

# Review Paper

## The Role of Anatomy in Medical Education



Hossein Bahadoran<sup>1</sup>, Reza Dadfar<sup>2,3</sup>, Mohammad Hosein Asadi<sup>1</sup>, Sajad Moghadami<sup>1\*</sup>

1. Department of Anatomy, School of Medicine, Baqiyatallah Medical Science University, Tehran, Iran.
2. Department of Anatomical Sciences, Faculty of Medicine, AJA University of Medical Sciences, Tehran, Iran.
3. Department of Education and Research, Army Health Center of Excellence (NEZAJA), Tehran, Iran.



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## ABSTRACT

Anatomical sciences are considered as the foundation of the medical education. Previously, the anatomy in medical educational environments was based on the lecture presentation and corpus dissection. Then, the newer protocols, such as teaching methods using human models, imaging, simulation, and internet-based webinars, were widely used in academic schools. In this era, the medical curriculums focused less on corpse dissection. Medical learning in the field of anatomy was basically based on the traditional approaches and presentation-based learning using the students under the teacher's supervision. The teacher, as the class manager, can design the curriculum contents using clinical applications along with knowledge assessment. This procedure can be achieved through planning for the future and the plans ensuring the persistent development of anatomy as a relevant clinical subject in any medical curriculum.

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**\* Corresponding Author:**

Sajad Moghadami

**Address:** Department of Anatomy, School of Medicine, Baqiyatallah Medical Science University, Tehran, Iran.

**Tel:** +98 (913) 2995767

**E-mail:** [sajad.moghadami@gmail.com](mailto:sajad.moghadami@gmail.com)

## 1. Introduction

**A**natomy education has always been discussed with concerns about its importance and educational standards in medical schools. There has been concern that the level of anatomy teaching has fallen below average [1]. A long time has passed since it was thought that hundreds of hours of dissection alone were necessary to prove medical professional competence, and it is hoped that this level of training will meet sufficient standards and provide the student with more information in less time. More innovative methods have been replaced so that some medical institutions officially consider the use of autopsies to be obsolete without the accompanying and replacement of related educational models and technology [2]. Technology in anatomy education has become increasingly popular and has proved to be an efficient and effective tool in teaching medical students. Anatomy education can now be conducted using virtual reality software, 3D printing, anatomical models, and computer programs. These technologies offer a more detailed and interactive experience for the students and allow them to explore anatomical structures in ways that were not possible in the past. Moreover, the integration of anatomy with other courses, such as pathology, imaging, and clinical medicine, has made the subject more interesting and clinically relevant. This integration allows students to understand how anatomical structures relate to specific diseases and conditions and how to interpret medical images. In conclusion, anatomy education has come a long way, and technological advancements have revolutionized teaching methods. Now, medical students have access to various educational tools that offer an immersive experience and allow them to learn anatomy more efficiently and effectively. As technology continues to evolve, it will be interesting to see what new educational methods will be developed for anatomy education in the future.

### Anatomy

The focus of the educational guideline available in the curriculum is anatomy education specialists, whose academic scope is the examination and study of the structure of the body and is known as macro anatomy or topography, which includes the analysis of normal structures that can be seen with the naked eye [3] and body organs and areas. Gross anatomy includes macroscopic anatomy, histology (microscopic anatomy), embryology (developmental anatomy), and comparative anatomy. Anatomy is also closely related to physiology through the correlation of structure with function and pathology (using knowl-

edge of normal and abnormal structure) in many clinical disciplines, especially surgery, radiology, and emergency medicine (using knowledge of normal and abnormal structure) [4]. In traditional medical courses, anatomy is studied separately in parallel with physiology, followed by the study of pathology and clinical disciplines. This teaching method is problem-based learning (PBL) before the introduction of medical courses [5].

In this way of teaching, it is necessary to develop a thorough understanding of all-natural anatomical structures as an introductory course, which is considered before starting the next areas of study. PBL offers a more holistic approach. In this way, pathology and clinical applications are studied simultaneously with the structure and function of the human body.

### History of anatomy

The standardization of anatomy education has come about by practicing different methods over the centuries and using new and more innovative ways. In this article, we review the history of anatomy education and its role in medical education and examine it during different times. Extensively, many historians worldwide have written about the extent to which ancient civilizations knew about the structure of the human body. Many ancient philosophers and doctors used to convey their knowledge about the structure and function of the human body to their students by talking about the dead mummy in training sessions [6]. In the Middle Ages, the teaching of anatomy was not sophisticated, and doctors were taught with primitive squat figurines containing almost unrecognizable organs [7]. The anatomical studies of Leonardo da Vinci at the beginning of the Renaissance period enabled them to create a better and clearer idea of the function of human organs. At that time, the correct deduction of the hidden structures in the superficial anatomy of the body, especially the muscles, which are often shown by artists [8].

