

**International Master's Programs of Chemical Engineering in the Graduate School of Engineering,
Kyushu University (Academic Year from October, 2026)**

Subject : Fundamentals of Bioengineering (1 sheet)

1. Answer the following questions. (20 points)

(1.1) Describe the differences in three-dimensional structure between DNA and RNA.

(1.2) Arrange the following DNA fragments (A–D) in descending order (highest to lowest) of predicted melting temperature (T_m).

DNA fragment A : 5'- GCATGCGATAAT -3'

DNA fragment B : 5'- GCGCGCGGCCGC -3'

DNA fragment C : 5'- TATTGCGGCCGCCGC -3'

DNA fragment D : 5'- ATATTAGATAAT -3'

(1.3) Explain the reason for the above T_m order. (Approximately 100 words)

2. Read the passage below and answer the following questions. (20 points)

ATP is synthesized via the electron transport chain, which begins with NADH and $FADH_2$.

(2.1) Identify the organelle in which this process occurs.

(2.2) Explain why ATP is referred to as the "energy currency".

(2.3) Explain the mechanism by which ATP is synthesized through the electron transport chain.

(2.4) In aerobic metabolism beginning with glucose, identify the name of the pathway that generates $FADH_2$.

3. Explain the procedures for generating human embryonic stem cells and discuss the associated ethical considerations. (10 points)