

NATURAL SCIENCES TRIPOS

SENIOR EXAMINER'S REPORT

SUBJECT: NST1A Physiology of Organisms (PHO)

Senior Examiner: [REDACTED]

Examiners: [REDACTED]
[REDACTED]

Structure of the examination:

Written paper/s: PHO/1: Section A, 10 compulsory short answer questions worth 25%;
Section C, 2 essays (from choice of 6) worth 50%

Practical components: PHO WP (Section B, 30 compulsory MCQs worth 25%)

Number of candidates: 168 (+3 withdrawn prior to exams)

Number sitting the exam/s outside the main exam hall/s: 7 (4 in College, 3 in Titan Rooms)

Conduct of the Examination:

Time table: PHO WP was held on June 1st and PHO/1 was held on June 3rd. Having the two papers so close in time could have benefitted students, also allowing them to move on to focus on other subjects.

Delivery: Both papers were held in SBS UG practical labs, with only 7 candidates taking the papers elsewhere. Papers were "open book", delivered through the Inspira Portal and Browser, with candidates given internet access and allowed to bring a range of materials, plus their own phones.

Incidents: (1) Although candidates had been advised not to query questions, one candidate (BGN unknown) queried a question (PHO-WP B2) with the Inspira technical team who contacted the Course Organiser for clarification. The question involved use of the Nernst equation and the query was what temperature to use given that the equation contains an absolute temperature term and the temperature for the experiment was not given. The Course Organiser replied that "the candidate should pick the best answer from the alternatives available, and that if the question proves to be flawed it will later be removed from the exam". Please see "Subject Examiners' Meeting" for actions taken. (2) One candidate contacted the Course Organiser to report that they had answered both C1a and C1b in PHO/1 Section C by mistake (only answering C1a or C1b is allowed). This information was conveyed to the Senior Examiner. Please see "Subject Examiners' Meeting" for actions taken. (3) One candidate was investigated for potential academic misconduct in the PHO/1 exam. Please see "Subject Examiners' Meeting" for actions taken.

Essay choices:

C1. **Either** (a) Discuss how muscle types differ in their structure and function, with particular reference to differences affecting whole body physiology. **28 answers**

Or (b) "Movement is not confined to animals". Discuss, with examples, movement of plants and microbes. **63 answers**

- C2. How do plants and animals benefit from symbiotic strategies for nutrient acquisition? **117 answers**
- C3. Given that diffusion of CO₂ and O₂ is low in water, how do plants and animals achieve gas exchange? **31 answers**
- C4. Compare and contrast the source, transport, and action of plant and animal hormones. **80 answers**
- C5. Discuss how the structure of plant and animal biomaterials is related to their function. **14 answers**

Marking/Scaling:

Arrangements: Marking schemes and guidelines for Assessors (Section A) were provided, marking out of 6. Examiners were assigned to mark an essay (out of 20). Answers from a question were not split between Examiners. Essay marking guidelines were provided by the Senior Examiner, including Faculty criteria for 1A essays.

Performance between papers: PHO-WP and PHO/1 are not directly comparable in terms of either content or assessment method. However, last year, PHO-WP MCQ score was compared to PHO/1 SAQ (short answer question). This year's comparison is shown in Figure 1. Candidates who did poorly in the written practical could do well in theory SAQs and *vice versa*.

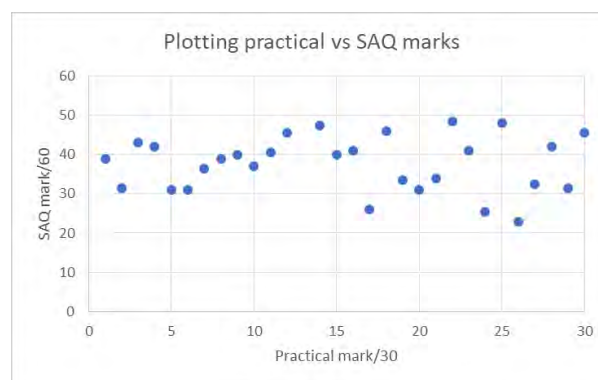


Figure 1. Comparison of PHO-WP MCQ and PHO/1 SAQ scores.
PHO-WP

First class scores were achieved in 22 out of the 30 questions (Figure 2). Score range was 12 to 28. Mean \pm SD score was 23.6 ± 2.9 . (76.6 %). This compares to 22.3 ± 3.8 (74 %) in 2021.

