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Review Article

Education Section

Planning an Objective and Need Based Curriculum: The Logistics with Reference to the Undergraduate Medical Education in Biochemistry

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ABSTRACT

Purpose: The medical education is recently being transformed into several domains in order to adapt to the need and the value based academics which is required for the quality doctors who serve the community. Presently, the biochemistry curricula for the graduate students of medicine have been questioned by as many experts, because of their multiple lacunae. In this review, we would like to highlight the scenario which is related to the existing biochemistry curricula for graduate medical students, which have been followed in several medical schools and universities and we also hope to share our ideas for implementing objective and pragmatic curricula. Evidence based research, wherein the articles which are related to innovative teaching-learning tools are collected and the pros and cons which are related to the different methods analyzed in biochemistry point of view.

Conclusion: Rapid changes in the content of the curriculum may not be required, but a gradual introduction of the novel approach and the methods of teaching biochemistry can be adopted into the curriculum.

Key Words: Curriculum, Medical education, Biochemistry

INTRODUCTION

Currently, the undergraduate teaching curricula for medical students in several places are largely 'Teacher centered', with didactic lectures taking the lead because of the lesser number of teaching hours and the large number of students [1,2]. Worldwide, the curriculum is focusing more on a 'student-centered' approach rather than the traditional way of teaching, which is teacher centered [3]. Although, newer innovative teaching modules and curriculum designs have been adopted in various medical schools and universities, the perception of biochemistry is often considered to be vague by the medical students. This is mainly attributed to the complex chemical structures and the intriguing metabolic cycles. In order to alleviate this distress, a student-centered approach must essentially be adopted, that would focus on 'problem solving' rather than on 'information gathering' skills. To achieve this, we should implement a combination of different teaching and learning methods [4-6]. Hence, the present review was planned with a view to highlighting the problems which are prevalent in the current scenario and also to share our proposed ideas for implementing objective and pragmatic curricula, in order to make biochemistry interesting and meaningful for even an average undergraduate medical student.

DISCUSSION

The Students' Perceptions About Biochemistry

The familiar misconception is that students should know biochemistry just to clear the I-MBBS course, so as to be relieved from the gate system (Medical Council of India) and also to clear the step I of USMLE. Instead, they should learn and appreciate the role of basic and clinical biochemistry in the day to day practice.

In future, while designing a comprehensive Biochemistry curriculum for MBBS students, the key concepts that need to be borne in mind include

a) In what way is it going to contribute to the diagnosis and the treatment of any clinical condition.

b) How to become successful doctors of tomorrow? [7].

The essential components of the curriculum should include: [8,9].

1. The learning objectives.
2. Selection and organization of the content.
3. The patterns of teaching and learning.
4. The programme evaluation.
5. Learning resource materials.

Objectives for designing the biochemistry curriculum

The key concepts which should be borne in mind prior to the designing and development of a curriculum include:

a) To know the fundamentals of various metabolic processes, their integration and defects.

b) To understand the concepts of medicine at the molecular level.

c) To master the laboratory results and to indulge in an objective and a practical interpretation of the reports.

d) To know the fundamentals of research methodology, ethics and biostatistics.

1. Selection and organization of the content

We should sincerely avoid giving too many details which pertain to the organic chemistry of biomolecules and its reactions [10]. Instead , we should strive to lay more emphasis on the metabolic and the nutritional roles of various biochemical reactions which are involved in health and disease e.g. Glycolysis in people with diabetes mellitus and in normal individuals. We should minimize the provision of details about the instrumentation techniques, which may not be applied by a vast majority of doctors who prefer the clinical disciplines and practice. However, the concepts on the applications of instruments and the interpretation of the laboratory results are mandatory for a clinician and they should be well addressed. We can teach the manifestation of diseases by providing the biochemical basis e.g. Cataract in galactosaemia is attributed to dulcitol.

A system-wise approach would enable the students to realize the importance of biochemistry in their day to day practice e.g. cardiovascular biochemistry, gastrointestinal biochemistry etc., We can impart teaching on how to prepare a model diet chart for different disease conditions e.g. prescribing a diet for Diabetes mellitus patients, etc. The students should also know how to perform certain simple and useful biochemical calculations like that for osmolality, Friedwald's formula for calculating LDLc, creatinine clearance and basic conversions Eg., expressing mg/dl in terms of mmoles/L . The students should also be trained to understand the relevance of ordering appropriate biochemical investigations at optimal clinical settings. They should also understand the molecular mechanisms which are involved in the progression of human diseases.

