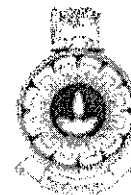


THE OPEN UNIVERSITY OF SRI LANKA  
 B. Sc / B. Ed DEGREE PROGRAMME  
 BOTANY – LEVEL 4  
 BOU2200/ BOE2200: PLANT PHYSIOLOGY  
 FINAL EXAMINATION 2017/2018



DURATION: THREE (03) HOURS

**Date: 4<sup>th</sup> April 2019**

**Time: 9.30 am -12.30 pm**

There are two (2) parts in this paper with eight (8) questions in five (5) pages. Each part comprises of four (4) questions. You have to answer FIVE (5) questions selecting at least TWO (2) questions from each part.

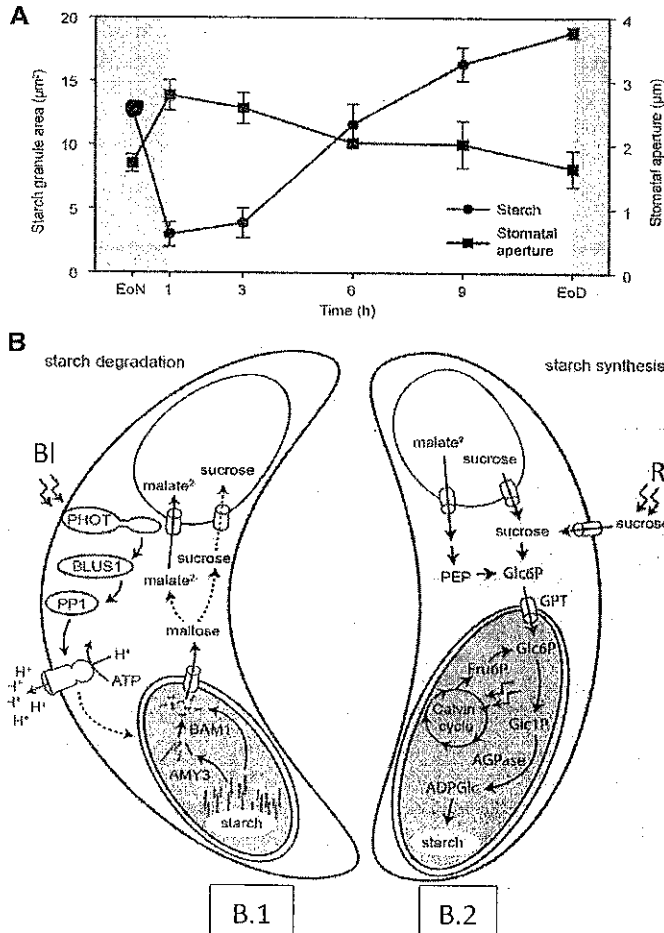
**Part 1**

**1. Questions in this section are based on the part of abstract extracted from a research publication.**

**Abstract:** The plant leaf apoplast is a dynamic environment subject to a variety of both internal and external stimuli. In addition to being a conduit for water vapor and gas exchange involved in transpiration and photosynthesis, the apoplast also accumulates many nutrients transported from the soil as well as those produced through photosynthesis. The internal leaf also provides a protective environment for endophytic and pathogenic microbes alike. Given the diverse array of physiological processes occurring in the apoplast, it is expedient to develop methods to study its contents. Many established methods rely on vacuum infiltration of an apoplast wash solution followed by centrifugation.<sup>1</sup> (Gentzel, I. N., Giese, L., Zhao, W., et al., *Plant Physiol.* pp.01076.2018 (2019))

- a) Define the apoplast. (6 marks)
- b) List all functions of apoplast you know of. (15 marks)
- c) Explain the processes of water movement that occur in the apoplast? (30 marks)
- d) If you received a sample of apoplastic extract, outline a flowchart of the method you follow to study the monovalent ion content? (20 marks)
- e) Briefly discuss the contribution of root tissue to apoplastic conduction of water and minerals. (30 marks)

2. Questions in this section are based on the following diagram extracted from a research publication (Diana Santelia, and Tracy Lawson Plant Physiol. 2016;172:1371-1392)



**Fig.** Guard cell starch breakdown and synthesis during stomatal movements in Arabidopsis. **A**, Guard cell starch content and stomatal aperture over the 12-h light phase ( $n = 110 \pm se$ ). EoD, End of day; EoN, end of night. Redrawn from Horrer et al. (2016). **B**, During stomatal opening, blue light-dependent activation of the plasma membrane proton pump leads to starch degradation in the guard cell chloroplast by amylases. B1 and B2 are status of guard cells under blue (B1) and red (R) light waves respectively.

