3. A biologist measured dissolved oxygen in the top 30 centimeters of a moderately eutrophic (mesotrophic) lake in the temperate zone. The day was bright and sunny, and the wind was calm. The results of the observations are presented below.

Hour	$[O_2]$
6:00 A.M.	0.9 mg/L
8:00 A.M.	1.7 mg/L
10:00 A.M.	3.1 mg/L
12:00 noon	4.9 mg/L
2:00 P.M.	6.8 mg/L
4:00 P.M.	8.1 mg/L
6:00 P.M.	7.9 mg/L
8:00 P.M.	6.2 mg/L
10:00 P.M.	4.0 mg/L
12:00 midnight	2.4 mg/L

(a) Using the graph paper provided, **plot** the results that were obtained. Then, using the same set of axes, draw and label an additional line/curve representing the results that you would predict had the day been heavily overcast.

(b) **Explain** the biological processes that are operating in the lake to produce the observed data. **Explain** also how these processes would account for your prediction of results for a heavily overcast day.

(c) **Describe** how the introduction of high levels of nutrients such as nitrates and phosphates into the lake would affect subsequent observations. **Explain** your prediction.

4. Proteins–large complex molecules–are major building blocks of all living organisms. Discuss the following in relation to proteins.

(a) The chemical composition and levels of structure of proteins

(b) The roles of DNA and RNA in protein synthesis

(c) The roles of proteins in membrane structure and transport of molecules across the membrane

END OF EXAMINATION

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Question 3

3. (a) 4 points possible

1 point for proper orientation of graph (independent variable on x-axis)

1 point for graph (all of the elements below must be present)

- Uniform spacing of units
- Correct labeling of axes
  - proper numbering (a minor error acceptable)
  - X-axis label: "Time"/ "Hour"/a.m., p.m. labels/a conversion to integers requires unit label as well
  - Y-axis: oxygen label **and** mg/L Unit

1 point for correct plot of data points

- No connecting line necessary
- No point if more than one data point is misplotted
- No point if there is a **solid** extrapolation line beyond the 6:00 a.m. data point to the origin **or** the 12 midnight data point

1 point for drawing the cloudy day prediction Line/Curve (all of the elements below must be present)

- Distinguish between the two curves with a legend or direct labeling of one curve
- Position completely under the bright-day curve (may touch toward the tails)
- There must be some curve to the line (no flat lines)

3. (b) 5 points possible

1 point Photosynthesis: production of O_2 correlated with light changes (i.e., explains changes in shape of bright-day curve). The student must link **photosynthesis** to **increase in light** to **increase in O_2** production. The student must use the term "photosynthesis" or an excellent replacement such as the chemical equation for the process.

1 point Respiration: consumption of O_2. Must link **respiration** to **decrease in O_2**. The student must use the term "respiration" or an excellent replacement such as the chemical equation for the process or the name of another appropriate process such as "decomposition."

1 point Description of the **interaction** of the above: photosynthetic rate changes while respiration rate remains relatively constant.

1 point Overcast prediction curve explanation

- Reduced light leads to decreased photosynthetic O_2 production, etc.
- No point given if there is no prediction line/curve on the graph.

1 elaboration point (maximum) for any one of the above. Examples of elaboration may include, but are not limited to:

- Water split/photolysis to produce O_2 in the light phase, etc.
- **Balanced** equation for photosynthesis or respiration (unless used as a substitute for the term above)
- Description of "light phase" processes (photosystem II, etc.)
- Gross vs. net productivity

Question 3 (cont.)

3. (c) 3 points possible

1 point for describing (predicting) a change in lake conditions such as (must be related to the question)

- increased/decreased O_2
- increased/decreased biomass or numbers of organisms
- increased/decreased CO_2,
- long-term or short-term changes
- no change

1 point for an explanation of the prediction above (may include toxic effects due to significant changes in pH, altered osmolarity, etc.)

1 elaboration point for the explanation of the prediction above **or** long term ecological consequences to lake.