The next cardinal question is when must the student get exposed to clinical chemistry?

This continues to be a grey area. The following is an example for illustrating when and how a student should be introduced to the clinical chemistry topics: What should be the level that should be taught in the pre-clinical year?

For example, regarding the inborn errors of metabolism, the basics can be taught in the first year curriculum and the details could be elaborated when they are posted in the paediatrics department. This can stimulate self-learning and enable the student to appreciate the relevance of the basic sciences. An in depth knowledge can be acquired if they choose to do post-graduation in biochemistry, internal medicine or related disciplines.

The next important question is... why, as a student, one must know?

A medical student should first realize that biochemistry is being taught to enable him/her to understand the fundamentals of the treatment of diseased conditions.

For instance, the electron transport chain is being taught to make them understand the basis of mitochondrial myopathy and the effect of various poisons on the cellular respiration; and also to highlight the manner in which free radicals (highly reactive chemical species) are produced.

The next question…… what should they know?

In metabolism, a greater importance should be given to explain to them as to what would happen if something goes wrong in a particular reaction which is involved in a metabolic pathway and why and when it goes haywire?

For instance, while teaching glycolysis, we could lay stress on the following points:

What are the major tissues where glycolysis takes place?

In which cellular organelle does glycolysis takes place?

Where and why glycolysis is regarded as important? What are the functions of glycolysis? When the body switches over from aerobic to anaerobic glycolysis, what are the consequences? We can also introduce the concept of lactic acidosis, a topic which is of great clinical interest. The next concept that is frequently ignored is INTEGRATION [11] [Table/Fig-1].

Modern Curriculum			Existing Curriculum
S	Student centered	T	Teacher centered
P	Problem based	I	Information gathering
I	Integrated	D	Discipline based
C	Community based	H	Hospital based
E	Elective	S	Standard
S	Systematic	A	Apprenticeship- based

[Table/Fig-1]: Pattern of teaching and learning [11]

1. Integrated teaching

Integrated teaching affords a holistic approach, whereas the basic tenets of biochemistry should be discussed in the light of the applied and clinical subjects. A discussion on acid- base homeostasis could be viewed from the perspectives of a medical biochemist, a chemical pathologist and an internal medicine specialist. This could be horizontal as well as vertical. The major advantages of integration are that complicated things can be broken down gradually to the scenario at the molecular level and we can also reinforce the essential biochemical concepts before the students emerge as complete doctors [12], the curriculum should also help the students in solving the clinical problems [10]. Learning about metabolism and the metabolic changes in our body could be made more effective and interesting by integrating it with other modalities of teaching [Table/Fig-2]. A horizontal integration is made with the anatomy which pertains to the gross and the histology, as well as to the functional physiology. For example, learning about the cardiac markers of heart diseases is in the purview of the problem based tutorials. The students should have done a concurrent anatomical dissection of the thorax and they should be familiar with the anatomical relations of the heart. They should also listen to the associated lectures on cardiovascular physiology. All these inherent concepts are termed as the HYBRID CURRICULUM [13,14]. Through a vertical integration, the concepts in basic biochemistry could be integrated with other clinical disciplines, which can be facilitated by a systematic approach [15].

Area	Experiment	Knowledge
1. Carbohydrate Metabolism	Oral Glucose Tolerance Test (OGTT)	**a)** Role of insulin and counter regulatory hormones. **b)** Diagnosis of Diabetes mellitus
1. Integration of metabolism	Lactate in blood prior to and following exercise	**a)** Neo-glucogenesis, lactic acid cycle (Cori's)
2. Structure and functions of DNA	Demonstration of Isolation of DNA and Polymerase Chain Reaction (PCR)	Techniques and applications of PCR, Types of DNA, structure and organization

[Table/Fig-2]: Examples of the relevant laboratory experiments for UG students of Medicine

Example: Acid base chemistry (conventional and modern) could form the nuclei for the integration with the critical care and other specialists, as is managed in a tertiary healthcare setup.

The modern modalities of the integration:

1. Blog development
2. Information technology
3. E-library

Design the learning objectives Identify the clinical problems Store the resource in common retrieval for study.

2. Community based learning:

The learning that takes place in a setting which is external to the educational centre is community based learning and here, the student teaches the community and in the process, acquires knowledge as well. There are 2 terms: community based education and community oriented education. In community based education, the students are introduced to the community facilities, namely community hospitals and general practices. Community oriented education is carried out outside the routine hospital, which highlights the plans and the objectives [16-18].

