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Examination Questions and Answers in Basic Anatomy and Physiology

2400 Multiple Choice Questions

Second Edition

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Preface to the Second Edition

Two thousand four hundred multiple choice questions that could be asked of a student of introductory human anatomy and physiology are presented in 40 categories. In addition, there are 62 topics for a written assignment (essay topics) that may be used in such a course and as an assessment task for such students.

It is assumed that users of these questions are teachers or students who have completed at least part of an Anatomy and Physiology course that might be offered in the first year of a university degree program. It is also assumed that they would have access to one of the Anatomy and Physiology textbooks (or similar) listed in the bibliography below. Each question category has an Introduction containing a summary of useful knowledge pertinent to that category of question. However, not all possible information is provided within these Introductions, so a textbook is indispensable. The summary Introductions are composed with vocabulary that may be unfamiliar to the beginning student but which should be known in order to understand the questions. You will need to look up the meaning of many unfamiliar words as your studies progress.

All questions have been used at least once, during the author's teaching career, in end of semester examinations of a university first-year undergraduate introductory anatomy and physiology course or a physical science course for Health Sciences students to support their anatomy and physiology study. Consequently, they reflect the author's choice of content. Students enrolled in the courses for which these questions were written include nursing, midwifery, paramedic, physiotherapy, occupational therapy, nutrition & dietetics, health science students, exercise science students and students taking the course as an elective. Many of the students do not have an extensive background in science from their secondary schooling. Some knowledge of physical science is required to understand physiology; hence, physical science questions are included. Students without some background knowledge in chemistry and physics will find such questions challenging and will need to work a little harder to develop their background knowledge. The boundary between chemistry and biochemistry is not distinct; nevertheless, chemistry is implicit in physiology. Furthermore, the physics of the body becomes physiology so gradually that sometimes the boundary between the two is only noticed after it has been crossed.

Some questions were difficult to categorise and may span two (or more) categories. Furthermore, in order to answer some questions, you may need knowledge drawn from other "sections" of anatomy different from the name of the section in which the question appears. This is not a bad thing as it emphasises the connected nature of human anatomy and physiology. Each question is unique (there are no duplicates). However, many questions will be examining the same (or similar) material albeit with a differently worded question or a different selection of answers. If the questions are to be used to compile an examination, then care should be taken to exclude questions that are too similar to already selected ones. On the other hand, if the questions are to be used for instruction or study purposes, I would suggest including several similar questions in consecutive order to emphasise the point and to give the student practice.

Advice to the Exam Candidate

The correct choice of answer for each question is provided. Accompanying the correct choice is a justification for the choice or an explanation of the correct answer, and sometimes of why the other choices are incorrect. The degree of difficulty varies, but not by intentional design. The perception of difficulty depends on that part of science that the question examines, the level of scientific background brought to the course by the student and their level of studious preparation for the examination.

There is only one best correct answer for each of the multiple choice questions among the four choices presented. However, there may be more than one correct answer. You must choose the **best** one. In marking multiple choice questions, I suggest that that one mark be allocated for a correct answer and that a quarter of a mark be deducted for a wrong answer or an unanswered question. Deducting a quarter mark will reduce the score that would be gained by selecting an answer from the four choices purely at random (i.e. guessing), from about 25% to about 6%. Not to deduct a quarter mark is, in my opinion, unsound. Hence in an examination, never leave a question unanswered. If you cannot decide on an answer, guess at it (after eliminating any choices that you deem to be incorrect). That is, you will be rewarded for the ability to decrease the number of choices from which you are guessing, from 4 to 3 or 2.

Be aware of questions that are asked in the negative. That is, have NOT true; or FALSE; or INCORRECT; or EXCEPT one, in the stem. In this case, you are seeking a statement that is wrong in order to answer the question. Do not be intimidated by arithmetical calculations. The calculation itself will be simple. Deciding what to add, multiply or divide with what, is the tricky part.

Some questions have been published before in the book: Caon, M. & Hickman, R. (2003) Human Science: Matter and Energy in the Human Body 3rd ed, Crawford House Australia Publishing, Belair South Australia, and are used with the authors' permission.

