

2014

# BioTechnology

*An Indian Journal*

FULL PAPER

BTAIJ, 10(19), 2014 [11194-11199]

## Research of introducing cell membrane into the teaching of human anatomy and physiology

Weiguo Kang

Department of Life Sciences, Heze University, Heze, Shandong, 274015, (CHINA)

### ABSTRACT

Human anatomy and physiology is one of the important courses in higher education. For students majored in medicine, it is a foundation course, which must be mastered firmly so as to complete their further study of relevant clinical knowledge; for students majored in biology, being masterful of which also constitutes the necessary condition for teaching this course in the future. Cell membrane, being the basic and important knowledge of human anatomy and physiology, how much a student masters its structure and characteristics always determines the degree of the understanding of subsequent chapters; it may be said that, only by mastering the structure and characteristics of cell membrane can one truly understand subsequent chapters where roles of cell membrane are related, and it is the necessary condition for mastering knowledge of cell membrane. However, students do not have right method of learning at their initial contact with this course, which itself is relatively hard to learn, and this leads to the fact that most of them can barely understand it by part with time-consuming efforts: it is unrealistic for students to be versed in it voluntarily in a short period. Therefore, the instructor should pay attention to the method of teaching, and make connections between cell membrane and knowledge points related in relevant chapters of human anatomy and physiology in daily work. As an instructor engaged in the teaching of human anatomy and physiology for many years, after summing up my own experience and reading lots of related literature, the author writes this paper with the intention of exploring how to better connect cell membrane with knowledge points related in relevant chapters of human anatomy and physiology, so as to effectively improve teaching quality of this course.

### KEYWORDS

Human anatomy and physiology; Higher education; Research of teaching method; Cell membrane.



## INTRODUCTION

Human anatomy and physiology is one of the important courses in higher education. For students majored in medicine, it is a foundation course, which must be mastered firmly so as to complete their further study of relevant clinical knowledge; for students majored in biology, being masterful of which also constitutes the necessary condition for teaching this course in the future. Cell membrane, being the basic and important knowledge of human anatomy and physiology, how much a student masters its structure and characteristics always determines the degree of the understanding of subsequent chapters<sup>[1]</sup>. As an instructor engaged in the teaching of human anatomy and physiology, after summing up my own experience and reading lots of related literature, the author writes this paper to research and analyze what should be done for making reasonable connections between cell membrane and relevant knowledge points of human anatomy and physiology.

**Focus On The Teaching of Basic Knowledge; Make Student Master Structure and Characteristics of Cell Membrane**

As human anatomy and physiology being itself an important course in higher education, for students whose major is medicine or biology, they have often gotten certain knowledge in middle school and from foundation course(s) taught at university, rather than learning this course from scratch. So, the instructor may skip the composition of organelle to a reasonable extent in explaining knowledge of cell's basic structure, while, in courses where relevant contents of nuclear structure and so on are taught, explanation should be conducted more towards basic structure and characteristics of cell membrane.

In explaining structure and characteristics of cell membrane, the instructor may emphasize following points according to the syllabus: (1) ion channel of cell membrane: as barrier and portal of materials within and without cell, cell membrane serves basically as the main channel of exchanging internal and external ion concentration, i.e., the ion channel in cell membrane, and which includes: voltage-gated ion channel, chemically-gated ion channel and mechanically-gated ion channel etc. These channels play important roles in forming resting potential and action potential of cell, and guaranteeing the normal operation of bioelectric behaviors;(2) ion pump of cell membrane: ion pump and ion channel function in coalition to maintain the stability of cell membrane potential; main ion pumps are Na-K pump, cytological basis of action potential's repolarization, proton pump,  $\text{Ca}^{2+}$  pump, basis of skeletal muscle's contraction and so on, and they work together with ion channel in regulating bioelectric activities of human body; (3) receptor of cell membrane: receptor on cell membrane is the basis of signal transmission between cells; specific target cells are endowed with characteristic receptor(s) of cell membrane, which, combined with materials such as antigen, drugs, neurotransmitter and hormone, can facilitate the change of cell's synthetic function and structure, and coordinate the different functions of human body<sup>[3]</sup>.

## UNDERSTAND THE CONNECTION BETWEEN CELL MEMBRANE AND RELEVANT KNOWLEDGE POINTS OF HUMAN ANATOMY AND PHYSIOLOGY

Cell membrane, being the basic and important knowledge of human anatomy and physiology, how much one masters its structure and characteristics always determines the understanding of following chapters.

