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TEACHING IN A CONNECTED WORLD: NEW APPROACHES IN TEACHING BIOCHEMISTRY ADOPTED AT THE MEDICAL UNIVERSITY OF VARNA, BULGARIA

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ABSTRACT

This paper aims at improving the content of the biochemistry curriculum and the methods by which it was delivered at the Medical University of Varna in terms of course content, examination standards and obtaining a feedback from the students. The paper presents two-year follow-up outcomes. A working collaboration was established with two Western European Universities, the University of Marburg, Germany and the University of Dundee, UK. The innovative teaching methodology developed and used in the Department of Biochemistry at the University of Dundee was adopted considering the particular circumstances in the Medical University of Varna. The content of the basic biochemistry course was revised and expanded emphasizing the molecular basis of metabolic variation between different organs and molecular events and clinical medicine. New clinically case-oriented studies of biochemically-based disorders were introduced for the first time in the basic biochemistry course in the form of tutorials and discussion sessions with the students. The laboratory classes in biochemistry were deleted and replaced by demonstrations and clinical laboratory tests, together with tutorial and group activity sessions. New interactive small group methods were adopted in our teaching with the aim to ensure better understanding and accessibility of the teaching material. One free elective discipline entitled "Molecular biology in medicine" has been introduced. A system for obtaining students' opinions about the courses and new teaching methods using feedback questionnaires was adopted.

Key words: medical education, globalization of education, teaching methods, biochemistry, molecular biology, Bulgaria

INTRODUCTION

Globalism is a philosophy of the joint action of the international community towards common interests and against common problems. Globalization is a natural process that develops independently of our will and does not allow preserving vast differences in politics and programmes of different countries.

The economic globalization in the world political and economic systems increases requirements for knowledge and information within that system. Hence, the educational requirements to the workforce of the future united world have risen. Science and education have been globalized for most of the past 50 years, and the fall of the Berlin wall inaugurated a new phase of extensive interaction with scientists and educators from former Soviet Bloc nations.

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The opening of the global community raises higher demands to those specialists most actively participating in the reformation of the East European economies, including the health care professionals among them. How should medical education develop in a connected world?

According to the "Strategy for the Development of Higher Education in Bulgaria" of the Ministry of Education and Science (1), Bulgarian universities are required to upgrade their educational programmes and curricula to bring them up to the best of the international standards.

The members of the Department of Biochemistry at the Medical University of Varna recognized the importance of unifying the teaching and responding on time to growing students' expectations for high quality of biochemistry and molecular biology education. Biochemistry is a key discipline in the pre-clinical sciences in the modern medical curricula, providing a molecular level of understanding for all branches of the life sciences.

To be able to practise modern medicine the medical graduate must understand the molecular basis of health and disease, be able to interpret laboratory data, facilitate further clinical research, and to exploit future developments in molecular life science.

MATERIAL AND METHODS

Medical University of Varna has for years a traditional of 6-year curriculum with approximately 80 students pted yearly to its medical doctor program. After the ndary school students are admitted to the three-year clinical studies, then they are taking clinical courses for ner 2 years, and a year of internship. During the last they take as well state exams that qualify them as cal doctors. Main forms of teaching include lectures n to the whole class and laboratory classes and semi- for groups of 10-12 students. However, this traditional of education was becoming less and less relevant to equirements for knowledge and information within the f globalization. The new technologies and techniques as the Internet, World Wide Web, and CD-ROM al- d for the dissemination of data, information and ledge making unbearable the task for a single person equately convey the huge store of knowledge in a sub- o vast as biochemistry. The academic practitioner was ing from someone just delivering information to the nts, into a navigator in the ocean of global knowledge. a curriculum based mainly on a didactic teaching, not singly, in recent time problems were encountered at Medical University of Varna. Our pre-clinical depart- s were almost entirely independent of each other in eaching: there had been no cooperation or interaction en departments and, therefore, there was no integra- between the contents of the various departmental curricula. Each department worked to its own stan- for assessment (i. e., there was no external validation mination standards). Also, the University had perma- inancial problems, which resulted in complete lack of g for teaching in the pre-clinical departments. A new ulum was needed: appropriate for accreditation of the al University of Varna in terms of course content, ex- tion standards and the fitness of its graduates to the ements of the medical profession worldwide.

RESULTS AND DISCUSSION

er or not the University would be engaged in a total , the academic staff of the Department of Biochemis- ided that a new approach to our teaching is neces- A working collaboration was established with two n European Universities, the University of Marburg, ny and the University of Dundee, UK. It was de- hat the innovative teaching methodology developed d in the Department of Biochemistry at the Univer- Dundee could be of value in our particular circum- . The collaboration between Varna and Dundee has re focused upon making improvements in the con- the Biochemistry curriculum and the methods by t was delivered. Revisions have been decided in the ng areas:

ision of the content and delivery of core course material for students in the first two years in their course;

2. Introduction of advanced, case-oriented special study modules;
3. Introduction of new interactive teaching methods to supplement the existing didactic teaching;
4. Constructing detailed learning aims and objectives, agreed by all members of the Department, for each section of the course and to provide the students with these in the form of printed handouts;
5. Constructing and printing student handouts outlining the content of each individual lecture and reproducing any illustrative diagrams shown during the lecture;
6. Introduction of formative assessment using computerized multiple choice questions (MCQs);
7. Publication of a booklet of clinically-orientated problems together with a guide to their solution;
8. Introduction of an element of continuous assessment into the summative assessment program;
9. Introduction of mechanisms (student feedback questionnaires and staff-student discussion meetings) by which student opinion about teaching quality can be obtained, discussed and (wherever possible) acted upon.