Some Thoughts on Writing Good MCQs and on Answering Poorly Prepared MCQ Quizzes

Ten Pieces of Advice for Writing Good Multiple Choice Questions

1. Make all the choices of answer about the same length.
2. Don't write choices that use "all of the above", "none of the above", "both A and B", "never", "all", etc. (If you can't think of sufficient choices for distractors, then discard that question).
3. Use plausible distractors (don't use funny, absurd, or cute choices).
4. If the choices are all numbers, list them in order of increasing magnitude.
5. Avoid choices where two are the opposite of each other (One might be guessed to be true).
6. Make the stem ask a question. Don't include irrelevant material in the stem. Don't unintentionally provide a clue in the question.
7. Spread the correct answer evenly (and randomly) among the choices. In questions with four choices, about 25% of the correct choices should be "A", about 25% "B", etc. Don't avoid having two or three consecutive answers that are the same letter choice.
8. Limit the number of questions "asked in the negative". That is, where a false statement is the correct choice.
9. Be grammatically correct when writing the question and the choices. Don't be ambiguous.
10. If only one choice is meant to be the best correct answer, make sure that it is so.

Five Ways to Score More Highly on a Poorly Prepared Multiple Choice Question Test

Knowing the subject matter is the best way to score well in a multiple choice test, but if you do not know the answer, always guess at it after crossing out the obvious wrong answers first. Your guess will then be an educated guess.

(i) Eliminate the obvious wrong answers first!!!

1. If marks are deducted for incorrect answers but NOT deducted for unanswered questions, do not answer the questions you are sure that you don't know the answer to.
2. If one of the choices is: "none of the above" or "all of the above", choose that answer.
3. Look at the answers to the preceding and following questions. If you are guessing, don't select a choice that is the same as the previous or the next choice. (This only works if you have chosen those answers correctly!)

4. Choose the longest answer.
5. Eliminate the choices with absolute statements such as: never, always, all…

Some Thoughts on the Marking of MCQ Tests (Where There Are 4 Choices of Answer, One of Which Is the Best Correct)

Testing for knowledge is an imprecise science. Using multiple choice questions (MCQ) for the testing simplifies the marking but also introduces additional uncertainties and some unfairness.

I award one mark for each correct answer. This would mean that someone may score 25% without any study simply by guessing (assuming that correct choices are spread evenly among the 4 choices). Hence, I also deduct ¼ of a mark for each incorrect answer or unanswered question. With this deduction, it follows that in a 100 question quiz, the total guesser will score approximately: 25 correct – (75 incorrect)× ¼ = 25 − 18¾ = 6¼% rather than about 25% if marks were not deducted for incorrect answers.

My reasoning is as follows. If you randomly choose the answers for 4 questions that each have a choice of four answers, the probability of guessing one correct answer from the four questions is: ¼ + ¼ + ¼ + ¼ = 1 and you would be awarded 1 mark out of 4. This would be undeserved as you did not know any answers. By deducting ¼ for each wrong answer, your score for guessing the answers to these four questions would become 1 – ¾ = ¼ mark. The score is still undeserved but more reasonable. Nevertheless, I advise my students to guess at the answer if they do not know it, after eliminating the obviously erroneous choices. If the student can reduce the potentially correct answers from 4 to 3 or 2 before guessing, the probability of guessing correctly from the remaining choices is higher and they will score more marks. For example, the probability of guessing 4 answers correctly after eliminating one or two obviously incorrect choices may be: $\frac{1}{3} + \frac{1}{2} + \frac{1}{3} + \frac{1}{2} = 1.67$. Hence, on average you would be awarded 1.67 of the 4 marks (minus the deduction for wrong answers). This is reasonable as you deserve some credit for knowing that some of the choices were wrong.

Should a ¼ mark be deducted for each unanswered question? Before I answer this, let's consider four possible strategies for awarding marks to a multiple choice question quiz with 100 questions.

Strategy 1: award 1 mark for a correct answer.
Strategy 2: award 1 mark for a correct answer and deduct a $\frac{1}{3}$ mark for wrong answers.
Strategy 3: award 1 mark for a correct answer and deduct a ¼ mark for wrong answers.
Strategy 4: award 1 mark for a correct answer and deduct a ¼ mark for wrong answers AND for unanswered questions.

