PASSAGE 3 – Questions 21-30

Animals and higher-order plants depend on nitrogen that is present in soil as they cannot utilize free nitrogen from the atmosphere. To enter living systems, nitrogen must be combined with oxygen or hydrogen to form compounds such as ammonia or nitrates that plants are able to use. Nitrogen gas is converted to ammonia fertilizer by a chemical process involving high pressure and high temperature. This process is called nitrogen fixation. Martinus Willem Beijerinck discovered nitrogen fixation.

The nitrogen molecule is quite inert and breaking it apart requires a considerable amount of energy. There are three processes that are responsible for most of the nitrogen fixation in the biosphere. They are atmospheric fixation, biological fixation, and industrial fixation. Atmospheric fixation occurs through lightning, forest fires, or even hot lava flows where energy **breaks down** nitrogen molecules and enables their atoms to combine with oxygen in the air, thus forming nitrogen oxides. These liquefy in rain, forming nitrates, that are then carried to earth.

In biological nitrogen fixation, the nitrogen is available to some species of microorganisms. Atmospheric nitrogen is converted to ammonia by bacterial enzymes called nitrogenase. More than 90% of all nitrogen fixation is **affected** by them. There are two kinds of nitrogen-fixing microorganisms: free-living (non-symbiotic) bacteria and symbiotic bacteria. Microorganisms that fix nitrogen are called **diazotrophs**. These need a chemical energy source if they are non-photosynthetic. However, if they are photosynthetic, they can utilize light energy. The free-living diazotrophs supply little fixed nitrogen to agricultural crops, whereas the symbiotic, nitrogen-fixing bacterias live close to plant roots and can obtain energy materials from the plants.

The symbiotic, nitrogen-fixing bacteria **invade** the root hairs of plants. Here they multiply the formation of root nodules, and enlargements of plant cells and bacteria in close proximity. Within the nodules, the bacteria convert the free nitrogen to nitrates, which the plant makes use of for its development.

To make certain of sufficient nodule formation and the best possible growth of legumes (beans, clover, peas, soybeans), seeds are usually inoculated, particularly in poor soils where bacteria is lacking. **This system is the most important for agriculture as many legumes are then able to grow vigorously under nitrogen deficient conditions, contributing nitrogen to the farming system or as green manure included in the soil.** Legumes are also a significant source of protein primarily for the developing world.

Industrial fixation takes place at a temperature of 600 degrees Celsius. In this method, atmospheric nitrogen and hydrogen can be combined to form ammonia, which in turn can be used directly as a fertilizer. It was during the early 19"1 century that the importance of fixed nitrogen to growing plants was understood. Where people practiced intensive agriculture, demand arose for nitrogen compounds to augment the natural supply present in the soil.

Around the same time, Chilean saltpeter was increasingly used to make gunpowder. This led to a global search for natural deposits of this nitrogen compound. Toward the end of the 19th century, it was realized that Chilean imports would not meet future demands, and, in the event of a major war, without the Chilean supply, manufacturing sufficient weapons would not be possible.

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[A] Several processes were then developed: directly combining oxygen with nitrogen, the reaction of nitrogen with calcium carbide, and the direct combination of nitrogen with hydrogen. **[B]** Combining oxygen and nitrogen was inefficient in its use of energy. Both were costly and the process was abandoned. **[C]** It is named after Fritz Haber and Carl Bosch, who determined that nitrogen from the air could be combined with nitrogen under enormously high pressures and fairly high temperatures in the presence of an active mechanism to produce an extremely high quantity of ammonia. **[D]**

Germany heavily relied on this process during World War I, which led to a rapid expansion of the construction of nitrogen plants in many other countries. This method is now one of the leading processes of the chemical industry throughout the world.

21. According to paragraph 1, how must nitrogen molecules enter living organisms?

A. They must be converted to ammonia or nitrates.

B. They must be combined with oxygen in the form of nitrate.

C. They must be absorbed by the plant to furnish its nitrogen.

D. They must be mixed with oxygen or hydrogen.

22. The phrase "<u>breaks down</u>" in the passage is closest in meaning to_____.

A. destroys B. discontinues

C. ceases D. decomposes

23. Which of the following can be inferred from paragraph 2 about nitrogen fixation?

A. Nature cannot make it occur by itself.

B. It is a process that does not necessarily require the influence of man.

C. The process needs perfect circumstances to happen.

D. Nitrogen is essential to all life on Earth.

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24. According to paragraph 3, one factor needed for photosynthetic biological fixation is____.

A. a light source

B. the presence of ammonia

C. 90% rainfall for a week

D. a chemical energy source

25. The word "affected" in the passage is closest in meaning to_____.

A. driven B. influenced

C. stopped D. changed

26. Why does the author mention "diazotrophs" in the passage?

A. To explain the industrial process of nitrogen fixation

B. To show how a plants roots are important for this process

C. To give an example of a living organism capable of fixing nitrogen

D. To explain the impact of nitrogen on a microorganism

27. The word "invade" in the passage is closest in meaning to_____.

A. attack B. defend

C. occupy D. dominate

28. Which of the following best expresses the essential information in the highlighted sentence? Incorrect answer choices change the meaning in important ways or leave out essential information.

A. The ability to grow legumes with little nitrogen is highly valuable.

B. Legumes do not need much nitrogen to develop and grow strong.

C. The farming system makes huge demands on the nitrogen level in the ground.

D. Agriculture creates a great need for legumes and their produce.

29. According to paragraph 8, which of the following is characteristic of the Haber-Bosch process?

A. Producing low amount of Ammonia

B. Using extremely high pressures

C. Reducing the supply of nitrogen compounds

D. Leading to widespread use during World War I

30. Look at the four squares [_] that indicate where the following sentence can be added to the passage.

However, the Haber-Bosch process which created ammonia from nitrogen and hydrogen is the most cost-effective nitrogen fixation process known.

Where would the sentence best fit?

A. [A] B. [B]

C. [C] D. [D]

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