

# The Application of Barrier-Based Learning (BBL) Method in Histology Learning from China

La Aplicación del Método de Aprendizaje Basado en Barreras (BBL) en el Aprendizaje de Histología en China

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**SUMMARY:** Histology belongs to the discipline of medical morphology. The knowledge is scattered and abstract in this discipline. It is difficult to the medical students beginner. Leading to poor effect on histology teaching. This study aimed to introduce medical students to the histology using barrier-based learning (BBL) method or traditional teaching method. We recruited 4 clinical medical classes, including two 5-years classes and two 7-years clinical medical classes, each of these classes randomly assigned to 1 of 2 groups. The control group received an introductory traditional teaching mode in histology. The experiment group received BBL method. Using final exam average scores, pass rate, excellent rates and phase tests to evaluate the teaching effect of these two teaching method. BBL teaching method is more effective than traditional teaching method, The application of BBL in histology is more easier to learning for the beginners of medical students.

**KEY WORDS :** Medical education; Histology; Barrier-based learning; Teaching method.

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## INTRODUCTION

It is known that histology is a morphological course which medical students always study at an early stage of their professional learning. It is a subject researches microstructure and related functions on the different levels such as tissue, cell, organelle and molecule. For the most time, we use microscopes to observe tissue sections in order to research the microstructure under the microscopes or electron microscopes (Dantas *et al.*, 2008). Histology is usually divided into 10 different systems based on the similar characteristics of organs. The disadvantage of this model is that knowledge is distributed to beginner medical students. It turns out that the majority of students consider the content that they learn from the histology is abstract and scattered. Additionally, because of less total class hours and faster course schedule, many students have trouble understanding and mastering, and even become tired of learning. Building a knowledge framework around clues can help them overcome this disadvantage.

Through the teaching experience of basic medicine for many years, the author summarized barrier-based learning method, which is an instructional student-centered approach which grasping barrier structure as emphasis and context of every system (Hung *et al.*, 2013). The structure and function of the body are learned with the center of the barrier. This teaching method can make students more systematically summarize medical knowledge, and improve the clinical application of the possibility of good performance in series.

## MATERIAL AND METHOD

There are two types of clinical medical model in this study: clinical medicine (7 years) and clinical medicine (5 years) (Table I). We choose two classes of clinical medicine (7 years) and two classes of clinical medicine (5 years)

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Table I. Clinical medical cultivate model in China.

Professional	Pre-medical education	Medical education( <i>Including basic medical, clinical medicine courses and clinical practice</i> )	Cultivate application ability	
			Clinical general practice	Scientific research training
Clinical medicine (7 years)	2 years	3 years	1 years	1 years
Clinical medicine (5 years)	1 years	2 years	1 years	0 years

and were randomly assigned BBL method group: clinical medicine (7 years) class 1 for 66 students, clinical medicine (5 years) for 67 students in class 1; traditional teaching mode group: clinical medical (7 years) for 68 students in class 2, clinical medicine (5 years) for 64 students in class 2. We applied barrier-based learning method in BBL group and based system and organ learning in traditional teaching mode group.

Using phase test to evaluate BBL method mode teaching effect during applying, there are four periodic tests, the test content is listed as following:

First phase test : system 1: circulatory system and system 2: endocrine system;

Second phase test: system 3: immune system and system 4: nervous system;

Third phase test: system 5: digestive system, system 6: respiratory system, system 7: urinary system; Forth phase test: system 8: reproductive system, system 9: skin, system 10: eye and ear. The test including class discussion, hands-on lessons, histology drawing, Slice observing.

At the end of the semester, the BBL group and traditional teaching group students 'comprehensive scores average: usual grade (10 %) + final exam grade (70 %) + skills test scores (20 %) are evaluated in a manner. Usual grade referred to hands-on lessons during having class, final exam paper using percentage system composed of single choice (60'), true or false question (10'), fill blanks (10'), short questions (10'), long questions(10'). skills test including ability of identify histology pictures and observed slices under microscope. Assessment index : average scores, pass rate ( $\geq 60$ ), excellent rates( $\geq 80$ ).

