# Teaching cell biology in a medical course in China: Applying appropriate methods

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## Abstract

With the current framework of teaching quality reform in higher education, this paper will review the current curriculum of a cell biology course and the ways in which it has been taught in the medical college of Xi'an Jiaotong University. Reasons for introducing new teaching methodologies to improve student-centred learning and self-directed learning will be discussed and three possible approaches which are considered more suitable for the large classes of first year students in cell biology will be considered: case study, team work and concept. The proposal will also make a case for the urgent development of an online student-centred learning environment, including possible activities that would be included in the course. A combination of multiple teaching approaches is necessary for changing students learning from surface learning to deep learning, passive learning to active learning, over-dependent learning to independent learning, and developing students in the 'generic skills' of a scientist and the skills for 'lifelong' learning including problem solving skills, communication skills, and cooperative skills.

## Introduction

Cell biology is an important basic subject of modern life sciences, consisting of fundamental life activities of the cell at the microscopic, submicroscopic and molecular levels. The cell is the basic unit of living things, with all of the activities of life taking place in the cell and with diseases also due to abnormal changes of cells. Thus, medical cell biology is a basic course for the first year students in the medical college at Xi'an Jiaotong University (XJTU). The course focuses on the function at a cellular level and favours the molecular perspective. Topics in the course include two main aspects: one is structure and function of the cell and its organelles, the other is the important activities of the cell and their regulating mechanism, including metabolism, growth and reproduction, cell cycle, cell division, differentiation, cell aging and cell death, apoptosis, signal transmission, evolution, and embryonic development. With the more recent developments in molecular biology, numerous molecular concepts and techniques are introduced into cell biology, so that it becomes difficult to cover all the content. One of the important aims of this course is to ensure that students have a good background in the major components of animal or human cells so that they are prepared for more advanced study. This is important for the professional courses involving histology, embryology, anatomy, biochemistry, molecular biology, genetics, and physiology. In addition, students need to become familiar with the basic skills such as microscopy, and those molecular and immunology techniques that are most widely used in the study of cell structure and cell function.

## Current teaching approaches

Cell biology is currently taught with lectures and laboratory classes. There are 30 hours of lectures and 24 hours of laboratory classes. There are 3 or 4 lectures per week for each course. The class size is limited to 100 students in each lecture group and 20-25 students in each laboratory class. There are about 25 laboratory groups per week.

### *Lectures*

The lecture is the main teaching approach in the course. The lecture gives the students a comprehensive introduction to the main knowledge of cell biology.

Although lecturers have tried different delivery methods, including multimedia, in their teaching, to stimulate student's interest in the course, and motivate them, the format is teacher-centred with passive learning taking place.

### *Laboratory class*
The major function of the practical course is to teach students many of the techniques used in cell biology and the contents of the practical course are related to the lectures so as to enhance the student's understanding and appreciation of the theoretical component of the course.

In the practical sessions, teaching staff usually begin each session with a brief introduction to the contents. Students work on the practical materials individually or in small groups, then write the practical report and think about some questions which is handed in for marking. The teaching staff is responsible for giving students feedback on their reports and giving an explanation of some questions.

### *Occasional tutorials*
There is no special time for tutorials. Teaching staff is usually present in the laboratories to help students as needed.

### *Assessment*
Usually we have assessment at the end of the semester, with 10% from the practical component. The examination paper has the following format: filling in the blanks; multiple choice questions; and short answer questions.

## Some issues to consider

### *Recent curriculum changes*
Up to three years ago the content of cell biology was included in a course called medical biology, which covered an introduction to the structure and function of cells, and some basic genetics. In addition there were courses of cell biology and genetics for medical students. To avoid repeating the work across different years, and to give students a more complete and systemic knowledge of the discipline, the University reviewed the curriculum and now offers cell biology and genetics separately for first year and third year students. This means that the cell biology course includes introductory and advanced knowledge. There is now an increase in content of cell biology, but with insufficient staff time available to support the students in developing independent learning strategies.

As a result of teaching the same content together to both first year students (with poor knowledge of cell biology) and second year students (with other related knowledge), the assessment of students indicates that the course is more difficult for the first year students.

### *Student background*
There are about 400 to 500 students each year. They come from different levels of high school and with different academic backgrounds. Some of the students have no interest in their studies but are doing the course because of the future job prospects or even the wishes of their parents. These students have less motivation. Many students neglect the basic courses in our medical college, instead they pay more attention to their other professional courses. For many students the sole purpose of their study is just to pass the examination.

First year students are in transition from a high school learning environment to the university learning environment. They have to get used to a different style of teaching and thus adopt a different style of learning. They find themselves in much larger classes and with much less staff support. More over the way Chinese students learn involves more passive learning and less researching and exploring than their western counterparts. The students tend to take notes following what the teacher is writing on the blackboard. Sometimes the students do not even know how to take the notes.

### *Insufficient materials of self-assessment*
Currently there is insufficient material available to enable students to self-assess their understanding of the content and concepts of the course, that is for students to check what they have learned and if they have mastered it or not.

### *Need for better communication between students and teachers*
Less communication between students and teachers leads to less feedback and understanding of each other, especially for large classes of first year students. Most of the students are too shy to ask questions in the class, and even after the class there are few students who will ask questions. It is difficult for the teachers to get to know the students very well and to find out how they are doing.

