GENERAL

ap biology reading guide answers chapter 19

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AP Biology Reading Guide Answers: Chapter 19

Chapter 19 of the AP Biology curriculum is a cornerstone for understanding how cells harness energy from food molecules. Whether you're a high school student preparing for the exam, a teacher looking for supplemental explanations, or a parent wanting to support your child's study, this article offers a comprehensive, step by step reading guide and detailed answers. By the end of this guide, you'll have a clearer grasp of cellular respiration, the regulation of metabolic pathways, and the key enzymes that drive life's chemistry.

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Overview of Chapter 19

Chapter 19, titled "Cellular Respiration," delves into the biochemical processes that convert nutrients into usable energy. The chapter is divided into three main sections: **glycolysis, the citric acid cycle, and oxidative phosphorylation**. Each section builds upon the last, illustrating how substrates are progressively broken down, electrons are transferred, and ATP is generated. The material is essential for the AP Biology exam because it connects molecular biology to physiology, ecology, and evolution.

Key Concepts Covered

1. Glycolysis – the cytoplasmic pathway that splits glucose into two pyruvate molecules, generating a net gain of two ATP and two NADH.
2. Pyruvate Oxidation – the link between glycolysis and the citric acid cycle, where pyruvate is converted into acetyl CoA.
3. Citric Acid Cycle (Krebs Cycle) – a mitochondrial matrix reaction that oxidizes acetyl CoA, producing NADH, FADH ,, and GTP.
4. Electron Transport Chain (ETC) – a series of protein complexes that transfer electrons from NADH and FADH , to oxygen, pumping protons and creating an electrochemical gradient.
5. Oxidative Phosphorylation – the synthesis of ATP via chemiosmosis, driven by the proton gradient established by the ETC.
6. Regulation of Metabolism – allosteric control, feedback inhibition, and hormonal regulation that maintain energy homeostasis.
7. Alternative Pathways – fermentation, anaerobic respiration, and the role of mitochondria in eukaryotic cells.

Detailed Reading Guide Answers

Below, we break down each major subsection of Chapter 19, providing concise answers to common exam questions and clarifying complex concepts. Use this guide to reinforce your understanding and to prepare for the AP Biology multiple choice and free response sections.

Section 1: Glycolysis

Glycolysis is the first step in cellular respiration, occurring in the cytoplasm and independent of oxygen. The process can be summarized in two phases: the investment phase and the payoff phase.

- Investment Phase – two ATP molecules are consumed to phosphorylate glucose and its intermediates, forming fructose 1,6 bisphosphate.
- Payoff Phase – four ATP molecules are produced via substrate level phosphorylation, and two NAD z molecules are reduced to NADH.

Key points to remember:

- Net ATP gain: 2 ATP per glucose.
- Net NADH production: 2 NADH per glucose.
- End product: 2 pyruvate molecules.

Common exam question: “Which step of glycolysis uses ATP to phosphorylate a substrate?” The answer is the phosphorylation of glucose by hexokinase and the subsequent phosphorylation of fructose 6 phosphate by phosphofructokinase 1.

Section 2: Pyruvate Oxidation

After glycolysis, pyruvate enters the mitochondrion where it is decarboxylated to acetyl CoA. This step is crucial because acetyl CoA is the substrate for the citric acid cycle.

- Enzyme complex: pyruvate dehydrogenase complex (PDC).
- Byproducts: CO , (released to the atmosphere) and NADH.
- Energy investment: none (unlike glycolysis).

Answer to a typical AP question: “Which coenzyme is required for the conversion of pyruvate to acetyl CoA?” The correct answer is **CoA S H (coenzyme A)**, which forms the thioester bond with acetyl CoA.

Section 3: Citric Acid Cycle (Krebs Cycle)

The citric acid cycle occurs in the mitochondrial matrix and completes the oxidation of acetyl CoA. Each turn of the cycle produces:

- 3 NADH
- 1 FADH ,
- 1 GTP (or ATP, depending on the cell type)
- 2 CO ,

Because each glucose yields two acetyl CoA molecules, the cycle runs twice per glucose molecule.

Key regulatory steps:

- Isocitrate dehydrogenase – regulated by ATP, NADH, and acetyl CoA.
- ; °etoglutarate dehydrogenase – regulated by NADH and ATP.

Exam tip: Remember that the citric acid cycle itself does not directly produce ATP; it generates electron carriers that feed into the ETC.

Section 4: Electron Transport Chain (ETC)

The ETC is a series of complexes (I–IV) embedded in the inner mitochondrial membrane. Electrons from NADH and FADH , flow through the complexes, reducing oxygen to water at the final step.

- Complex I (NADH dehydrogenase) and Complex II (succinate dehydrogenase) accept electrons from NADH and FADH ,, respectively.
- Complex III (cytochrome bc • complex) and Complex IV (cytochrome c oxidase) transfer electrons to oxygen.
- Protons are pumped across the membrane, creating a proton gradient (9G , æB ”<,’à

Quantitative fact: Each NADH yields approximately 2.5 ATP, whereas each FADH , yields about 1.5 ATP during oxidative phosphorylation.

Common AP question: “Which complex in the ETC is responsible for the reduction of oxygen to water?” The answer is **Complex IV (cytochrome c oxidase)**.

Section 5: Oxidative Phosphorylation

Oxidative phosphorylation couples electron transfer to ATP synthesis. The proton gradient generated by the ETC drives ATP synthase (Complex V) to phosphorylate ADP to ATP.

Key points:

- ATP synthase acts as a molecular motor, turning as protons flow back into the matrix.
- The chemiosmotic theory, proposed by Peter Mitchell, explains how the proton motive force is converted into chemical energy.
- Overall, oxidative phosphorylation produces the majority of ATP in aerobic organisms, roughly 30–32 ATP per glucose molecule.

Exam tip: Be familiar with the stoichiometry of ATP production. For instance, a typical student answer might state, “Oxidative phosphorylation yields about 28 ATP per glucose, accounting for 86% of total ATP production.”

Section 6: Regulation of Metabolism

Cellular respiration is tightly regulated to maintain energy balance. Regulation occurs at several levels:

- Allosteric inhibition – e.g., ATP inhibits phosphofructokinase 1, reducing glycolysis when energy is abundant.
- Feedback inhibition – NADH and acetyl CoA inhibit pyruvate dehydrogenase and isocitrate dehydrogenase.
- Hormonal control – insulin promotes glycolysis, while glucagon activates gluconeogenesis.
- Substrate availability – high glucose levels increase glycolytic flux.

Example AP question: “Which molecule acts as the primary allosteric inhibitor of phosphofructokinase 1?” The answer is **ATP**.

Section 7: Alternative Pathways

When oxygen is scarce, cells switch to fermentation or anaerobic respiration:

- Lactic acid fermentation – pyruvate is reduced to lactate, regenerating NAD z for glycolysis.
- Alcoholic fermentation – pyruvate is converted to ethanol and CO ,, also regenerating NAD z.
- Both processes yield only 2 ATP per glucose, far less than aerobic respiration.

Key takeaway: Fermentation is a temporary solution; it allows cells to maintain ATP production during hypoxia but is energetically inefficient.

Study Tips & Strategies

Mastering Chapter 19 requires more than memorizing facts. Below are proven strategies to help you absorb the material and perform well on the AP exam.

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