This teaching method study was approved without review by the first affiliated hospital of xinjiang medical university ethics committee as it involved negligible risk. The data published in this study have been restricted to xinjiang medical university in China. Using only this segment of data allowed to medical teaching study.

**The traditional teaching mode in Histology.** Histology studies the organism at the level of cells, tissues and molecules. Cell is the basic unit of body structure and function. It is composed of cells and the extracellular matrix. There are four types of tissues, namely epithelium tissue, connective tissue, muscle tissue and nerve tissue. The four basic tissues combine to form organs in different types, quantities and modes. In the early stage of histology learning, the four major organizations should be first learned and then transferred into the learning of various systems. The systematic learning is dominated by organs. For example, the circulation system should learn the structure of heart, arteries, veins and capillaries. According to different system, students are required to learn and master about structures of 50 organs, In previous, most students learn the microstructure and related functions one by one. This is difficult for beginner medical students. In the process of learning, it is easy to forget, memory is not strong, the impression is not deep and so on. As showed in Figure 1.

**The BBL teaching mode in Histology.** BBL teaching model is a learning method based on barrier structure, which is specific for histology learning. How to quickly grasp the key content of histology. Traditional learning methods are sequential, memory instability, poor relevance; BBL has specificity, stability, and good relevance.

There are numerous and varied of barriers in the human body, distributed in various organs and tissues. According to the different location, barriers can be divided into two categories:(1) Barriers between the body and external environment, such as skin mucous barrier. Skin barrier, which is composed of sebum membrane, keratin in the stratum corneum and lipid, can prevent moisture diffusion and protect against inflammation. (2) Barriers between the body's own organs, tissues, or material, such as blood-brain barrier, blood-thymus barrier, blood-testis barrier, blood-air barrier, and filtration barrier. This type of barriers generally is composed of capillaries and related structures. Capillaries consist of endothelial cells, basement membrane, and a small amount of connective tissue. In different organs and tissues, capillaries, combining with their structure, formation barriers. Just as blood-brain barrier, continuous capillary endothelium,

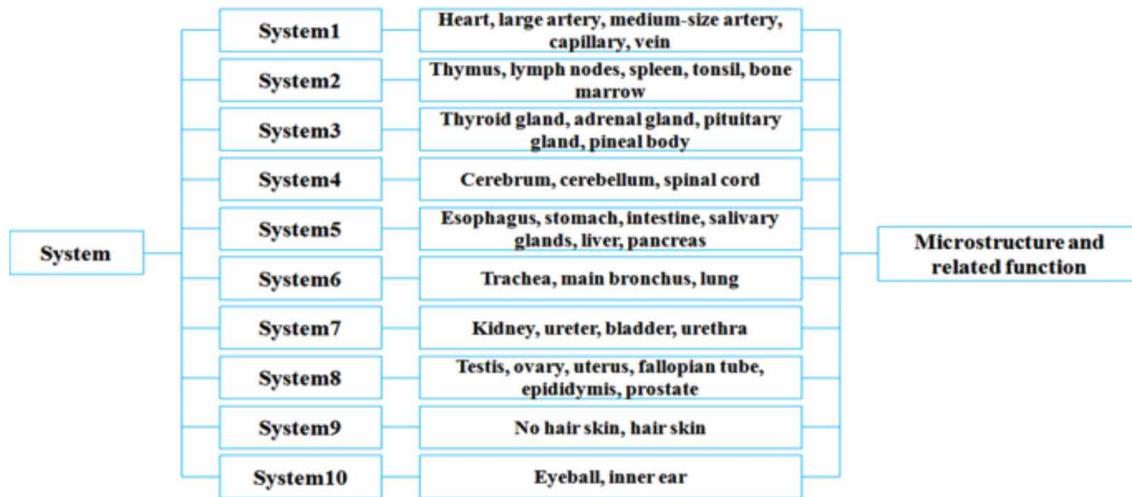


Fig. 1. The traditional teaching mode in Histology.

basement membrane, pericyte, and astrocyte footplate make it up. Filtration barrier consists of endothelial cells and basement membrane of capillaries, and podocyte slit membrane. Capillaries and pigment epithelial cells form blood-retina barrier. This type of barriers is crucial to maintain the body's internal environment stable. It shows the capillaries in the circulatory system are the key structure of barriers.