Given that there are 4 choices to each question and only one is correct, and that the correct choice is evenly allocated between choices A, B, C and D, which strategy is fairer? Clearly the more you get correct, the higher the score. It is also clear that students who bring their knowledge to bear on answering the quiz, that is, are not merely selecting choices at random, will choose far more than 25% of the answers correctly.

Consider strategy 1. If a student attempts all questions, the lowest probable score (by random guessing) is 25%, not zero. Hence, 25% is equivalent to zero (no knowledge), and the range of possible scores in a four-choice MCQ quiz is from 25 to 100, rather than from 0 to 100. This strategy suffers from rewarding lack of knowledge with 25% of the marks and also constricts the range of marks to about three-quarters of the true range. To account for the marks obtained by guessing, the examiner may choose to set as a pass mark, a number greater than 50/100 as the passing score for the quiz, for example, 60 or 70 or 75/100. If another student leaves some questions unanswered, perhaps because this student does not know the answers, then their maximum possible score is reduced by the number of unanswered questions. The scenario for such students remains largely as described above. However, it is possible for both students to answer the same number of questions correctly and so attain the same score despite the second student leaving some questions unanswered (Table 1, column 4). The examiner may consider that this outcome is fair.

It seems reasonable to me to deduct marks for an incorrect answer when the answer is chosen from four possibilities, as is the case for the type of multiple choice questions being considered. It also seems too great a penalty to deduct a mark (or half a mark) for an incorrect choice as the result would be a negative score when less than 50% (or 33%) of questions are answered correctly. Would deducting ⅓ mark or a ¼ mark produce a fairer result?

Consider strategy 2. In a 100 question quiz, when ⅓ mark is deducted for incorrect answers only, Student #1 who answers 50 questions correctly and 50 incorrectly is awarded 33.3 (see Table 2, column 6). Furthermore, Student #3 who chooses not to answer 10 questions but still answers 50 questions correctly (and 40 incorrectly) is awarded a higher score (36.7) than student #1. Is this an intended consequence?

Table 1 Considers 4 students who all answer 50 questions correctly but choose to leave different numbers of questions unanswered. Two scenarios are considered where a ¼ mark is deducted for wrong answers (column 6), and for wrong answers and also for unanswered questions (column 7)

	# of MCQ answered	Unanswered MCQ	Correctly answered MCQ	Incorrectly answered MCQ	Score when −¼ for incorrect answers	Score when −¼ for incorrect and for unanswered	Extra score if the unanswered MCQ were guessed at
Student 1	100	0	50/100	50	37.5	37.5	na
Student 2	95	5	50/95	45	38.75	37.5	+1.25
Student 3	90	10	50/90	40	40	37.5	+2.5
Student 4	50	50	50/50	0	50	37.5	+12.5

Table 2 Considers 4 students who all answer 50 questions correctly but choose to leave different numbers of questions unanswered. A $\frac{1}{3}$ mark is deducted only for wrong answers

	# of MCQ answered	Unanswered MCQ	Correctly answered MCQ	Incorrectly answered MCQ	Score when $-\frac{1}{3}$ deducted for incorrect answer
Student 1	100	0	50/100	50	33.3
Student 2	95	5	50/95	45	35
Student 3	90	10	50/90	40	36.7
Student 4	50	50	50/50	0	50

Compare this with strategy 3 where a ¼ mark (rather than $\frac{1}{3}$ mark) is deducted. The same scenarios above result in the Students #1 and #3 being awarded 37.5 and 40, respectively, for their 50 correct answers (see Table 1, column 6), instead of 33.5 and 36.7 (if a third of a mark were deducted). Hence, there is more reward for effort when only a ¼ mark is deducted. However, both strategies will result in students scoring more highly if they are able to strategically omit answering questions that they are sure they don't know the answer to. Thus, students are rewarded for knowing what they don't know – or for omitting to study a section of the course and avoiding the questions on that part of the course. This is the same as inviting students to choose which questions they wish to answer and rewarding them for answering fewer questions. It is for this reason that I deduct a ¼ mark for unanswered questions. When marks are deducted for wrong answers (but not for unanswered questions), even for the same number of correct answers (50 in Tables 1 and 2), the more MCQ you leave unanswered (between 0 and 50), the higher will be the score. Hence, students would be encouraged to leave answers to questions that they are unsure about (or have not studied), blank.