Primarily, the student, along with other facilitators, acquires knowledge about the society, the social taboos, and the lifestyles of different people in the rural and urban population settings. In view of the ever increasing private medical colleges in India and also because of the fact that the students who join are mostly from the affluent group, they don't have a thorough knowledge about rural settings. Hence, community based teaching is deemed essential.

For example, the topics on nutritional biochemistry could be allotted to each student, wherein they will have to educate the community (Eg.Labourers or slum dwellers, etc.) Following this, their feedback could be obtained.

Advantages:

1. This facilitates a rapport among the medical students, the staff and the community.
2. It fosters a holistic learning with a healthy mix of cognitive, social and emotional aspects.
3. It enhances the assurance, knowledge, completeness and awareness about various community values.
4. It promotes the student interest to work in a rural setup.

Disadvantages:

1. Sparse information on the mode of training as related to community based learning.
2. A misperception of the students about the community is possible.
3. Financial, human resource and material constraints are not well defined [19].

Elective teaching programmes:

'A teaching module which is systematically designed as a proposal with key components and mandatory skills which have to be acquired for all students'.

e.g., Duke University and Stanford University follow the elective curriculum.

Advantages:

1. The students can choose their field of interest in order to satisfy their individual aspirations
2. More time is available to comprehend the subject

Disadvantages:

1. Extra burden for the teachers in supporting the needs of the student.
2. The electives may impinge on other coursework.
3. A uniformity in the assessment may be difficult [11,13].

Systematic methods

This method refers to the outcome based teaching with a provision for a clear curriculum map, which could be distributed to the teachers and the taught. In addition, this method facilitates a transparency which pertains to the information on clear and specific objectives that would enable in deciding when, what and how they should be taught. Furthermore, the time of their assessment should be made transparent [11,20].

Advantages

1. A lesser chance to miss the essential knowledge as compared to the traditional way of teaching
2. Exposure to a broad area of knowledge with competencies

Disadvantages:

Interference with the continuity of the teaching programme

Suggestion: The subjects such as molecular biology and intermediary metabolism can be dealt with in this manner.

Problem –Based Learning (PBL):

PBL uses carefully constructed problems as a context for the students to define their learning needs and for conducting self-directed enquiries. Integrate theory-practical; apply knowledge and skills to develop a solution to label a defined problem [Table/Fig-3 & 4].

It serves as a stimulus in the process of acquiring new knowledge [20,21].

Advantages of PBL:

- It enhances self-directed learning, it is more enjoyable and stimulating and it motivates the teaching –learning (T-L) process, especially for the low achievers and slow -learners.
- It also identifies the learning problems and the knowledge lacunae among the students, and it enables the students to consult a variety of learning resources and to essentially return to the group to discuss and share what they have learnt [22-24].

Disadvantages: It demands more manpower and time and is difficult if the teacher and the student lack enthusiasm when there is a large student strength [25].

Designing and implementing a curriculum module by using PBL can be supported by other teaching methods [24, 25].

Example:

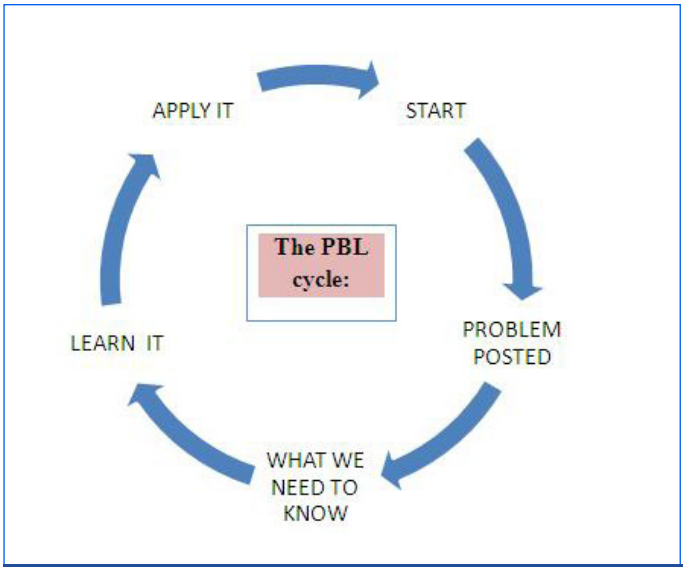
A 12 years old boy complains of muscle fatigue while participating in a gym class. He has more trouble with the anaerobic activities and the blood analysis prior to his exercise. This indicates very little lactate production.