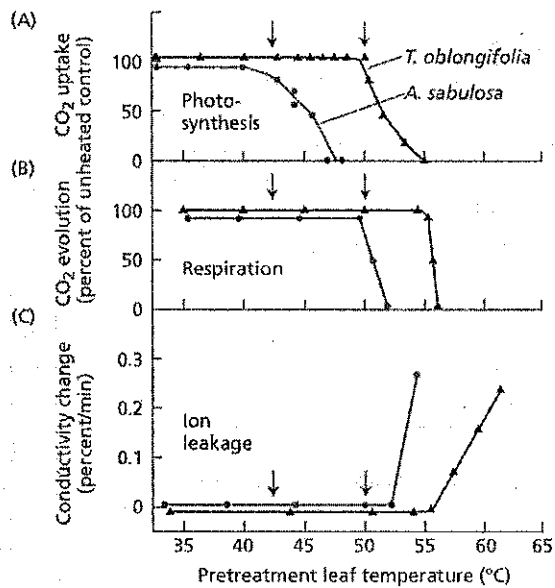
- What is the relationship that can be deduced from the above results (in fig A) between the starch and stomatal opening? (9 marks)
- How does the blue light affect the plasma pH? (12 marks)
- How does the starch synthesis start? (18 marks)
- Compare the status of water potential in B.1 and B.2 cells. (30 marks)
- Briefly discuss the effect of stomatal pore size on the physiology of plants (32 marks)

**3. Questions in this section are based on the abstract given below.**

**Abstract:** Light-induced chloroplast movement is one of the most important responses for utilization of photosynthetic light. Chloroplasts move toward weak light- irradiated areas to efficiently absorb light (the accumulation response), whereas they move away from excess light to avoid photodamage (the avoidance response). In Arabidopsis, the accumulation response is regulated by phototropin1 (phot1) and phototropin2 (phot2), whereas the avoidance response is mainly regulated by phot2. Using various Arabidopsis mutants deficient in chloroplast movement, Gotoh et al. (pp. 1358–1369) demonstrate that the accumulation response enhances leaf photosynthesis and plant biomass production. Conspicuously, phot2 mutant plants specifically defective in the avoidance response but not in other phototropin-mediated responses, displayed a constitutive accumulation response irrespective of light intensities, enhanced leaf photosynthesis, and increased plant biomass production. (Minorsky, P. V. On the Inside. *Plant Physiol.* **178**, 950 LP-951 (2018)).

- a. Illustrate the chloroplast. (10 marks)
- b. State the process in the cell that facilitates movement of chloroplasts? Briefly explain the method you followed to observe it? (12 marks)
- c. Compare avoidance and accumulation responses of chloroplast? (27 marks)
- d. What can you say about the effect of Phot2 mutation? (9 marks)
- e. Briefly explain other mechanisms in chloroplast to minimize the photodamage. (15 marks)
- f. Discuss how the transfer of radiation energy occurs between pigment molecules in the chloroplast. (30 marks)

4. Following graphs were taken from the Björkman, et al (1980) N. C. Turner and P. J. Kramer, eds., Wiley, New York, pp. 233–249. These graphs indicate the sensitivity of key physiological parameters of two plant species (*Atriplex sabulosa* and *Tidestromia oblongifolia*) for increasing temperature. Following questions are based on these graphs (a to c).



- Which is the variety that is more sensitive to heat? explain briefly. (20 marks)
- Define the temperature compensation point and identify the highest temperature compensation points of the two species studied? (10 marks)
- Explain why the ion leakage increased at higher temperature? (20 marks)
- Explain why the higher temperatures are more detrimental to the C3 plants than C4 or CAM plants? (15 marks)
- Compare the efficiency of the transpirational cooling to ameliorate *in planta* temperature in upright habit and prostrate habit? (25 marks)
- List the roles of heat shock protein in thermotolerance. (10 marks)

**Part 2**

5. "Photosynthesis mechanism in higher plants are evolved into three types as an adaption to environmental stresses." Discuss this statement. (100 marks)
- 6.
- "Glycolysis and Kreb's cycle are the main pathways of respiration. Yet, there are alternative pathways of respiration which serves as the sources of intermediates of metabolism." Discuss this statement. (50 marks)
  - Explain briefly how the temperature, oxygen concentration, inorganic salts and wounding and mechanical stimuli affect the rate of respiration. (50 marks)
7. Explain the following observations in detail (20 marks per each section)
- Shoots of plants grow towards the light while roots always grow away from light
  - A sample of seed of a species that exposed to 50 °C at dry state retain viability to germinate in ambient temperature whereas another seed sample from the same batch fail to germinate at 45 °C
  - Cytokinins are used to elongate vase life of cut flowers.
  - Success of micro-propagation of plants largely relies on the addition of growth regulators to the tissue culture medium at accurate proportions.
  - Rice plants submerged for more than 10 days had long culms.
8. Discuss the effect of internal and external factors on the dormancy and senescence in plants.

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