(1) Knowledge points of kinetic system are skeletal muscle movement, impulse conduction, nerve and joint, and its mechanism is the formation of excitation.

(2) Knowledge points of sensory system are vision and audition, and its mechanism is the formation of vision.

(3) Knowledge point of blood physiology is surface antigen of red cell membrane, and its mechanism is blood coagulation.

(4) Knowledge of circulatory system is cardiac electrophysiology, and its mechanism is the transportation of nutritive materials by epithelial cells of small intestine.

(5) Knowledge of digestive system is small intestine's nutrient absorption, and its mechanism is the electric activities of myocardial cells.

(6) Knowledge point of endocrine system is hormone, and its mechanism is how hormone acts on target cells.

### Cell membrane and bioelectric activity

#### Cell membrane potential

Membrane potential includes resting potential and action potential of cell membrane, which are the basis of cell's electric activities. Owing to resting potential of cell membrane and equilibrium potential of  $\text{K}^+$ , the permeability of cell membrane under resting state is rather low with respect to  $\text{Na}^+$ , and it is right the reverse case with  $\text{K}^+$ , for corresponding channels on the membrane are opened. Concentration of  $\text{K}^+$  within the cell is higher than that without due to regulating effect of  $\text{Na}^+\text{-K}^+$  pump, and  $\text{K}^+$  passes through ion channel along concentration gradient, which results in the fact that cell membrane being negative and positive respectively on its inside and outside surface, forming potential gradient with outside high and inside low. Resting potential forms when these two gradient forces are at balance with each other<sup>[4]</sup>. Resting-action potential of cell membrane means that, on the basis of resting potential,  $\text{Na}^+$  channels open after cell membrane receiving suprathreshold stimulus and lots of  $\text{Na}^+$  flow inside, which leads to the depolarization of cell or repolarization when  $\text{K}^+$  flows outside, thus forming an action potential. Resting potential and action potential of cell membrane are both connected with knowledge of ion channel and ion pump etc on cell membrane, in preceding chapters, and that of cell electric activities of skeletal muscle cells and myocardial cells, in following chapters, therefore, allocation of some time for review preceding

chapters will contribute to the mastering of this part, as is the case with reasonable extension, by which students can make further study. The formation of action potential is shown as Figure 1.

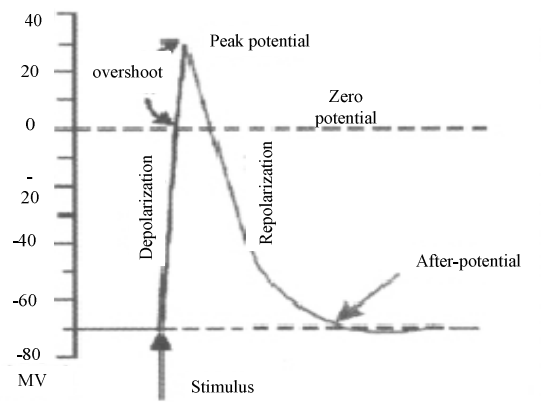


Figure 1 : Formation of action potential

**Electric activity of skeletal muscle**

Systolic and diastolic motion of skeletal muscle are indispensibly connected with corresponding electric activities, which is intimately connected with the formation of resting potential and action potential of cell membrane and can be interpreted as special resting potential and action potential. In teaching this part of the course, the instructor should focus on reviewing relevant knowledge of resting potential and action potential of cell membrane, for which presents as a good opportunity for promoting students’ understanding of bioelectric activities besides review of knowledge; according to my years of teaching experience, many students, after learning electric activities of skeletal muscle, can get a deeper understanding of structure characteristics, resting potential and action potential of cell membrane, and may even have the feeling of seeing the blue sky which was shadowed within mist and cloud.