Which metabolic pathway is involved in the above condition?

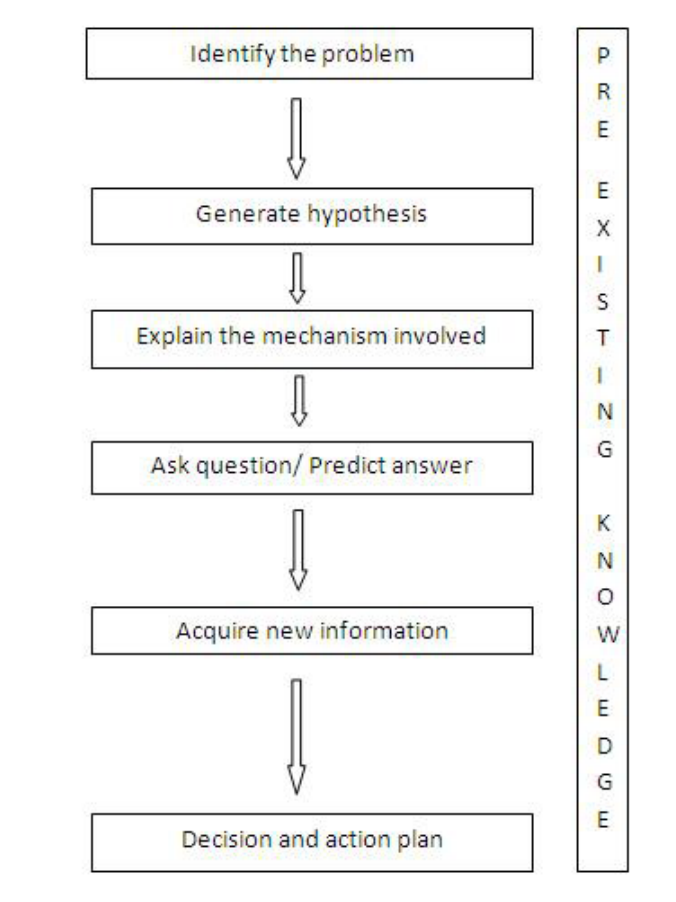
The defect of which enzyme may lead to this condition and why?

Comment: This problem will help the student in understanding the significance of the aerobic and the anaerobic phases of metabolism and it will also enable a meaningful learning.

The Problem Based Learning (PBL) can facilitate the students in such a way that they can correlate with their own practice. Cogni-



[Table/Fig-3]: The PBL cycle



[Table/Fig-4]: Steps in problem based learning

tive way of problem solving skills and also promotes collaborative and cooperative learning rather than competitive learning [13].

How to develop a PBL module and to implement it?.

[TABLE/FIG-5] AN ALGORITHM FOR THE DEVELOPMENT AND THE IMPLEMENTATION OF A PBL MODULE

Inquiry based learning

A student centered, active learning approach which focuses on questioning critical concepts, and problem solving. It is often associated with the idea of "involve me and I understand" [26,27].

Key principles and advantages

- Driven by the learner's questions, not the teachers'.
- Adaptable to many types of projects.
- Touches several learning skills
- Hits multiple skills
- Emphasizes collaborative learning

The disadvantages

- Demands a lot of preparation time and planning
- The onus is on the students to be active learners.
- The assessment can be difficult.
- A pre-planning is required, which includes the following types of questions.

What question do the students have?

Topics?

What will be the time frame?

What will be the scope?

Will it facilitate tie-ups with other course works and how?

Learning objectives?

Media/resource/information needs?

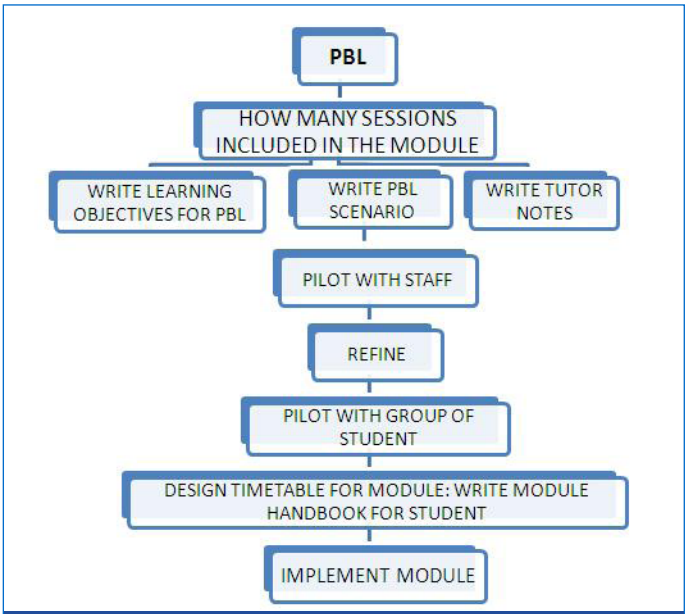
Group works.

