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GENERAL MEDICINE STUDENTS IN HIGHER EDUCATION INSTITUTIONS THROUGH VERTICAL AND HORIZONTAL INTEGRATION

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Abstract. This article describes a methodology for teaching medical chemistry to students enrolled in the General Medicine programme at higher education institutions through vertical and horizontal integration. Within the framework of horizontal integration, the relationships between medical chemistry and anatomy, physiology, biology, and other relevant subjects taught during the same academic year are examined. Vertical integration is used to analyse ways of systematically linking fundamental chemical knowledge acquired in the early years of study with biochemistry, pathophysiology, pharmacology, and clinical subjects studied in later years. The article also explores methodological approaches to organizing interdisciplinary collaboration, using integrated assignments, applying interactive teaching methods, and assessing students' knowledge progressively. The proposed approach is aimed at enabling students to acquire medical chemistry knowledge systematically and understand its professional significance.

Keywords: medical chemistry, General Medicine, higher education, medical education, vertical integration, horizontal integration, interdisciplinary integration, fundamental sciences, clinical sciences, anatomy, physiology, biology, biochemistry, pathophysiology, pharmacology, chemical knowledge, curriculum, interdisciplinary relationships, integrated learning, interactive teaching methods, problem-based learning, clinical reasoning, knowledge assessment, teaching methodology.

INTRODUCTION

One of the key objectives of modern medical education is to develop future physicians' ability to apply the knowledge acquired in fundamental sciences to understanding and analysing clinical situations. From this perspective, the use of interdisciplinary integration in teaching medical chemistry to students enrolled in the General Medicine programme is of considerable methodological importance. Medical chemistry provides a scientific foundation for understanding chemical processes in the human body, the properties of solutions, acid–base balance, biogenic elements, and the characteristics of biologically active compounds.

In medical education, vertical and horizontal integration are approaches that help ensure continuity between fundamental and clinical sciences. According to the scientific literature, horizontal integration refers to the interrelationships between the content of subjects studied at the same stage of education, whereas vertical integration involves the systematic incorporation of fundamental knowledge into subsequent clinical education [1; 2].

Certain topics in medical chemistry are directly related to anatomy, physiology, biology, and biochemistry. In subsequent years of study, this knowledge can provide a theoretical foundation for learning pathophysiology, pharmacology, internal medicine, and other clinical subjects. Therefore, teaching medical chemistry should not be limited to treating it as a separate discipline; its connections with other subjects and professional practice should also be demonstrated.

The aim of this article is to describe the content, methodological potential, and practical applications of teaching medical chemistry to students enrolled in the General Medicine programme through vertical and horizontal integration.

MAIN BODY

Teaching Medical Chemistry through Horizontal Integration

Horizontal integration is an approach based on establishing connections between the content, concepts, and learning outcomes of subjects studied at the same educational stage or within the same academic year. In the General Medicine programme, this approach can be implemented by integrating medical chemistry knowledge with anatomy, physiology, biology, histology, and other relevant subjects taught during the same year. The specific list of subjects should be determined in accordance with the curriculum of the respective higher education institution.

The figure below illustrates the interrelationships between medical chemistry and anatomy, physiology, biology, and other relevant subjects. The image of a chemical laboratory positioned at the centre represents the importance of medical chemistry as a source of fundamental knowledge. The surrounding images of a cell, heart, kidney, brain, and tissue demonstrate the relationship between chemical knowledge and the understanding of biological structures and physiological processes. This integrative approach helps students connect knowledge acquired across different disciplines, develop a comprehensive understanding of topics, and relate their theoretical knowledge to medical contexts (Figure 1).

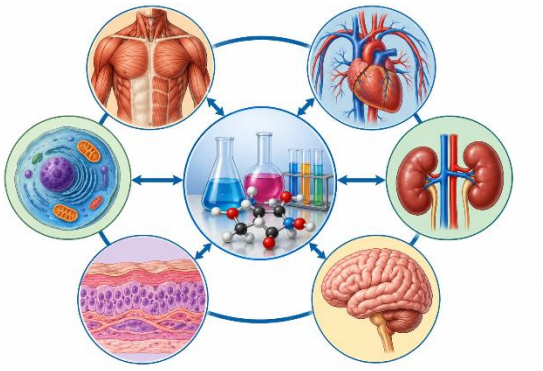


Figure 1. Model for Teaching Medical Chemistry through Horizontal Integration

The primary objective of horizontal integration is to help students connect concepts acquired in one subject with knowledge gained in other disciplines. For example, when studying solutions and osmotic pressure in medical chemistry, their relationship to water–electrolyte balance in physiology can be explained. This enables students to apply the physicochemical properties of solutions to understanding processes associated with body fluids.

When teaching acid–base balance and buffer solutions, the relationship between medical chemistry and physiology can be used. Students study the chemical nature of buffer systems and subsequently relate this knowledge to the mechanisms responsible for maintaining pH stability in the human body. In this process, chemical equations, diagrams, and problem-based questions can be used to reinforce theoretical knowledge.

In the study of biogenic elements, the biological functions of chemical elements are linked to relevant concepts in biology, histology, and physiology. For example, an interdisciplinary approach can be used to examine the importance of iron as a component of haemoglobin, calcium in bone tissue and muscle function, and sodium and potassium in maintaining ionic balance and membrane potential.