Vesalius, the founder of modern anatomy, tried to make dissection compulsory in the university in the 16th century [9]. Multimodal approaches to teaching anatomy and surgical fundamentals have gradually become the most popular choice among all medical institutions, including those in the UK recognized by the General Council (GMC 2006). However, it seems that autopsy is still the preferred method for teaching and providing optimal examples of pathology by professors and students. According to the needs of the patients, the method of teaching anatomy and dissection laboratories should also be adapted to the changing needs of the students

[10]. In the beginning, doctors were trained by the internship method for medical training, and there were few methods for teaching anatomy [11]. Specimens that were not fixed or mummified had to be dissected immediately. There was almost no particular method for teaching anatomy. Compared to other medical subjects, anatomy education was of great interest to students from a clinical point of view, but with problems such as the increase in the number of medical schools, especially in developing countries, the lack of cadaver donation and its preservation were facing. Many illegal and for-profit colleges were collected, and accredited colleges were developed. Anatomy became a major part of the Basic Science curriculum, which included lectures, dissection, and anatomy labs. It comprised the first 2 years of a 4-year course (bachelor of science), which was later reduced to one year [12]. Gradually, due to the increase and advancement of information related to molecular biology, the curriculum of basic sciences increased, and the time related to anatomy education became more intensive. Adding new disciplines (such as communication skills, professionalism, ethics) to the medical curriculum reduced total anatomy hours and actual content.

### Anatomy in traditional lessons

The anatomy program in traditional courses was usually defined regionally. All the parts of the body were divided separately and equally during the weeks of training, and this teaching method made them forget to explain some details of the body; for example, they explained the lower and upper limbs first, and then the trunk, head, and neck [13] were presented separately. In this case, it is possible that the student does not understand the relationship between organs and muscles well, and only his view of anatomy is limited to a part of the body. Due to the sequential nature of this teaching method, some students have difficulty understanding the material [2]. This problem became more complicated when, for example, they reached the brachial network in the armpit, and it was very difficult to understand all this information. Regular teaching method is not necessarily the most suitable arrangement for learning the subject. For example, the anterior wall of the abdomen and the abdominal cavity were explained before the posterior wall in the traditional method, and the student could not understand the relationship between the abdominal cavity and the posterior wall. A suitable alternative to better explain anatomy regionally or regionally is the systemic explanation, in which each body system is described separately (skeletal, muscular, cardiac, vascular, respiratory, digestive, exocrine, urinary, reproduction, and nervous system) and each system is studied [14].

However, a purely systematic training program can be just as long, and some body details are forgotten. The systematic training method helps to observe the internal relationships of the same type of body structure, but it cannot emphasize the important relationships between neighboring structures. In addition, studying all the body's bones before working on muscles or other areas can be tiring. In practice, the best way to teach anatomy can be a combination of regional and systemic teaching of structures or a detailed description of attachments and their functions [15].

### Anatomy in current courses

Project-based learning (PBL) is a student-centered learning practice designed to teach concepts using real-world problems and challenges. PBL is commonly used to develop critical thinking skills and produce high-quality, engaging classroom models and lesson plans [16]. PBL courses are suggested to influence traditional approaches and compensate for their shortcomings. This course is valuable and sufficient for artificial division between pre-clinical and clinical areas and for covering the workload caused by the expansion of anatomy-related science [17]. In this course, it is intended to achieve transverse integration in addition to longitudinal integration. This technique contributes to the system-to-system relationship approach. In many curriculums, teaching anatomy is divided into parts according to the desired order in all teaching cases. It is not taught separately as an independent subject; in some cases, areas of the body unsuitable for teaching are ignored [18]. It is taken (despite the justified complaints of anatomists and relevant surgeons), for example, the walls of the chest, abdomen, and pelvis, along with the corresponding cavities, were not considered as direct components of the respiratory, digestive, and urogenital system. To fit the entire material for the student, the desired side areas were not paid much attention, and only the desired system was explained in the area.