Question types:

It is factual, interpretative and evaluative and it should help in inferring, interpreting, transfering and hypothesizing.

Team Based Learning (TBL):

The smaller groups of students in a team interact in a class to apply the contents to simple and complex problems [28].



[Table/Fig-5]: Algorithm for development and Implementation of PBL Module.

Pre-class: An individual learns the assigned teacher specific content, which is co-ordinated by the team leader.

In the class: The team members apply themselves in a teacher specified content to a problem solving discussion. During the class, the student receives a frequent and an immediate feedback.

[TABLE/FIG-6]. THE STEPS IN THE "TEAM BASED LEARNING" PROCES

Four essential principles of TBL

1. A proper formulation of the groups, and their management

2. Accountability of the student for the pre-class preparation and the team performance.

3. Assignments of the team that promote learning, group discussions (interaction) and team development.

4. A frequent and an immediate student feedback.

The advantages of TBL for the students [29-32].

- It motivates to attend the classes
- It helps in participating actively in the education
- Applied knowledge
- Develops interpersonal skills.

Example: We suggest that organ function tests can be better taught by TBL.

THE PROGRAMME OF EVALUATION AND FEEDBACK

Quality evaluation of the curriculum

Any curriculum needs evaluation periodically by a set of experts [33,34]. The feed back from the students should be meticulously evaluated, because they are the ones who are going to apply biochemistry successfully in the realms of medicine. Additionally, the services of an experienced general practioner may also be called for and included in the expert committee.

A Model Curriculum-Checklist:

1. Have the objectives been specified?

2. Are the objectives relevent and feasible?

3. Has the decision been made on

a) Who will teach?

b) When will it be taught?

c) How long will it be taught?

d) How will it be taught?

e) What are the sources of the references? Textbooks/notes/handouts/web links, etc.,)

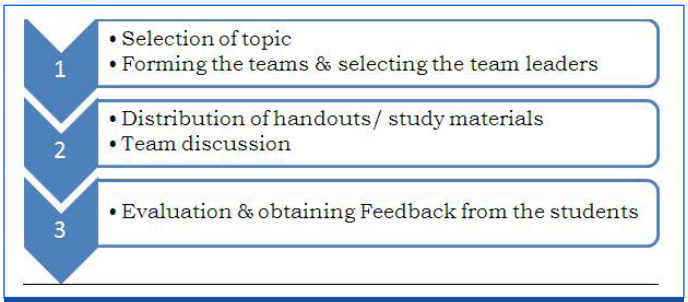
f) What are the Teaching /Learning aids which are required?

4. How will the course be evaluated and by whom?

5. Is there a provision for change, if it is deemed necessary?

LEARNING RESOURCE MATERIALS

The students should be encouraged to learn on how to use other learning resources e.g. Internet is an effective way in addition to the text books and class notes. e- resources based learning is a new and an emerging arena, which has a positive impact on learning biochemistry [2].



[Table/Fig-6]: The Steps in "Team Based Learning" process

We are listing below, a few of the websites which may be useful for the students of biochemistry [Table/Fig-7].

http://www.medscape.com/ http://www.ncbi.nlm.nih.gov/pubmed/ http://www.proquest.com/en-US/catalogs/databases/detail/medline_ft.shtml http://www.freemedicaljournals.com http://www.medicalteacher.org/ http://Medicalbooksfree.com/ http://www.fb4d.com/ http://sites.google.com/site/faimertraining/webbasedlearning http://www.cebm.net/ http://ebm.bmj.com/ http://emedicine.medscape.comlam.blogspot.comhttp://www.academicjournals.org/http://medicaleducationunit.googlepages.com

[Table/Fig-7]: Listing few of the websites

CONCLUSIONS

Rapid changes in the content of the curriculum may not be required, but the gradual addition of a novel approach and the inclusion of effective methods in teaching biochemistry could be explored in medical schools and institutes, in order to acquire skillful and thoughtful medical professionals. This in turn, largely depends on the availability of manpower and other essential resources.

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