Example Answers

International Master's Programs of Chemical Engineering in the Graduate School of Engineering, Kyushu University (Academic Year from October, 2025)

Subject: Fundamentals of Bioengineering (1 sheet)

1. (26 points)

(1.1)

cDNA is synthetic DNA produced from the transcription product (that is, RNA) through a reaction using the enzyme reverse transcriptase. cDNA is utilized in various applications, including gene cloning, gene expression studies, and the creation of cDNA libraries.

(1.2)

The main polymer found in plant cell walls is cellulose. Cellulose is composed of glucose monomers linked together by β(1→4) glycosidic bonds.

(1.3)

E. coli is prokaryote. *E. coli* is favored for recombinant protein production due to its rapid growth, ease of genetic manipulation, and cost-effectiveness. However, *E. coli* struggles with complex post-translational modifications and protein folding. Animal cells are eukaryotes. They excel in producing proteins with accurate post-translational modifications and proper folding. They are ideal for therapeutic proteins but are more expensive and have slower growth rates compared to *E. coli.*

1. (24 points)

(2.1)

Prokaryotic cells have a higher proportion of protein in plasma membrane.

(The ratio of proteins to lipids in plasma membrane is 3:1 (3-3.6) in prokaryotic cell and 4:3 (about 1.3) in eukaryotic cell.)

In prokaryotic cell, functions such as respiratory metabolism are carried out by the plasma membrane, whereas in eukaryotic cell, these functions are carried out by independent organelles (mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, nucleus, etc.).

(2.2)

(a) DNA helicase generates single-stranded DNA from double-stranded DNA using the energy of ATP.

(b) DNA primase synthesizes RNA primers

(c) DNA polymerase synthesizes a complementary DNA strand from a DNA template.

(d) DNA ligase joins DNA strands together.