Consider strategy 4. When a ¼ mark is deducted for wrong answers and also for unanswered questions, students are compelled to answer all the questions. In a 100 question quiz, student #1, who answers 100 questions – 50 correctly and 50 incorrectly – is awarded 37.5 (see Table 1, column 7). Student #3 who chooses not to answer 10 questions but still answers 50 questions correctly (and 40 incorrectly) is also awarded the score of 37.5 (rather than the higher score of 40 if strategy 3 was used to encourage the student to guess at the answers to the 10 unanswered questions). If the second student had, instead of leaving 10 MCQ unanswered, simply guessed at the 10 answers, they would probably have scored another 2 or 3 marks (Table 1, column 8). Indeed if they had guessed the answers after first eliminating any choices they knew to be incorrect, they may have scored more than 2.5 extra marks (on average).

This marking strategy rewards students for correctly guessing at answers instead of leaving some questions unanswered. This is compensated for by the ¼ mark deduction for incorrect answers. However, students are penalised if they do not answer (or don't guess at) questions on some parts of the course. Furthermore, students who guess from fewer choices are rewarded for having the knowledge to eliminate some choices prior to guessing from the remaining choices. Such students will probably guess correctly more than 25% of the time. This is a more

Table 3 Considers 4 students who all answer the same number of questions (and choose to leave 10 questions unanswered), but who answer different numbers of questions correctly

	# of MCQ answered	Unanswered MCQ	Correctly answered MCQ	Incorrectly answered MCQ	Score when −¼ deducted for incorrect answer	Score when −¼ also for unanswered	Extra score if unanswered MCQ were guessed
Student 1	90	10	90/90	0	90	87.5	+2.5
Student 2	90	10	80/90	10	77.5	75	+2.5
Student 3	90	10	70/90	20	65	62.5	+2.5
Student 4	90	10	50/90	40	40	37.5	+2.5

searching test of their knowledge of the course and is why I deduct ¼ for each unanswered question.

Table 4 When 1 mark is awarded for a correct answer and ¼ marks are deducted for wrong answers AND also for questions that are not answered, column 2 of the Table below displays the score that would be awarded by answering correctly the number of questions in column 1

Correct answers (out of 100)	Awarded score (%)	Correct answers (out of 100)	Awarded score (%)	Correct answers (out of 100)	Awarded score (%)
100	100	73	66	46	33
99	99	72	65	45	31
98	98	71	64	44	30
97	96	70	63	43	29
96	95	69	61	42	28
95	94	68	60	41	26
94	93	67	59	40	25%
93	91	66	58	39	24
92	90	65	56	38	23
91	89	64	55	37	21
90	88	63	54	36	20
89	86	62	53	35	19
88	85	61	51	34	18
87	84	60	50%	33	16
86	83	59	49	32	15
85	81	58	48	31	14
84	80	57	46	30	13
83	79	56	45	29	11
82	78	55	44	28	10
81	76	54	43	27	9
80	75%	53	41	26	8
79	74	52	40	25	6%
78	73	51	39	24	5
77	71	50	38	23	4
76	70	49	36	22	3
75	69	48	35	21	1
74	68	47	34	20	0

Deducting ¼ mark for incorrect and blank answers also advantages the better students – those who answer more questions correctly – by increasing their score. Table 3 displays the result of four students who all answer 90 questions (and leave 10 unanswered) and score different numbers of correct answers. If strategy 1 is used, the students' scores would range from 90 to 50 (Table 3, column 4). Strategy 4 would result in a spread of scores between 87.5 and 37.5 (column 7) when 10 MCQ are left unanswered. The score would likely increase 2.5 or more if the students had guessed at these 10 answers, rather than leaving them blank, and the highest scoring student has their mark "restored" to 90. Hence, the student marks would be spread out over a larger range of scores (90–40) than for strategy 1.

When ¼ marks are deducted for wrong answers and also for blank answers, the lowest possible score (by random guessing) is close to 6%, not zero. Hence, 6% is equivalent to zero, so the range of possible scores is from 6 to 100 (see Table 4). The examiner may wish to neglect this discrepancy from zero and use a score of 50% as the passing score for the quiz. Note also from Table 4 that the student who gets 80/100 answers correct has their score adjusted down to 75 due to the guessing deduction, while the student who gets only 40/100 answers correct has their score adjusted more severely to 25 due to the guessing deduction.

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