BIOLOGY
SECTION II
Time—1 hour and 30 minutes

Directions: Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in this booklet.

1. Prokaryotes are found throughout the biosphere. Answer two of the following.
   a) Provide three examples of adaptations found in various prokaryotes. Explain how these three adaptations have ensured the success of prokaryotes.
   b) Discuss how prokaryotes early in Earth's history altered environments on Earth.
   c) Discuss three ways in which prokaryotes continue to have ecological impact today.

   a) Archaea bacteria are found in environments with extremely high temperatures. This adaptation helps them by far because in such environments there are no or not many competitors. Sexual reproduction in prokaryotes by conjugation of the pilus is a very good adaptation because this increases genetic variation. The rapid reproduction of bacteria by binary fission increases differential reproductive success with the exchange of DNA, resistance to antibiotics can spread very fast in a population.

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1) Endosymbiosis is what made the eukaryotic cells of today what they are. Chloroplasts and mitochondria used to be individual cells. Evidence is shown by the organelles having their own DNA. Chloroplasts did photosynthesis in which O₂, needed for cellular respiration, is released. The native mitochondria moved into the chloroplast cells making cellular respiration of the organism much more efficient. The Eukaryotes then evolved and began to move onto land.

Earth was originally a reducing atmosphere until phototrophic prokaryotes produced mass amounts of O₂, making the atmosphere oxidizing. The Ozone (O₃) layer formed. Obligate anaerobes died. Some molecules of existing organisms denatured causing some species to lead to mass extinction.

2) Prokaryotes are excellent samples in which genetic engineering could be done. Prokaryote are of the primary subjects of gene expression. Some prokaryotes even clean up disasters such as oil spills. Prokaryotes also still cause many sicknesses such as food poisoning. Speciation and microevolution is also studied from prokaryotes because of things like resistance to antibiotics.
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   In some prokaryotes, specifically archaea bacteria, they can survive very extreme environments, such as extreme temperatures, or extreme salinity (halophiles). This is a good adaptation because it allows prokaryotes to live in places that no other organisms could live, such as in the hot springs of Yellowstone National Park. It also allowed prokaryotes to be the first colonizers of Earth. Another example is adaptation is that prokaryotes lack double membrane bound organelles and a nucleus. This can be a good adaptation because bacteria reproduce by binary fission, thus there is are no organelles to get in the way as the bacteria...
prokaryotes divide. Another adaptation is that prokaryotes have a single circular strand of DNA which contains no introns. This allows for easy replication of the DNA before binary fission. Additionally, since genes that code for a metabolic pathway are side by side, operons are used as a form of gene control. This means that some genes code for anaerobic or aerobatic pathways, and those genes are right by one another. Therefore the expression of these genes can be controlled by one thing: the repressor blocking the beginning first gene by repressing it.

Early prokaryotes in Earth’s history altered the environments on Earth. The early atmosphere of Earth contained little oxygen. Thus, when autotrophic prokaryotes (such as cyanobacteria) started to produce oxygen as a byproduct of photosynthesis, the amount of oxygen in the atmosphere greatly increased. Without prokaryotes in Earth’s early history that were able to adapt to the new environmental changes such as archaea/bacteria, further life on Earth may not
have evolved.
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In Earth's history, one of the first prokaryotes found on the Earth's surface was cyanobacteria (blue-green algae) that was one of the earliest photosynthetic organisms that (due to the reduced atmosphere of the earth) used H₂ (hydrogen) instead of H₂O to break down the hydrogen needed for photosynthesis. However, the cyanobacteria soon began using O₂, a more abundant molecule, that resulted in the increased use of oxygen in the primitive atmosphere and allowed aerobic respiration to sustain on Earth's surface. This led to the oxidizing atmosphere (unable to have O₂ in the atmosphere) to the present day reduced atmosphere (O₂ diluted in the atmosphere).

The theory of endosymbiosis explains how prokaryotes were engulfed (phagocytized) by heterotrophic eukaryotes. Two examples of this are the chloroplast and the mitochondria.
The early heterotrophic prokaryotes relied on cellular respiration and the chloroplast for photosynthesis, and as a result, this adaptation still enabled the success of prokaryotes (they are still found in present-day living organisms such as plants). Proof for this theory of endosymbiosis is that the membranes of the mitochondria and the chloroplast more closely resemble the membranes of eukaryotes than of the prokaryotes in which they reside. Another means of survival in some prokaryotic organisms is parasitism. Some prokaryotic parasites reside in the host cell and do not kill the host cell (as they need a place to live and access nutrients from the host). An example of this would be chickens and algae. As a result of living in the host, these parasites ensure their own success.