**Barrier almost appears in each chapter.** There are blood-brain barrier, blood-retina barrier, and blood-aqueous barrier in nervous system. Immune system has blood-thymus barrier. Respiratory system has blood-air barrier, while urinary system has filtration barrier. Reproductive system has blood-testis barrier. The capillaries in each barrier belong to circulatory system and there is placental barrier in embryology. In the face of these barriers, the beginners in medical domain can be confused easily. Therefore, how to sort out and contrast so many barriers, in order to make students master organization structures distinctly and connect as well as distinguish each system organically, is a challenge. In the process to teach students, in the first place we should make them clear that capillaries are the center of the barriers. So there are capillaries as long as barriers exist (except for skin and mucosal barriers). Therefore it has endothelial cells and basement membrane. After that, each specific system has dependency structures. There are neuroglial cells in the nervous system, thymic epithelial cells in the immune system, alveolar epithelial cells in respiratory system, podocytes in the urinary system, and sustentacular cells in the reproductive system. Through vertical and horizontal comparisons of above barriers, students could have profound knowledge about the structures primarily. Then centering on the barriers, students could learn divergent thinking, so

as to understand the constitution of every system, organ, and tissue. For instance, in the nervous system, major tissue components are nerve cells and neuroglial cells. The functions of nervous system depend on nerve cells and barriers are able to protect nerve cells. So it is neuroglial cell that participates in barriers. There are many kinds of neuroglial cells, including astrocytes, microglial cells, oligodendrocytes, and ependymal cells. Every type of them has different morphological structures and various functions. Only astrocytes take part in the formation of barriers. Regarding barriers as the center and thinking creatively, students could be sure to include primary structures in each system. Structure is the basis of the function. We can see from the comparison in Figure 2 that continuous capillaries exist in blood-brain barrier, blood-thymus barrier, blood-air barrier, blood-testis barrier, and blood-retina barrier, while fenestrated capillaries exist in filtration barriers. So there are differences between their permeability and functions.

The barriers which are formed of continuous capillaries mainly prevent certain macromolecular substances from entering into tissues and maintain the stability of internal environment. However, different kinds of translocators, from endothelial cells of blood-brain barrier, are unobstructed enough for most of the nutrient substance and metabolite to get through. Blood-air barrier and placental barrier mainly come down to exchanges of substances. Blood-air barrier is a place that main for air-exchange, while placentas are for the nutritive materials and metabolism between mother and fetus. At the same time, placental barrier, mucus-bicarbonate barrier, and mucocutaneous barrier all have separating effect. Mother and fetus are barred from placental barrier in order to prevent rejection. For gastric membrane, mucous-HCO<sub>3</sub>-barrier is an effective shield