Retaining the principles of anatomy and subjects related to histology, embryology, and physiology are essential and valuable components of an undergraduate student's education included in a PBL program. The fact that all the anatomy cases in the order of education, which is a combination of regional and systemic anatomy, requires the active participation of the education working group in the design of the codified curriculum, as well as the implementation and then the evaluation and evaluation activity of the student. The advantage of the PBL curriculum is that the student learns all the educational items completely and comprehensively, and all the basic con-

cepts are introduced in the early stages. At regular intervals, the entire curriculum with depth More will be reviewed [19]. The study of human structure and function should be done in the field of clinical application, based on providing an integrated and one-handed program. To fully understand why particular facts about structure and function need to be studied and to ensure reasonable retention of knowledge, the presentation of anatomy education should be integrated with relevant clinical and functional details. Hence, there is a concept presented by the term clinical anatomy, unlike the older titles that were used. Another important element of the PBL curriculum should be the assessment of basic science and diagnosis by the relevant staff alongside the doctors during the examination periods until the final year of teaching [20]. Increasing the visibility of anatomists and scientists of basic and diagnostic sciences for students can emphasize the importance of reviewing the basic structure and function of the human body in the clinical environment.

Some colleges have decided to abandon human anatomy and train students using fixed and plastinated cadaver specimens and models in anatomy and clinical skills labs [21]. There are several reasons why these faculties have chosen this path, including the poor teaching experience of the curriculum design team members during their undergraduate studies and the reduction of anatomy course time in the timetable. In addition to these cases, factors such as cost (financial and staff) and difficulty in obtaining a sufficient number of corpses for the entire class are important factors affecting this process.

Autopsy is a way to discover the inside of the body. Therefore, this method is the most appropriate way to study the three-dimensional anatomy of the human body. The practical skills of description are a great way to learn; in the future, they can develop the activities needed for a student's job. A cadaver can be considered the first disease a student encounters in the first year of medicine and acts as a part of a vital experience in the medical profession. When it comes to students' ability to successfully examine a patient in a clinical environment and perform surgery, this success can be one of the important results of an autopsy during student life [22].

Learning anatomy involves a focus on learning outcomes, and this is essential if medical graduates are to make valuable and effective use of what they have learned when faced with actual cases. Medical knowledge in basic sciences is organized in a self-related manner, even for similar structures, such as ligaments or tendons, compared to clinical areas. From the point of view of the field of anatomy, ligaments are considered in terms

of their composition - for example, collagen, which is a type of dense connective tissue that resists stretching and thus transmits force, but in special elastic ligaments, elasticity, and elasticity are They can also be classified in terms of classification, location, connections, shape, function, nerve supply (separated by proprioceptive and pain fibers), blood supply to an area, contact with other body organs and systems, and their changes with age, gender, and structure were considered [23]. From the clinical professional point of view, ligaments vary in terms of damage and pathological conditions such as the type of damage, sprain, partial tear and complete tear; predisposing factors; mechanism of injury; damage effects; Injury related to related structures such as dislocation or fracture of bone; signs and symptoms; types of necessary research; diagnosis; treatment; Complications such as ligament strain and weakness due to insufficient repair; Prognosis and prevention are addressed through strengthening, training, or bandaging. Both methods of organizing knowledge about ligaments are correct. These two methods have a different focus and complement each other. In the past, managing principles derived from a professional perspective did not play an essential role in anatomy curriculum design because the disciplinary view of anatomy was the dominant view. Currently, the absolute disciplinary perspective is less seen regarding PBL courses combined with the common clinical professional attitude. Lack of adequate clinical communication creates a sense of confusion and, as a result, fatigue [24]. In addition, an insufficient anatomical foundation creates anxiety and confusion for the student because there is not enough preparation to understand the clinical environment. It seems that for students who want to learn only pure anatomy and anatomy teaching, a traditional course is more suitable, while for those who want to enter the clinical profession, a PBL course is more suitable.

There is a great divergence and separation between schools in medical anatomy education in general, which discusses the role of dissection and considers the student's exposure to the corpse as important in medical education. Anatomy itself has suffered enough due to its failure to evolve and rapidly adapt to the teaching conditions of the day. This process is moving forward, and we hope to reach a balance point, as the standard medical course is probably a combination of traditional and PBL courses. Autopsies (focusing on clinically important areas) and PBL tutorials (with learning tasks that interpret the basis of clinical anatomy) play a vital role. Traditional learning correlates well with regional anatomy, while PBL doses are closely and directly related to systemic anatomy [25].

In the ideal and new anatomy program, the points of view of anatomy and clinical profession are also integrated. Teaching and learning activities and assessment of anatomy should force students to continuously move from one perspective to another in explaining clinical phenomena and their observations. This can occur during hands-on anatomy classes, including dissection (for example, where students are challenged to determine whether their findings are normal on a specimen or cadaver), and during PBL instruction (for example, where students are challenged to determine whether the radiographs of the presented case are normal or not, are challenged) occur [26].