During the years 1998-2000 a number of changes were made in our biochemistry course. Laboratory classes were deleted, and a limited number of demonstrations of clinical laboratory tests, together with tutorial and group activity sessions were introduced in their place. Two were the main reasons for that. First, medical students did not appreciate laboratory classes, but they did like being involved in sessions of analysis of laboratory data. Physicians do not often perform as lab technicians, but they do have to be able to understand how to interpret and integrate different sources of scientific data to arrive at their diagnosis and to formulate patient care. Second, laboratory practical classes are expensive and, in our situation, the finances could be better employed in other aspects of the teaching (e.g., in the "in-house" production of printed paper teaching materials, especially important in a department, which has few available textbooks).

The new interactive small group methods are of two main types:

1. Students are given questions or problems to solve as a group, without recourse to notes or reference sources. Each group then presents the own conclusions, orally and with the use of an overhead projector, to the rest of the class. This approach teaches the group how to work as a team, how to pool fragments of information from different people and how to express the collective answer in a coherent manner to staff and to fellow students. All of these are essential skills for future clinicians.
2. Students answer questions and discuss their answers. This tests individual knowledge and encourages debates. A set of MCQs and problems to be solved are provided in Appendix 1 as an example. The questions

are based on the content of the contemporary textbooks in biochemistry (2-6).

The content of the basic biochemistry course in Varna was revised and expanded in many areas, including the molecular basis of metabolic variation between different organs. New units, such as "Metabolic effects of insulin and glucagon", "Metabolism of the well-fed state", "Metabolism in starvation and diabetes mellitus" were introduced as new items in our seminars and discussion sessions.

With the aim to emphasize the link between molecular events and clinical medicine, new clinically oriented case studies of biochemically-based disorders were introduced in the form of tutorials and discussion sessions with the students. New case-oriented studies were introduced for the first time in the basic biochemistry course, such as acute intoxication with ethanol and chronic alcoholism, obesity, gout, cholera, xeroderma pigmentosum, cystic fibrosis, and -thalassemia. A new optional special study module (SSM) based on case-oriented approaches was developed and introduced into a list of 23 elective studies offered by other departments in the University. The course of 'Molecular biology in medicine' is covering the main principles of molecular biology and molecular genetics and their use in developing diagnostic and investigation tools in clinical medicine. The course consists of 14 academic hours of lectures and 14 hours of seminars. It is opened to the medical students from both the undergraduate and graduate courses. It has been found out that even the first-year students are willing to attend the course and that all of the participants (11 individuals for the first year) are very highly motivated. Students were initiators in giving presentations on different topics of the molecular biology. They do realize the growing importance of molecular biology in clinical practice for diagnosis and therapy. In this optional SSM the students acquire information during the lectures and take part in the discussion sessions that follow the lectures. All students then prepare a dissertation that is assessed and they all make oral reports to the other students in the group. Some of the students' dissertations presented in the first year included:

Molecular biology methods: How to clone a specific gene; Methods to study gene structure and localization; Methods to study the gene expression.

Apoptosis. Molecular mechanisms. Apoptosis and tumorogenesis.

Cytochrome P450 superfamily. Role in the metabolism of xenobiotics. Polymorphism of cytochrome P450 and tumorogenesis.

Prions.

Cystic fibrosis and its gene therapy.

Prenatal diagnosis with the methods of molecular biology.

Questionnaires to the students have been constructed concerning the students' opinion on the course content, teaching quality and of the new methods and approaches to delivery of the SSM. The students evaluated the content of the course as 'very interesting, contemporary, exciting, new'. They recommended more actual genetic cases to be discussed, the course to be extended through the whole academic year with doubled horarium, laboratory demonstrations to be introduced, the course to be open to the practising physicians that might be interested, and a second part of this course to be introduced at a higher level covering different topics. The students required books and printed materials to be supplied by the library and handouts to be prepared and given to them in the beginning of the academic year, access to additional printed materials corresponding to their scientific interests.