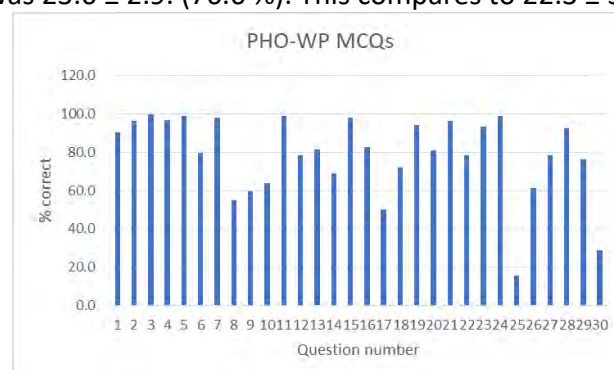


Figure 2: Mark distribution for MCQ questions in PHO-WP.

PHO/1

Section A

The mean \pm SD score from the SAQs was 33.4 ± 7.6 out of 60 (55.7%); range of mean score was 13 to 48.5. Mean \pm SD score per question is shown in Figure 3. Mark distribution is shown in Figure 4. Score range was 0-6 for all but A5 (0-5.5), indicating that excellent answers were achievable.

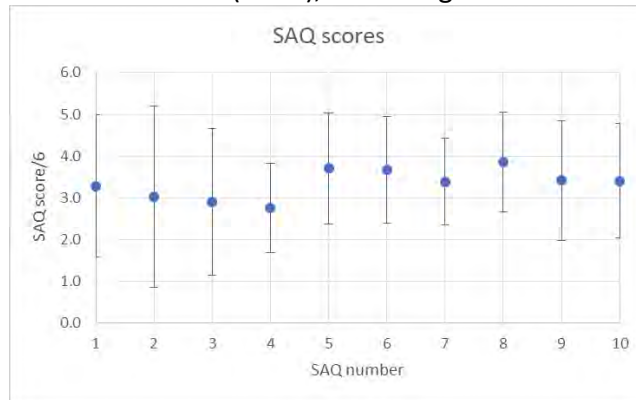


Figure 3: Marks (mean \pm SD) per short answer question in PHO/1 Section A.

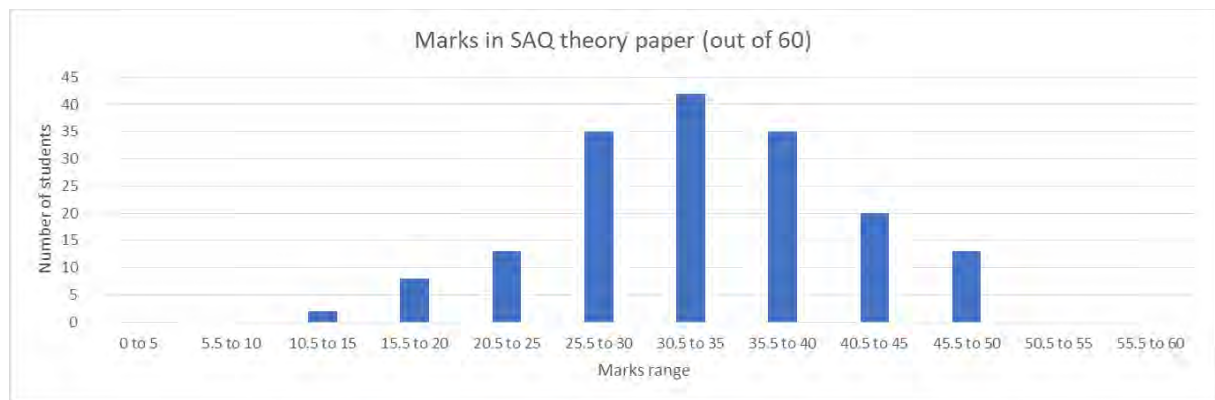


Figure 4: Mark distribution for PHO/1 Section A.

