## Introduction

- An ability to problem solve is a critical skill graduates should possess.
- It is a transferable life skill which students can utilize to solve biological problems of any nature, not just in their chosen discipline.
- Problem exercises are however taught with a discipline specific theme to increase engagement of students.
- This specificity illustrates the practical applications of the theory taught in lectures.
- Problem solving exercises change in nature over the degree programme with increased data handling content in the third and fourth years.

## Aims

- We want the student asking "what do I need to know in order to answer this question" and then have the motivation to go and find that information and use it to answer to question posed.
- We want the students to work together with their peers to "brain storm" and discuss all possible answers. This builds relationships between students and develops interpersonal skills.
- At years 1 and 2 where the problem solving exercises are staff led and not assessed we want to promote an atmosphere where students feel comfortable engaging with staff, can explore points of personal interest in more detail and can receive one-to-one attention where required.
- We want to build a level of problem solving skills in our students that will enable them to perform well in the problem based medical school in the final diet of honours exams. This paper is a reliable discriminator between strong and weaker students.

## Examples of exercises

<table>
<thead>
<tr>
<th>Phase I MBChB</th>
<th>Urinary/Acid/Base Problem Solving</th>
<th>Posit Codder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1. A patient with renal insufficiency has a blood sample taken and the following values are obtained (normal values are shown in parentheses): Serum Na+ (mEq/L)</td>
<td>130 mEq/L (140-145 mEq/L)</td>
<td>Control Codder</td>
</tr>
<tr>
<td>Serum glucose (mmol/l)</td>
<td>5.5 mmol/l (5.5-5.0 mmol/l)</td>
<td></td>
</tr>
<tr>
<td>Serum urea (mg/dl)</td>
<td>100 mg/dl (30-50 mg/dl)</td>
<td></td>
</tr>
<tr>
<td>Peter's equation for normal range:</td>
<td>310 mmol/kg H2O (285-295 mmol/kg H2O)</td>
<td></td>
</tr>
<tr>
<td>a) Can you suggest why the value for Na+ was outwith the normal range?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Can you suggest why the urea concentration was outwith the normal range?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q.2. A 35 year old man develops an acute episode of vomiting and diarrhoea and loses 3kg in body weight in a 24-hour period. A blood sample shows that the plasma [Na+] is normal at 145 mEq/L. Indicate whether the following parameters would be increased, decreased or unchanged from what they were before his illness.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## What to do

- Disciplina specific problem solving exercises are delivered by the School of Medical Sciences from second year to honours level for students studying biomedical science subjects in the BSc (Hons) programme and to students in Phase I of the MBChB programme.
- At levels 1 and 2 these exercises have a clinical and sports orientation and aim to illustrate the practical relevance of the academic material taught in lectures. Data handling is minimal at this level although some basic calculations are required.
- At levels 3 and 4 (BSc Hons programme) data interpretation and critical analysis becomes the focus of the exercises. Students are provided with an abbreviated scientific paper and asked questions based on the information provided.
- At level 3 students are also provided with case study exercises where they are given clinical or sports related scenarios and asked questions which examine their knowledge of the physiological basis of the scenario in question.
- At the higher levels these questions should be formulated in such a way that students cannot find the answer directly out of a text book.
- At levels 3 and 4 these exercises form part of the continuous assessment and must therefore be written up independently and submitted as an individual assignment.
- In all cases students have the opportunity to work with their peers in the preparation of the material.
- Time between distribution of the exercise and submission of answers varies between levels and courses. Level 2 science students receive and work through the exercise in class, third and fourth year students have between one and six weeks from receiving the exercise to submission.
- Submission of answers can be done under exam conditions.
- An unseen problem solving exercise forms an exam paper in the final diet of Honours exams.

## Positive aspects

- Student feedback on these exercises is very positive.
- At Honours level there is a direct correlation between students who perform well in problem solving exercises and who perform well in their overall degree.

## Negative aspects

- Setting up exercises is time intensive initially but the problems can be used over and over again so investment early on can reap rewards indefinitely.
- Where there is no assessment students can have the perception it is not important and therefore participation may fall.
- Allows identification of problems early on, including undiagnosed special needs.
- Increase the variety of teaching styles to address different learning styles.

## Outcomes

- Student feedback on these exercises is very positive.
- At Honours level there is a direct correlation between students who perform well in problem solving exercises and who perform well in their overall degree.

### Table: Data handling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.56</td>
</tr>
<tr>
<td>HCO3</td>
<td>109 mEq/L</td>
</tr>
<tr>
<td>K+</td>
<td>3.9 mEq/L</td>
</tr>
<tr>
<td>Na+</td>
<td>14 mEq/L</td>
</tr>
<tr>
<td>PCO2</td>
<td>5.33 kPa</td>
</tr>
<tr>
<td>O2</td>
<td>3.60 ml/dl</td>
</tr>
</tbody>
</table>

### Questions

1. Name the major coronary arteries, state the regions supplied and define what is meant by "functional end-artery".
2. What is the probable underlying coronary pathology here, and what is the role of endothelium?
3. Which sensory fibres mediate ischaemic cardiac pain?
4. How can the myocardium be ischaemic when the left ventricle contains fully oxygenated blood?
5. If the arterial oxygenation was 190 ml O2 per litre, the mixed venous content 90 ml O2 per litre, and the O2 consumption 300 ml/min, what was the patient’s cardiac output?
6. How do you account for the low cardiac output and blood pressure?
7. What makes the skin pale, cold and sweaty (clammy)? What general response is this a characteristic of, and what is its purpose?
8. Draw a normal ECG and show how it aligns with atrial and ventricular action potentials. What causes the delay between the P wave and the QRS complex? What causes ST-segment displacement in myocardial ischaemia?
9. How does low-dose aspirin improve the prognosis?
10. What are the dangers of abruptly restoring blood flow to a tissue after prolonged ischaemia?