In order to provide accurate, modern and affordable information sources for the students, handouts were prepared for every lecture following the experience of the Biochemistry Department in the University of Dundee. These guide the students through the lecture and provide copies of the diagrams. They are constructed in ways that the student has to actively interact with the handout during the lecture. Handouts and aims and objectives of every topic have been prepared for the SSM, the final editing of all such teaching material for this course is still in progress. A collection of MCQs transferred to a formative examination question bank was prepared using 'Question Mark Designer' (7), a computer programme to create and deliver tests, surveys and other kinds of computerized assessments. Sets of clinically based problems together with guidance for their solution have been also constructed and it is planned to collect these into a booklet that will be made available to the students. In Dundee University the course guides and lecture handouts supplement the available textbooks whereas in Varna they substitute for a textbook, since the number of library copies of current textbooks is limited.

Since the course taught in Varna is basic (core) biochemistry course it has been also decided that it would be of educational advantage to the students to have an opportunity to study certain biochemical topics in depth. It is planned to introduce into the first year of the course a new style of SSM that will be compulsory rather than optional. The menu of available topics will cover the entire biochemical curriculum and student will choose which topic they wish to pursue as an in depth study. Each SSM topic will have one or two starter references, and the onus will be on the student to carry out literature, database such as PubMed (8), the US National Library of Medicine's search service that provides access to over 12 million citations in *MEDLINE*, Pre*MEDLINE*, and other related databases, with links to participating online journals and Internet searches as well as to produce a short dissertation which will be formally assessed. Students will be expected to ensure that their research is properly focused upon that topic. We believe that the students will learn not only about an aspect of science but they will learn to distinguish between primary and secondary sources of information and how to organize their information in a small written dissertation.

Our plans include also adopting a system of quality control via external examiners but this is out with departmental control. It is hoped that the advantages of the reforms we have started will persuade our colleagues in the other pre-clinical departments to adopt them also and for a new

it of cooperation to enable us to design a fully integrated -clinical course. That should mean the curricular topics e presented in the order which best helps the students to milate the material, irrespective of which department ents it. To meet the knowledge, educational and learn- challenges and opportunities presented by globalization ve responses should occur at institutional, national and national levels. To teach in a connected world it is not a challenge to be faced, it is a privilege East European ersities should consider and be prepared for.

CONCLUSION

paper has attempted to explain the problems encoun- l in teaching biochemistry to pre-clinical medical stu- s in the Medical University of Varna and the ap- ches we have started to employee to overcome the dif- ties. We believe that we are having some success but vould be very grateful to receive comments and advice other teaching techniques that those of you who read paper may suggest to us. Some of our achievements, as organization of teaching and assessment of teaching ty, have been previously reported (9).

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APPENDIX 1. SAMPLES OF MCQs AND PROBLEMS TO BE SOLVED

"Biological oxidation"

A. Answer the following questions and give explanations where necessary:
   1. Which is the complex in the electron transport respiratory chain where the synthesis of ATP occurs? Explain its molecular structure and function.
   2. What would be the consequences of inhibition of the ADP/ATP translocase?
   3. Arrange the following redox-pairs in an electron transport chain based on the value of their standard reduction potentials, E_0.

Redox-pair	E_0 (V)
cyt b_6 (Fe^{2+}) / cyt b_6 (Fe^{3+})	-0,006
cyt f (Fe^{2+}) / cyt f (Fe^{3+})	+0,365
ferredoxin (red)/ ferredoxin (ox)	-0,432
Ferredoxin reductase (red)/ ferredoxin reductase (ox)	-0.60

   4. The rate of the electron transfer in intact mitochondria highly coordinates with ATP needs and is high when ATP is actively utilized. The P/O ratio is equal to 3 when electrons are supplied by NADH.
   a) How would high and low concentrations of an uncoupler affect the P/O ratio and the electron transfer rate. Why?
   b) Why when an uncoupler is applied the result is an increase in the body temperature and intensive perspiration?
   c) Explain the reasons for the toxic action of 2,4-dinitrophenol.
   5. Why is the electron acceptor in the succinate dehydrogenase (SDH) reaction FAD (E_0 = +0,005), and not NAD (E_0 = -0,032)?

A. Discuss the statements:
"Biological oxidation is performed only in the respiratory chain."
"Respiratory control is an activation of the electron transport rate promoted by a stimulus of a high oxidation level."

B. MCQs:

1. Which of the following statements about the reduction potential of a redox system are correct?
a) it gives information about the affinity of the redox system to the electrons
b) it depends on the concentration of oxidized and reduced forms of the redox system
c) it depends on the temperature and pH
d) the standard reduction potential of the hydrogen electrode is assumed to be equal to zero
e) the electron flow is always from a redox system with higher reduction potential to a redox system with lower reduction potential.

2. Which of the following are high-energy bonds?
a) enolphosphate
b) thioester
c) acylphosphate
d) pyrophosphate
e) glycoside.

3. Which of the following statements about the electron transport chain are correct?
a) electron transfer is an exergonic process
b) electron transfer is an endergonic process
c) free energy is released at once
d) free energy is released stepwise, in portions
e) free energy released at some of the individual stages is enough for the synthesis of one ATP molecule.

4. Which is the correct answer? A thioester high-energy bond is present in:
a) acetyl-CoA
b) acyl-CoA
c) 1,3-bisphosphoglycerate
d) phosphoenolpyruvate
e) ATP.