Section C

The mean \pm SD score from the essays was 24.6 ± 3.6 out of 40 (61.5%). Mean \pm SD score per question is shown in Figure 5. The low number of candidates (14) answering C5 may reflect the lecture material's being delivered in Easter Term. Mark distribution (by Class) is shown in Figure 6.

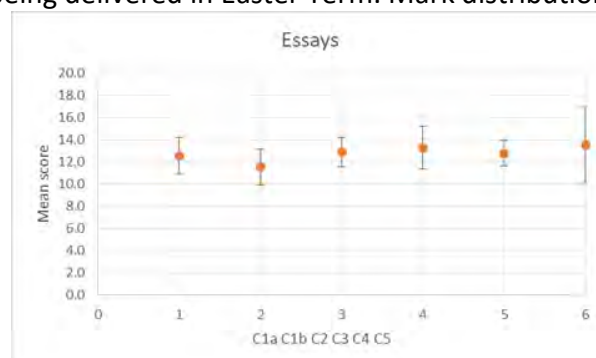


Figure 5: Marks (mean \pm SD) per essay question in PHO/1 Section C.

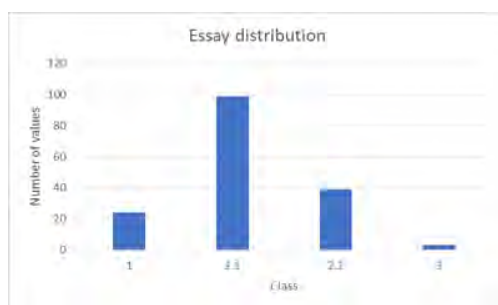


Figure 6: Mark distribution for PHO/1 Section C.

Scaling:

Application of the NST1A scaling factor provided by the Chair of Examiners yielded the distribution shown in Table 1 (no deviation from the 0.6 tolerance).

Class	Target %	% of candidates	Mean mark	Standard deviation
1	25	25.6	74.0	2.8
2	65	64.88	61.1	5.1
3 and F (F)	10	9.52 (1.2)	44.3 (26.3)	8.6 (NA)

Table 1. Class distribution.

Subject Examiners' Meeting:

This was held on Teams on June 28th with all Examiners in attendance.

PHO-WP

This section of the exam continues to lack discriminatory power, despite the best efforts of Examiners. This year, the practical content of the course was reduced due to Covid. It may be that a return to full coverage and a closed book format could improve discriminatory power. Additionally, providing 4 rather than 5 possible answers may be more testing for candidates.

B2. Queried by student in the exam. The question had been checked by Examiners and two Assessors who supervise the course. All information on the underpinning practical class uses 20 °C for the Nernst equation. It was agreed that only the correct answer was feasible. All candidates had answered the question; success rate was 96.4%. It was agreed that the question would not be removed.

B25. This was investigated as the only question to generate a mean score of less than 20% (level that chance alone might effect). The question asked which growth condition would be best for testing for nitrate-specific induction of nitrate reductase. Answer C was feasible but answer A was the best option. The Senior Examiner reported on the answer distribution: 55.4 % of candidates answered "C", 17 % answered "A". It was held that the question was not flawed and marks were taken forward.

PHO/1

One candidate answered both C1a and C1b. The rubric clearly states that this is not allowed and this had been made clear by the Senior Examiner at the Exam briefing (also on Moodle). C1a and C1b allow candidates to focus on animals or plants/microbes respectively, but the other essay must be chosen from C2-C5 which compare animal with plant/microbial physiology, a

fundamental aspect of the course. The Examiners held that the highest mark from the two essays would be taken forward.

No concerns were raised about plagiarism or collusion. Questions were held to be fair.

Penalty and Marginal candidates

One candidate incurred a marks penalty in PHO/1 set by the Chair of 1A Examiners, following investigation of academic misconduct relating to cutting and pasting of pre-prepared material into an essay.

Class boundaries were examined. Examiners agreed that there was no justification in moving marginal candidates up or down.

The Class List was agreed.