The formation of skeletal muscle’s resting potential is the same as that of normal cell membrane, however, the instructor still should make explanation of which rather than dismiss it out of convenience. In explaining the formation of skeletal muscle’s action potential, difficult and important parts come first, but not without combining them with knowledge of preceding chapters, for instance, the formation of action potential also requires a stimulus above threshold value, which, however, is specific<sup>[5]</sup>, and it comes from neurotransmitter of nerve cell’s presynaptic membrane; voltage-sensitive  $Ca^{2+}$  channels on cell membrane, after the formation of action potential, will open and  $Ca^{2+}$  flows inside: increased concentration of  $Ca^{2+}$  will facilitate the opening of  $Ca^{2+}$  channels on sarcoplasmic reticulum, an internal organelle of cell, which in turn increase concentration of  $Ca^{2+}$  within muscle cell; combination of  $Ca^{2+}$  and troponin further initialize mutual shortening movement between thin and thick myofilaments(Figure 2). And the series of changes lead to the contraction of muscle.

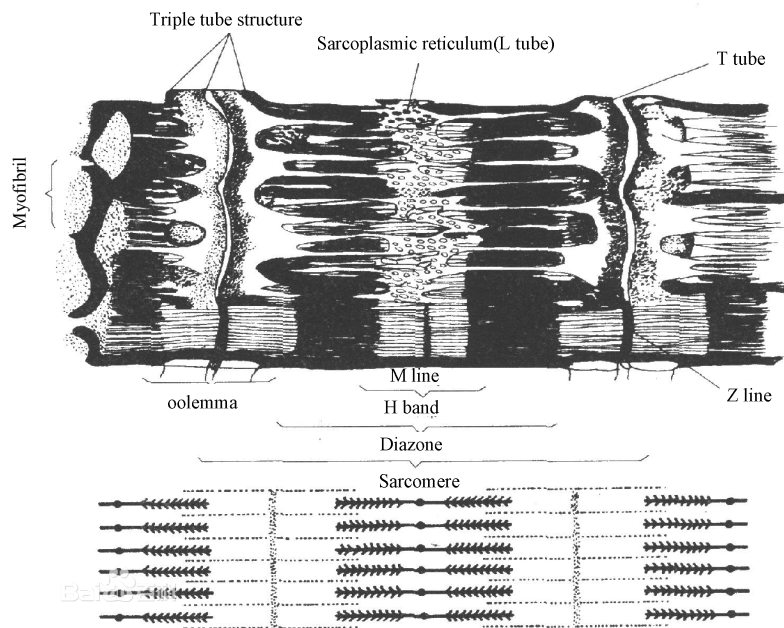
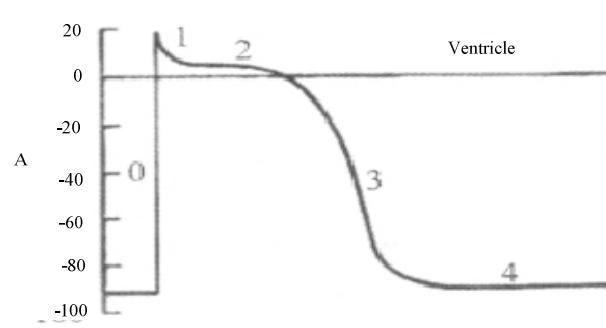


Figure 2 : Diagram of thick and thin my filament

### Electric activity of myocardial cell

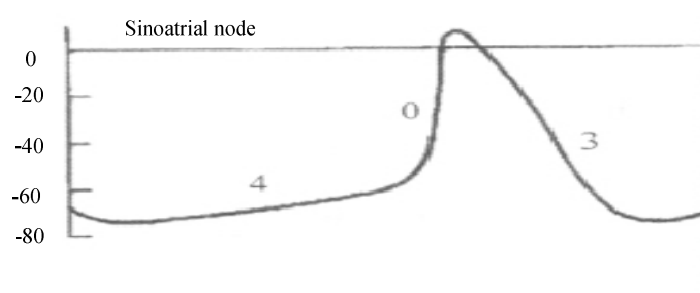
Electric activity of myocardial cell is another application of resting potential and action potential of cell membrane after that of skeletal muscle, and it can be interpreted as the formation of special resting potential and action potential of cell membrane. The instructor, in teaching this part of the course, should pay attention to the review of relevant knowledge of resting potential and action potential of cell membrane, for which presents a good opportunity of promoting students' understanding of bioelectric activities besides knowledge review itself. Formation of myocardial cell's electric activity is the same as that of normal cell membrane, and the instructor should make re-explanation rather than omitting it out of convenience, ensuring that repeated review contributes to improving memory thereof. Skeletal cell can be divided into myocardial working cell and autorhythmic cell, according to its character and function, and these two kinds of cells differ in action potential<sup>[6]</sup>.