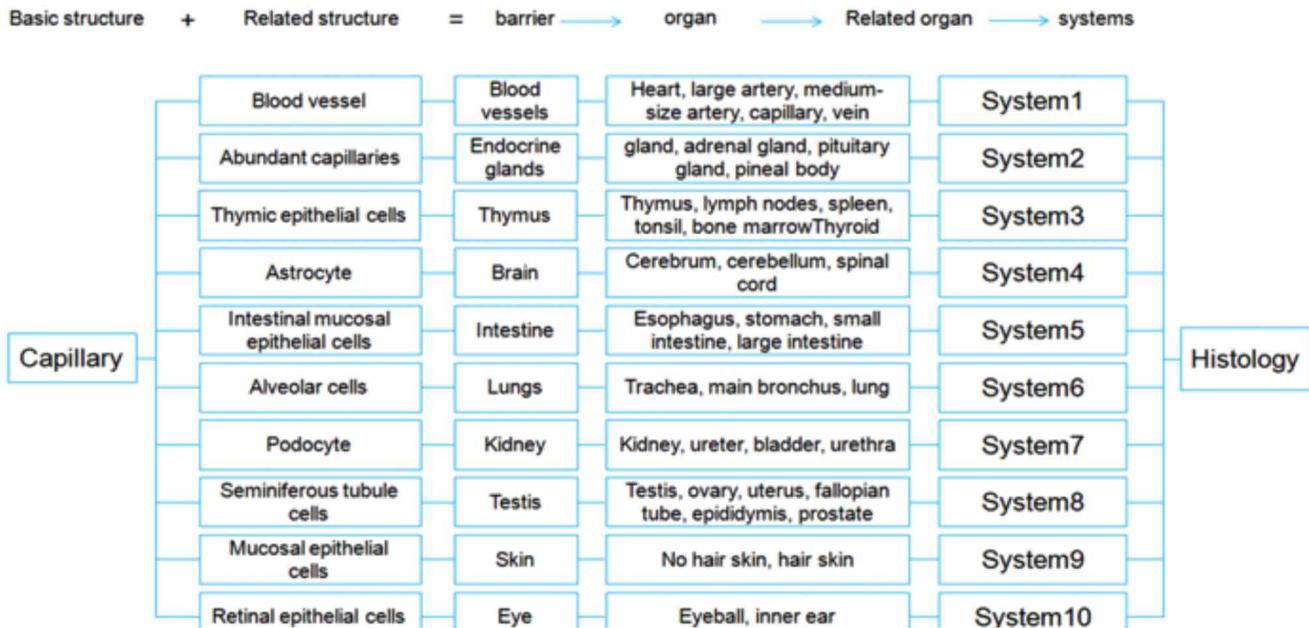


Fig. 2. The BBL teaching mode in Histology.

against corrosion from hydrochloric acid. Mucocutaneous barrier makes body and external environment separated. It is able for filtration barrier to screen the substances that molecular weight is below 70 kD, such as water, polypeptide, glucose, and carbamide. Filtration barrier can also save plasma Protein (Langer *et al.*, 2010; Paulsen *et al.*, 2010). Being acquainted with structures and functions about barriers, students could realize that a body is a organic whole.

Barriers, with general character and individuality, primarily maintain internal environment homeostasis, ensure body to operate normally, keep substances balanced, protect our bodies, or be positive for human generation, development, and physiological status. Any dysfunction would lead to diseases. Taught in this way, students would learn more systematically, would draw inferences, and would bring together all the individual parts of the course.

## RESULTS

**The evaluation of phase test.** The average score of every phase test in clinical class 1 (7 years) was higher than that of clinical medicine (5 years), The number of students with excellent scores was 7-12 times higher than that of the latter. Besides, compared in longitudinal, The phase test results in these two classes showed the number of pass students, excellent students in both class with an increasing trend (Table I).

**The evaluation of final examination.** In the final examination, the average score, pass rate and excellent rate ( $\geq 80$ ) were higher in BBL group than traditional teaching mode group in the clinical medicine class 1 (7 years). Consistent with clinical medicine (7 years), in clinical medicine (5 years) class 1 also demonstrated that BBL group is superior to traditional teaching mode group. Moreover, the clinical medicine (5 years) class 1 is lower in the average score, pass rate and excellent rate than clinical medicine class 1 (7 years) (Table II). These results show that BBL teaching method is more effective than traditional teaching mode in histology (Table III). Furthermore, this teaching method effect is related to the student's foundation.

## DISCUSSION

**Histology belongs to morphological courses.** Researching the relationship between normal microstructures and functions, observing sections, reading light and electron microscopic sections, and describing them correctly, are basic skills for teachers to work (Kumar *et al.*, 2006; Mione *et al.*, 2016). How to connect the scattered knowledge is especially important. In traditional teaching mode, We usually learn the histology based on organs and systems. For example, four type of tissues formed digestive organs, and similar organs form digestive system, are all connected to assimilation. When we learn based on organs, we usually

Table II. Score analysis on evaluation of BBL method teaching mode.

N	Performance		Barrier-based learning group	
			clinical medicine class1 (7 years)	clinical medicine class1 (5 years)
	first phase	average scores	66	67
		≥60	68.54	45.88
		≥80	50	9
			12	1
	second phase	average scores	73.43	54.31
		≥60	57	30
		≥80	16	2
	third phase	average scores	76.71	58.25
		≥60	65	28
		≥80	22	2
	forth phase	average scores	84	61.85
		≥60	65	37
		≥80	36	5

Table III. Analysis on medical students' score in histology.

