerase Chain Reaction) method, assuming that the reaction efficiency is 100%, how many times is the template DNA amplified in 30 cycles? Answer the number.

B. (Fundamentals of Information Sciences) Answer the following questions.

(1) We consider computation using floating point numbers with binary representation. 0.5 + 0.5 equals to 1.0, but 0.1 + 0.1 does not equal to 0.2. Explain the reason in one line.

(2) Write the following storage devices in the order of faster sequential reading speed.

A. Hard drive B. DVD-ROM C. DRAM

(3) In the context of disease testing, the probability of a diseased individual testing positive is defined as *sensitivity*, while the probability of a non-diseased individual testing negative is defined as *specificity*. Given that the sensitivity and specificity of this test for adults are both 90%, and the prevalence of the disease in the tested population is 5%, calculate the probability that a person who tested positive has the disease.

(4) When the test from (3) was conducted on 15 diseased children, 11 tested positive. Can we conclude that this test has a lower sensitivity for children than that for adults? Answer at a 5% significance level. Note: The probability distribution of the frequency of successes when repeating a trial with the probability of 0.9 for 15 times is as shown in the following table.

Table

# Successes	15	14	13	12	11	10
Probability	0.206	0.343	0.267	0.129	0.043	0.010

(5) In Linux or UNIX, answer a command that displays the list of all files currently present in the specified directory.

(6) Select <u>all</u> strings from the provided options that do not match the regular expression "`A[CG]*[^CG]?T`" and answer with a symbol.

A. `AT` B. `AAT` C. `AATT`

D. `AGCGT` E. `AGAGT` F. `AGGCCGGGT`

(7) There is an array, A, containing n random numbers. When searching a given number x, in A using linear search, answer the most appropriate average number of comparisons.

A. 1 B. $(n+1)/2$ C. n D. $\log n$ E. $n \log n$

(8) Select the most suitable data for lossy compression from the following.

A. Microscopic movies

B. Genome sequences

C. Medical test results

D. Computer programs

(9) Answer the contents of array X after the program shown below processes array $X = \{3,2,5,-3,1\}$.

for (increase i by 1 from 2 to 5)

$X[i] \leftarrow X[i] + X[i-1]$

endfor

(10) Answer the inverse matrix of the following 2×2 matrix.

$$\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$$

（The end of Question 1）