Action potential of myocardial work cell (Figure 3) divides into four main stages, and phase zero of depolarization:  $\text{Na}^+$  channel opens when stimulus above threshold value acts on skeletal cell, which is also termed as fast  $\text{Na}^+$  channel as its opening and closing speed are both fast, and  $\text{Na}^+$  flows inside; phase 1 is fast repolarization, when a transient inflow of  $\text{Na}^+$  occurs; phase 2 is plateau, main currents during which time are inflow of L-type  $\text{Ca}^{2+}$  current and outflow of delayed rectifier potassium current; phase 3 is last phase of fast repolarization, which is formed due to the weakened inflow of  $\text{Ca}^{2+}$  and enhanced outflow of  $\text{K}^+$ ; phase 4 is resting phase, when cell membrane returns to resting state, which is primarily due to effect of  $\text{Na}^+-\text{Ca}^{2+}$  exchanger and  $\text{Na}^+-\text{K}^+$  pump on cell membrane.



**Figure 3 : Myocardium action potential**

Myocardium autorhythmic cell is mainly comprise of sinoatrial node cell and atrioventricular node cell; I here shall focus on introducing the action potential of sinoatrial node cell (Figure 4), which reaches repolarization potential at the last phase of repolarization-membrane potential of phase will start repolarization immediately rather than staying at that potential-its ion mechanism is of weakened outward current and enhanced inward current, having the tendency of increasing with time, and new action potential will outbreak randomly when repolarization reaches certain level. The excitation whose transmission will further lead to the excitation of whole myocardium, which forms the ion basis of myocardium cell's spontaneity.



**Figure 4 : Action potential of sinoatrial node**

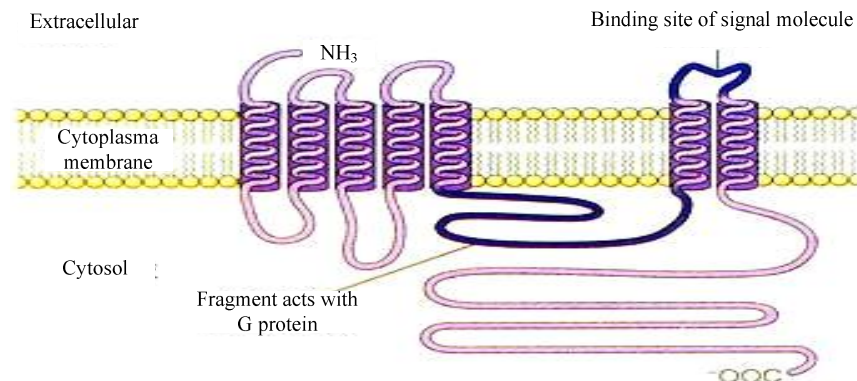
Action potential of myocardial work cell and autorhythmic cell forms quite differently from that of normal cell membrane, which constitutes new-difficult-key part of explanation; allocation of some time for reviewing will help student better understand it, and reasonable expansion is good for further study thereof. I believe that, through repeated review of relevant knowledge of resting potential and action potential of cell membrane, on the instructor's part, and further understanding of the formation of skeletal muscle's action potential, on student's part, it will be not hard to master knowledge of this part. It may be said that, when student can understand action potential of myocardial work cell and autorhythmic cell to a good extent, he or she then gets a firm grasp of cell bio-electricity, which also testifies to the success of instructor.

### Cell membrane & neurotransmitter and its physiological function

We can, through the learning of above knowledge, find out that: action potential occurred in cell's bio-electric activities is primarily formed out of stimulus above threshold value, which, however, is realized through cell membrane and neurotransmitter as research has told us. Self-learning contents of human anatomy and physiology illustrate what shall be taught about cell membrane, neurotransmitter and its physiological function; students, while learning by oneself, need to know that contacts between nerve and muscle will lead to the formation of structure of neurotransmitter junction, which connects knowledge of nervous system and muscle movement to a certain extent; the instructor lets students have a profound understanding of why skeletal muscle has voluntary movement while muscle does not, so as to make them achieve a thorough understanding of the whole book.