	Clinical Medicine (7 years)		Clinical Medicine (5 years)	
	Traditional teaching group (n=68)	Barrier-based learning group (n=66)	Traditional teaching group(n=64)	Barrier-based learning group(n=67)
Final exam (average scores)	68.71	77.26	62.12	68.71
pass rate (≥ 60)	79.41%	92.42%	54.84%	79.41%
excellent rate (≥ 80)	20.59%	46.97%	9.67%	20.59%

describe and classify them by hollow or parenchymal organs. It is easy to distinguish each chapter, but hard to connect other chapters.

The breakthrough point that treats barriers as clues is an effective, available teaching method. Because barrier refers to most chapters of histology and embryology. To learn capillaries, the core structure of a barrier, which is the component of circulatory system, we should learn the tissue structure, component, layering of circulatory system and distinctions between organs. Capillaries exists in each barrier, so we should connect in our mind to learn more. For instance, blood-thymus barrier in immune system, consists of continuous capillary endothelium, basement membrane, macrophage, basement membranes of epithelium, and neurite of thymic epithelial cells. After mastering the structures, we can learn immune system adequately. Next we can spread to other chapters, such as nervous system, respiratory system, urinary system, reproductive system, eyes and ears, embryology.

During the teaching process, teachers should guide students to establish the model, of which barriers are the core, in order to make teaching process more targeted and scientific. Using this method helps students to contact chapters, distinguish chapters, and grasp knowledge.

The first problem that medical students faced is substantial professional knowledge which is strange and needs to be memorized. Not only knowledge itself, but also how to study should be taught to students. Teach him to fish. In histology and embryology, there are disperse knowledge points, a great deal of conceptions and terms. To know these knowledge well, we should connect them in the mind instead of memorizing mechanically. Barrier-based learning is a suitable way. Barrier itself is a keynote in histology and embryology. If we generalize all barriers, find their generality and individuality, diverge to each chapter, there will be a clear thinking about histology and lighten the load for students to have a firm grasp. After application of BBL method in histology, it showed that the average score,

pass rate and excellent rate were higher than traditional teaching mode in histology in the final examination.

In short, learning barrier structures can not only help to master most basic structures in histology, but also extend to clinical knowledge. The proposal of the learning method, treating certain knowledge point as the core, promotes us to think deeply, take cognizance of the dialectical unity between structure and function in histology, chain morphological structure and physiologic function together, bring knowledge together and understand thoroughly, gain a complete and systematized idea. It helps students to think and analyze problems scientifically by related questions. We will train students for profession, as well as give them an insight into the importance of basic medicine.

## CONCLUSION

This study shows that BBL teaching method is superior to previous traditional teaching mode in histology. A good teaching and learning method are the main drivers of learning outcomes for students in a histology course. However, the foundation of student has a significant additional impact on learning outcomes.

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**RESUMEN:** La histología es una disciplina de la morfología médica. El conocimiento es disperso y abstracto en esta disciplina. Es una asignatura que resulta difícil para los estudiantes principiantes de medicina. Este estudio tuvo como objetivo presentar a los estudiantes de medicina la histología mediante el método de aprendizaje basado en barreras (BBL), comparándolo al método de enseñanza tradicional. Reclutamos estudiantes de 4 clases de medicina clínica, incluidas dos clases de quinto año y dos clases de medicina clínica de séptimo año, cada una de estas clases asignadas al azar a los grupos. El grupo de control recibió un método de enseñanza tradicional de introducción en histología. El grupo experimental recibió el método BBL. Usando los puntajes promedio del examen final, la tasa de aprobación, las tasas de excelencia y las pruebas de fase para evaluar el efecto de enseñanza de estos dos métodos de enseñanza, se determinó que el método de enseñanza de BBL es más efectivo que el método de enseñanza tradicional. La aplicación de BBL en histología permite un aprendizaje más sencillo para los estudiantes principiantes de medicina.

**PALABRAS CLAVE:** Educación médica; Histología; Aprendizaje basado en barreras; Método de enseñanza.

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