Administration: The Senior Examiner and [REDACTED] appointed Assessors. [REDACTED] provided BGNs, final scaling spreadsheet (scaling set by the Chair) and this report template. Exam warnings were received by the Senior Examiner from L [REDACTED] [REDACTED] then disseminated. Questions for PHO-WP were set by Examiners and for questions underpinning stomatal practicals by [REDACTED], checked by Examiners. All PHO-WP questions were further checked by two Assessors. Questions for PHO/1 A were set by Lecturers and Examiners. Questions for PHO/1 B were set by Examiners. The entire paper was checked by Examiners. All papers were password protected. Papers were loaded into Inspira by [REDACTED] and checked by the Senior Examiner. Papers for delivery via Moodle were provided by the Senior Examiner through a specific Teams channel. The Senior Examiner disseminated information on Inspira to Examiners and Assessors. [REDACTED] ran a zoom meeting on marking in Inspira. [REDACTED] provided written guides. [REDACTED] downloaded PHO/WP marks and PHO/1 answers as PDFs. She liaised on candidate withdrawal, candidates sitting outside the main venues and checked Inspira scans. Due to Covid, three Section A answers were marked by Examiners rather than the Assessor. As some Examiners and an Assessor could not access answers on Inspira or load marks, marks were collected in Excel files and collated by the Senior Examiner.

Conclusions and Recommendations:

The Examiners conclude that the papers set were fair.

Whilst we have no evidence of plagiarism or collusion, we are concerned that open book exams encourages use of pre-prepared material. Allowing multiple devices (including phones) into exams makes such practice easier. We recommend a return to closed book exams for MCQs and SAQs and that a return to closed book format for essays is considered. This would encourage revision, rather than reliance on “on the day” ability and pre-prepared work.

We recommend that this year’s practice of not allowing questions to be queried in the exams be retained.

We support the continued use of typed answers.

We appreciate the enormous effort made by the Inspira team to apply the platform and support candidates. We were disappointed by Inspira’s lack of reliability in allowing graders to access

answers. It also lacks analytical function, particularly for MCQ answers. Analysis of answer distribution had to be done manually. We are also concerned about the level of resource needed to maintain its use (Bootcamps) and the possibility that more administration (entering questions etc) will be given to Examiners and Departments rather than Exam Opps. If Inspira were retained, then Senior Examiners and candidates should be made fully aware, well in advance of the exams, of how Exam Opps intends to deploy Moodle in the event of Inspira failure (release of access code to Invigilators). It was disquieting not to know this.

A review of Turnitin procedures is needed if Inspira were retained so that there is a standard and transparent procedure across 1A courses that can be communicated to Senior Examiners and candidates before exams begin.

Notification of all withdrawn candidates should have come to [REDACTED] before or shortly after the exam; this process requires improvement.

Date: 28.6.2022

Notes on answers and marks distributions

PHO/1

A1 List TWO points of similarity and TWO points of difference relating to how a skeletal muscle fibre and an auditory hair cell in the mammalian inner ear become electrically excited, under normal circumstances (focus on those specific cells only, not any other cells that might be involved). **Range: 0-6; Mean 3.3 ± 1.7.**

A2 Given action potentials are all-or-none events, how is a graded force produced by a single motor unit? **Range: 0-6; Mean 3.0 ± 2.2.**

A3 Explain how the autonomic nervous system contributes to the cardiovascular baroreflex response to a decrease in arterial blood pressure. **Range: 0-6; Mean 2.9 ± 1.8.**

A4 How does urea contribute to the concentration of urine in the mammalian kidney? **Range: 0-5.5; Mean 2.8 ± 1.1.**

A5 Considering an otherwise healthy and (until now) well-fed human: Which metabolic fuels would be released from the body's reserves and used by the brain and other tissues, a) during an overnight fast, and b) after 3-4 weeks of starvation? **Range: 0-6; Mean 3.7 ± 1.3.**

A6 Briefly explain how vertebrates transduce olfactory signals. **Range: 0-6; Mean 3.7 ± 1.3.**

A7 Summarise the key features which distinguish C3, C4 and CAM pathways. **Range: 0-6; Mean 3.4 ± 1.0.**

A8 Briefly describe three similarities and one difference between shoot and root apical meristems. **Range: 0-6; Mean 3.9 ± 1.2.**

A9 Outline the events that occur in plant non-host resistance. **Range: 0-6; Mean 3.4 ± 1.4.**

A10 Briefly compare the challenges posed by gravity to fluid transport in plants and animals and how these are overcome. **Range: 0-6; Mean 3.4 ± 1.4.**