### Cell membrane and hormone

As the function of hormone relies on specific structure(s) on cell membrane, in teaching corresponding chapters on hormone, it is of necessity to involve relevant knowledge of cell membrane. Mastering the connection between cell membrane and relevant knowledge of hormone contained within human anatomy and physiology, at this point, will not only help students get a deeper understanding of hormone's mechanism, but also review and consolidate related contents of cell membrane, thus knowing the how and why. For instance, hormone is kind of material, with efficient biological activity, secreted by endocrine system of human body, and it mainly includes: estrogen, progestational hormone, growth hormone, thyroid hormone and so on, which control all biological activities of human body, however, their mechanisms are mostly the same, mainly including: hormone of specific function is secreted through the combination of some big endocrine glands and sporadic endocrine cells; hormone is transmitted to target cell through blood circulation; what's currently considered as capable of acting on receptor on cell membrane is G-protein-coupled receptor (Figure 5), which, through the act of second messenger within cell, will initiate a series of change of cell, such as promoting cell growth and accelerating cellular metabolism. Knowledge mentioned is intimately connected with basic contents of cell membrane<sup>[7]</sup>.



**Figure 5 : G-protein-coupled receptor**

### CONCLUSION

Human anatomy and physiology is one of the important courses in higher education. For students majored in medicine and biology, being masterful of which constitutes the necessary condition for learning and teaching this course in the future. As students do not have the right method of learning at their initial contact with this course, which itself is relatively hard to learn, most of them consider that it is not easy to learn and master. On the basis of summing up my own experience and reading lots of related literature, I come to the conclusion that, making connections between cell membrane and relevant chapters of human anatomy and physiology can effectively improve teaching quality of this course.

In specific teaching work, the instructor can make connections between cell membrane and relevant chapters of human anatomy and physiology from following aspects: focus on the teaching of basic knowledge, and let students get a firm grasp of structure and feature of cell membrane, including: ion channel, ion pump and receptor; knowledge of cell membrane and bio-electric activity mainly include basic understanding of cell membrane potential, electric activity of skeletal muscle and myocardial cell, in explain which, the instructor must focus on reviewing the formation of resting potential of myocardial cell and skeletal muscle cell, and teaching the difference in the formation of action potential between them, thus making cross reference of what's recently learned and old knowledge and facilitating the study of students. In learning cell membrane, neurotransmitter and its physiological action by oneself, students need to know that contacts between nerve and muscle will lead to the formation of structure of neurotransmitter junction, which, to a certain extent, connects knowledge of nervous system and muscle movement, thus getting a thorough understanding of the whole book. Finally, cell membrane and hormone, the function of which relies on specific structure(s) on cell membrane, therefore, in teaching relevant chapters on hormone, it will necessarily involve relevant basic knowledge of cell membrane.

Through joint efforts of teacher and student, students will finally get a better understanding of the connections between cell membrane and relevant knowledge points of human anatomy and physiology, having a thorough understanding of the whole book, so as to effectively improve teaching quality of this course.

#### REFERENCE

- [1] Ruijuan Fu, Discussion on the teaching reform of *human anatomy and physiology* of psychology major in higher normal college[J], Examination Weekly, **10(17)**, 45-46 (2011).
- [2] Wen Chen; Exploration and research of experimental teaching system of human anatomy and physiology [J], Journal of Hulunbeier University, **4**, 16 -20 (2007).
- [3] Dan Zhu; Some thoughts and teaching experience on the teaching reform of *human anatomy and physiology*[J], Science-Technology Information, **12(11)**, 78-79.7 (2012).
- [4] Keli Liao; Exploration on teaching method of *human anatomy and physiology* of psychology major[J], Journal of Sichuan College of Education, (**22**), 22 (2006).
- [5] Feihua, Wu, Jieyun, Jiang, Yuanyuan, Xuan; Improve experimental teaching quality of human anatomy and physiology[J], Journal of Nanjing University of Chinese Medicine, **16(03)**, 64-65 (2010).
- [6] Dan Zhu; Some thoughts and teaching experience on the teaching reform of *human anatomy and physiology*[J], Science-Technology Information, (**1**), 193 (2008).
- [7] Shaopu Yan; Research on curriculum reform of *human anatomy and physiology* for students not majored in biology in normal college[J], Journal of Shaanxi Normal University, **34(3)**, 254-256 (2006).
- [8] Lirong Fu; Trial exploration on teaching reform of human anatomy and physiology[J], Journal of Biology, (**4**), 55 – 57 (2005).