4. The flow of genetic information from DNA to protein in eukaryotic cells is called the central dogma of biology.

   (a) **Explain** the role of each of the following in protein synthesis in eukaryotic cells.

   - RNA polymerase
   - Spliceosomes (snRNPs)
   - Codons
   - Ribosomes
   - tRNA

   (b) Cells regulate both protein synthesis and protein activity. **Discuss** TWO specific mechanisms of protein regulation in eukaryotic cells.

   (c) The central dogma does not apply to some viruses. **Select** a specific virus or type of virus and **explain** how it deviates from the central dogma.

END OF EXAM

AP® BIOLOGY
2009 SCORING GUIDELINES

Question 4

The flow of genetic information from DNA to protein in eukaryotic cells is called the central dogma of biology.

(a) **Explain** the role of each of the following in protein synthesis in eukaryotic cells. **(5 points maximum)**

	Description (1 point each)
RNA polymerase	DNA → RNA
Spliceosomes (snRNPs)	Removes the introns and connects (splices) the exons in RNA
Codons	Codes for amino acids/signals
Ribosomes	RNA → protein or site of protein synthesis
tRNA	Transports amino acids

(b) Cells regulate both protein synthesis and protein activity. **Discuss** TWO specific mechanisms of protein regulation in eukaryotic cells. **(4 points maximum)**

Idea of the mechanism (1 point)	**Discussion (1 point)**	
Promotor	increases RNA polymerase binding	**Protein Synthesis**
Enhancer	increases transcription	
Methylation	adding methyl group inhibits transcription	
Acetylation	adding acetyl group promotes transcription	
DNA packaging	loosening/tightening chromatin promotes/inhibits transcription	
RNA processing	GTP cap or Poly-A tail	
RNA editing	removing of introns	
Alternative splicing	editing in different ways to get new/different RNA/polypeptides	
mRNA degradation	targets RNA for destruction (miRNA or siRNA)	
Protein processing	polypeptide → protein modifications (folding, chaperonins, cleavage, etc.)	
Protein degradation	proteases break down proteins	
Feedback: negative/positive	correct explanation of the identified feedback loop	**Intracellular Protein Activity**
Allosteric/noncompetitive	conformational change/binding to alternative site	
Competitive	binding to (or blocking) active site	
Environmental conditions	**intracellular** control by pH/temperature/substrate/enzyme concentration	
Phosphorylation	protein kinase/phosphorylase activating enzyme/altering 3-D shape	
Hormones	correct action for steroid or protein hormone	
Coenzymes/Cofactors	presence/absence controls reactions	

AP® BIOLOGY
2009 SCORING GUIDELINES

Question 4 (continued)

(c) The central dogma does not apply to some viruses. **Select** a specific virus or type and **explain** how it deviates from the central dogma. **(3 points maximum)**

Names a specific RNA virus or type of RNA virus (HIV, flu virus, etc.)	**(1 point)**
Deviation from the central dogma (RNA → DNA or RNA → protein or RNA → RNA)	**(1 point)**
More **detailed explanation** of the deviation from the central dogma	**(1 point)**