- C1. **Either** (a) Discuss how muscle types differ in their structure and function, with particular reference to differences affecting whole body physiology. **28 answers: Range: 10-16; Mean 12.6 ± 1.6.**

This essay was generally well answered with most candidates able to give key information about different muscle types and draw some reference to whole body physiology and specialisation of each muscle type. Stronger candidates did this in a function-based way – not just noting differences as they wrote about each muscle type, but structuring their essay to focus on differences in the micro- and macro- scale organisation of the muscles, ways they are innervated, force and duration of contraction. Excellent candidates did this articulately and comprehensively. Weaker candidates often wrote very little about smooth muscle both in terms of structure and function, or spent a long time giving intricate details of how muscles contract without noting the ‘big picture’.

Or (b) “Movement is not confined to animals”. Discuss, with examples, movement of plants and microbes. **63 answers: Range: 7-15 Mean 11.5 ± 1.6**

This was a popular and well answered essay that encouraged candidates to synthesise information from across the plant and microbial lecture blocks. Strong answers covered a wide and relevant range of examples, with attention to several types of microbes, and succinctly described mechanisms. Shoot/root comparisons were done well overall. Information from outside of the course was evident. It was surprising that phototropism, as fundamental to plant survival, was not always used as an example. Weaker answers neglected to discuss microbial movement in any detail. Several answers took “movement of” to mean “movement within” and discussed fluid movement in xylem/phloem, movement of ions in long distance signalling, cytoplasmic streaming rather than or in addition to tropism/taxis. Several answers compared movement with that of animals, which was not relevant.

- C2. How do plants and animals benefit from symbiotic strategies for nutrient acquisition? **117 answers: Range 9.5-16.5: Mean 12.9 ± 1.3.**

On the whole, candidates answered this question well, drawing on material from both the plant and animal components of the course. In their answers, most candidates discussed the benefits that organisms derive from symbiotic strategies, but also how those organisms are adapted to derive such benefits, and doing so they had answered the question. Specific examples discussed included cellulose digestion by microbiota in the cow gut, mycorrhizal fungi with particular reference to phosphate acquisition, and nitrogen fixation by Frankia and Rhizobium in legumes. Some candidates gave other relevant examples, including some that they had encountered on the Evolution and Behaviour course. If these examples illustrated physiological principles that were focused on processes of nutrient acquisition, then they were rewarded. Most answers were factually correct throughout. The strongest essays gave relevant, mechanistic detail to illustrate key concepts, including detail on how higher organisms are themselves adapted to support the physiology of their symbionts. At the lower end of the scale, essays tended to give only the briefest of overviews which lacked detail, or simply listed examples of symbiosis.

- C3. Given that diffusion of CO₂ and O₂ is low in water, how do plants and animals achieve gas exchange? **31 answers Range 10.5-17: Mean 13.3 ± 1.9.**

Most answers addressed accurately the laws governing diffusion, then went on to consider the effects on gases entering an aqueous phase and what consequences there are in physiology. From there, plant and animal adaptations were considered with varying degrees of depth and accuracy. The strongest answers compared a wide range of organisms and had good levels of detail. Weaker answers neglected to consider the lung, lacked detail or only considered aquatic plants and animals.

- C4. Compare and contrast the source, transport, and action of plant and animal hormones. **80 answers: Range 10-14.5: Mean 12.8 ± 1.2.**

This question was generally well answered. Most answers started with a definition of hormone and went on to describe with examples both similarities and differences between plant and animal hormones separately for source, transport and action. The best answers discussed exceptions to the general principles and

included functional or evolutionary explanations. The weakest answers described the action of different plant and animal hormones without directly answering the question.

C5. Discuss how the structure of plant and animal biomaterials is related to their function. **14 answers:**
Range 6-20; Mean 13.5 ± 3.4.

Most answers showed a good level of detail and understanding when presenting examples of biomaterials. The strongest answers discussed a wide range of biological functions, compared animals and plants with each other, and used the examples to illustrate general points about biomaterials. Weaker essays only gave examples without any attempt to summarise or compare them, or to discuss general trends. The choice of examples was often unfortunate, as only rigid materials with a support function (wood and bone) were discussed. Several essays presented material that was not relevant to the question.