To implement horizontal integration effectively, academic staff teaching different subjects should coordinate the sequence of topics, align overlapping content, and establish common learning outcomes. The primary task is not simply to repeat information from one subject in another, but to clarify the conceptual relationships between them.

Teaching Medical Chemistry through Vertical Integration

Vertical integration is the process of systematically linking the knowledge and skills developed in fundamental sciences with clinical subjects and professional situations encountered at subsequent stages of education. In medical education, this approach aims to ensure continuity throughout the learning process, from the acquisition of initial theoretical knowledge to the development of clinical reasoning [2].

In the General Medicine programme, vertical integration can be planned by linking medical chemistry, from the initial stage of its study, with relevant clinical subjects taught in the later years of the programme, including the sixth year. In this context, medical chemistry does not replace subsequent disciplines but provides the fundamental foundations necessary for understanding them.

The figure below illustrates the close relationship between the fundamental knowledge acquired in medical chemistry and the biological, anatomical, physiological, and clinical knowledge studied at subsequent stages of education. The learning process begins with chemical substances and molecular structures and progresses towards concepts related to cells, human organs, physiological systems, medicinal products, and clinical practice. This model is intended to deepen students' chemical knowledge progressively, ensure continuity between fundamental and clinical sciences, and help them understand the professional significance of theoretical knowledge (Figure 2).



Figure 2. Model for Teaching Medical Chemistry through Vertical Integration

For example, the concentration of solutions, electrolytes, and osmotic pressure are studied in medical chemistry. At subsequent stages of education, this knowledge helps students understand conditions associated with fluid and electrolyte balance in physiology, pathophysiology, and clinical subjects. Students progressively develop an understanding of the clinical significance of chemical concepts.

The study of buffer solutions and acid–base balance is also a suitable area for vertical integration. Initially, students acquire knowledge of the composition and mechanisms of action of buffer systems in medical chemistry. Subsequently, they may study the regulation of acid–base balance in physiology, the mechanisms underlying its disruption in pathophysiology, and the significance of relevant laboratory parameters in clinical subjects. In this way, fundamental concepts are developed further at subsequent stages of education.

Vertical integration is also possible in the study of biogenic elements. Initially, students study the chemical properties and biological functions of these elements. In later years, this knowledge is linked to the understanding of biochemical processes, pathological changes, and clinical laboratory parameters. However, the study of clinical conditions associated with the deficiency or excess of a particular element should be conducted in accordance with the relevant subject syllabus and the students' level of preparation.

To implement vertical integration systematically from the first to the sixth year of study, it is advisable to develop an interdisciplinary curriculum map. This map should indicate the foundational concepts introduced in medical chemistry, how these concepts are developed in subsequent subjects, and how they are applied in the later years of study. The map should be based on the actual subjects included in the educational programme, their teaching sequence, and their intended learning outcomes.

Methodology for Integrating Vertical and Horizontal Approaches

When teaching medical chemistry through integration, vertical and horizontal approaches should not be treated separately but should instead be used as complementary methodological tools. While horizontal integration establishes connections between subjects studied within the same academic year, vertical integration ensures the further development of this knowledge at subsequent stages of education.

This approach can be organized through the following stages:

1. Defining learning outcomes. The knowledge and skills that students are expected to acquire for each topic in medical chemistry are identified.

2. Identifying interdisciplinary connections. Horizontal links between the topic and subjects taught during the same academic year are established, along with vertical links to relevant subjects taught in later years.

3. Developing integrated assignments. Chemical problems, concept maps, tables, and educational scenarios with clinical content are designed.

4. Using active learning methods. Problem-based questions, small-group work, situational tasks, and interdisciplinary discussions are organized.

5. Assessing knowledge and providing feedback. Students are assessed on their ability to explain chemical concepts, connect them with other disciplines, and apply them in relevant situations.

For example, when studying the topic of "Buffer Solutions," students may first be asked to explain the concepts of chemical equilibrium and pH and then relate them to acid–base balance in physiology. In subsequent years, the application of this knowledge in pathophysiology and clinical subjects can be addressed in accordance with the relevant curricula. This approach focuses on understanding and progressively developing knowledge rather than simply memorizing information.

The effectiveness of integrated teaching is determined not only by the connections established between topics. The alignment of learning outcomes, the suitability of assignments for students' levels, interdisciplinary collaboration, and the clarity of assessment criteria are also important. Therefore, academic staff should coordinate their subject curricula and monitor the progressive development of students' knowledge.

CONCLUSION

Teaching medical chemistry to students enrolled in the General Medicine programme through vertical and horizontal integration helps ensure continuity in fundamental knowledge and clarify its connections with clinical disciplines. While horizontal integration links the content of medical chemistry with anatomy, physiology, biology, and other relevant subjects studied during the same academic year, vertical integration involves the progressive development of this knowledge from the early years of study through to the clinical education stages in the sixth year.

To implement this methodology, it is recommended that interdisciplinary curriculum maps be developed, learning outcomes be coordinated, integrated assignments be used, and students' knowledge be assessed regularly. In this context, medical chemistry should be regarded not as a substitute for clinical disciplines but as a subject that establishes the fundamental knowledge necessary for mastering them.

To determine the effectiveness of the proposed methodological approach, future work should involve conducting pedagogical experimental studies, assessing students' learning outcomes against relevant criteria, and analysing the results of applying interdisciplinary connections.

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