However, the key to the renaissance of anatomy is the emergence of new subjects such as “general anatomy” and “clinical anatomy”, which introduce terminology along with the basic structure and general arrangement of organs in body systems before proceeding to the detailed study of a particular system [27]. Also, the general arrangement of organs in the body and the basis of their observation through imaging methods can be presented. Understanding the principles of anatomical logic is another basis for understanding the clinical manifestations of the disease. Thus, the ideal anatomy program is “principles and logic-based”, and its principles are directed to their clinical applications so that it is also “problem-oriented” [28]. Similarly, the ideal medical course would become a “principles-oriented and problem-oriented” course, unlike traditional discipline-based or learning-based approaches.

The general type precedes the specific type for subjects such as anatomy in a standard syllabus. “General anatomy” provides the foundation for “specific anatomy” in the clinical setting, including both theoretical (systemic and regional) perspectives as well as practical aspects. General anatomy is the scaffolding that holds specific anatomical components together [29].

While the study of anatomy as an introduction is present to some degree in most curriculums, the amount is at worst sparse and at best sporadic. The way forward is to put more effort and spend more time teaching the basics and how to find more detail when necessary (at the cost of trying to cover all of the direct training material, especially in a comprehensive summary). Students will be equipped with the intellectual tools necessary to fully master the subject they encounter at any point in their education. This is the foundation of anatomical literacy and flexibility that enables anatomy to be successfully regenerated [30]. A distinct and new field is needed to adequately address all theoretical and practical components of general anatomy.

General anatomy is a conceptual and general term. A concept is an idea or understanding of an object or an event. Each principle is a recurring pattern of related concepts (especially of an object related to an event) and, as a whole, provides principles of general rules that relate objects and events to each other. This point allows for inductive reasoning in which particular cases are examples derived from a generalization. In contrast, deductive reasoning allows patterns to emerge after gathering all the detailed information and reflecting on it. Therefore, specific cases lead to a generalization. Astute and versatile learners need both forms of reasoning. The application of anatomical principles is primarily in clinical fields. The main goal is to help the learner face new situations in his future career with skill and confidence and to be able to reason from basic principles [31].

An anatomical building unit is an anatomical structure (derived from the Latin word: “Build”) or organ (derived from the Greek word: “Tool”). Organs may be grouped based on a common function within systems (derived from the Latin word: “Organized”) or based on a common location within body areas (derived from the Latin word: “Areas”). Thus, an organ is simultaneously a structural (and functional) unit of an apparatus as well as a region of the body. Systemic anatomy is related to an organ’s organizational or internal features (structure, innervation, and blood supply) [32]. Regional anatomy is concerned with an organ’s positional (external) features related to the position (peripheral relation with the body as a whole and the relation with the neighboring regions in the body). Information about specific individual organs is within what might be called “specific anatomy as opposed to general anatomy” [33].

Theoretical knowledge about specific organs, based on general principles, helps to understand that the body is made up of the sum of its parts. This knowledge includes components that manifest themselves in different ways depending on the type of organ they are dealing with [34].

Knowing anatomical structures theoretically is not enough; it is also vital to experience and know how natural structures appear in various ways that can be accessed in living patients. Cross-sectional anatomy of the body at important clinical levels is the basis of the interpretation of computed tomography (CT), magnetic resonance (MR), and ultrasound (US) images. Surface anatomy (including the protrusion of the lower limbs), along with functional anatomy (movements, actions, and reflexes), is the basis for conducting a physical examination of the patient as well as performing clinical procedures, including medical emergencies [35].

A practical knowledge of specific organs, based on the general principles of the methods by which they can be observed and applied, makes it possible to understand how to deconstruct an intact body. This knowledge consists of components that manifest themselves in different ways depending on the type of practical perspective they deal with. The reconstruction of the human body occurs with the clinical application of this knowledge of anatomy [36].

There will be many advances in the near future regarding diagnostic (such as ultrasound) and interventional (such as angioplasty) imaging techniques, as well as endoscopic and microsurgical procedures. Today, it is more important than ever to acquire comprehensive anatomy knowledge so that the diagnostician does not see too few or too many cases [37].

What type of anatomy teaching is appropriate for undergraduate versus graduate students? The challenge of any undergraduate curriculum is extracting this information from the additional descriptive details that may only be useful to a postgraduate or anatomical science researcher. However, undergraduate anatomy can be called “basic anatomy”, and professional anatomy can be called “advanced anatomy”.

## 2. Conclusion

In the end, it can be said that anatomy, if active enough, can help shape the future of medical education and form the educational system. By progressing, rather than simply maintaining the best practices of the past and present, anatomy can be a pioneer by becoming an educational model for other programs to revitalize itself and medical education. In the future, it may even help some undergraduate medical courses that are in danger of being eliminated and provide a solid foundation for graduate studies.

## Ethical Considerations

### Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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## Authors' contributions

All authors equally contributed to preparing this article.

## Conflict of interest

The authors declared no conflict of interest.

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