## Modifications for the future

We have been introduced to a number of theories of learning and ways in which we can teach science to encourage the development of deep learning strategies in our students. Contemporary teaching approaches in the sciences currently focus on student-centred activities, and how we can encourage students to develop lifelong learning skills. This is especially important in science with the current 'information explosion'.

The purpose of teaching is not to import content knowledge only, but to encourage the development of generic skills of a scientist (e.g. scientific writing, communication, computing, problem solving and experimental design, data handling skills and lifelong learning skills). Teachers need to reconsider what they will teach and must also understand how students learn. Encouraging a student-centred learning approach and helping students to develop their generic skills are urgent tasks for our teachers in China.

### *The use of online learning approaches for student-centred learning in biology in China*
One of the main ideas is to create a student-centred environment in which we can encourage the students to work independently of us but within a community of learners (Peat 2000; Franklin and Peat 1998). Good examples of electronic learning environments are the Virtual Learning Environment (VLE) in first year biology and the use of *WebCT* at the University of Sydney, which encourages student-centred activity and thus helps to promote learning. The VLE is an online resource that permits synchronous, collaborative interaction among teachers and students, and also provides asynchronous

learning resources for individual use by student at any time. A VLE can offer a learning system, made up of many components, with all the advantages of computer based learning but with the added advantage of access and use over the Internet, giving students access any time and from any place.

For large heterogeneous groups of students such as large first year classes, a VLE can be used to meet the needs of students with varying academic backgrounds and interests in the subject. The VLE offers students a flexible, self-paced, self-centred learning experience, allowing easy access to specific course materials, such as lecture notes, laboratory information, general course information and learning modules. In addition a VLE can offer links to external resources such as the university library web site, student services web sites, etc. and also offer communication to 'CyberHelpers' such as 'CyberTutor' (for academic help), 'CyberAdmin' (for information about admininstration matters) and 'CyberTech' (for technical computer support). For a university course, a Virtual Learning Environment can offer a place where much of the material for a course can be kept, managed and monitored and where student learning outcomes can be encouraged.

When I return to China I would like to introduce a VLE into my teaching. Of course, I believe this will be a difficult task for me to do. I will need to gain my colleagues' interest in this idea so that together we can collaborate to develop a VLE. In addition we will need to review the curriculum and introduce changes that will enhance student-centred learning.

In the first phase, I will:

- set up a web site for the biology course and show the students how to use the resources;
- develop multimedia resources that can be put on the web site such as lecture notes, *PowerPoint* presentations, images, audio and video;
- use the web site to communicate with students by email or using a chatroom, (and emphasise this as a way to offer feedback to students); and
- design modules to help students self-assess their understanding of content and concepts using the Sydney model of different levels of difficulty.

During this process of development I will have both students and staff evaluate the materials and designs so that the final resource will be of benefit to student learning.

## *Combination of multiple teaching strategies*

For teaching our course, I do not believe there is a single teaching method suitable. The methods will depend on the characteristics and content of the course. We should combine multiple methods of teaching together, using them appropriately according to the actual situation.

At present, we should retain the traditional teaching form – the lecture. Probably the most useful teaching and learning strategies that could be introduced into the lecture would be the use of case study scenarios and concept mapping. Activities such as teamwork, including poster preparation and presentation, are better introduced into the practical classes.

## *Use of case studies*

The use of case study scenarios is a very appropriate teaching method for the sciences which have been employed in western higher education for many years (Christensen and Hansen 1987; Barrows and Tamblyn 1980; McNair and Hersum 1954; Barrows 1986).

Case studies need to be real or imaginary stories dealing with real live situations so that the students can immediately relate to the 'story'. Case studies serve to illustrate facts, general principles and good practices. One of the values of the case study is to show great scientists in action. It is not so much to teach the content of science but to teach how the process of science works and its limitations and to develop higher-order skills of learning.

Case studies are extraordinarily flexible as a teaching tool. The use of a good case gives a teacher an immediate advantage. It is easier to hold a student's attention. Depending upon the case, teachers might employ different types of teaching methods such as thinking, discussion, and searching for more information. It helps the students work through the facts and analyse the problem and then consider possible solutions and consequences of the actions that they might take.

In cell biology, a good example of a case study is 'Dolly' the sheep. The case study could be presented as follows:

*News: The young lamb named Dolly was created by cloning at the Roslin Institut, February 24, 1997.*

*On February 24, 1997, a lamb named Dolly was born in the Roslin Institute in Edinburgh, Scotland. She looks like a rather ordinary lamb, but the news of her creation and photographs had made front pages around the world! Because of her startling pedigree, she is unlike any other mammal that has ever lived in the world. She is an identical copy of another adult and has no father. She is a clone! She is the first product of research in which complete genetic material from an adult mammalian cell has been used in the development of an identical new individual. That work has provided an important new research tool – cell cloning. (Beardsley 1997)*

When the case is put to students, it should stimulate their interest and encourage them to want to know more. The teachers can ask questionsto help students focus their attention on the issues to do with genetics and cell biology of the situation.

- What is the process of cell cloning?
- How is it done?
- Will cloning produce a greater diversity of genetic material in a species?
- Will cloning produce more or less genetic traits?
- Why or why not?
- What is the use of cloning?
- What is the present situation and how will it develop in future?
- Should cloning be allowed for animals?

- Should cloning be allowed for humans? If yes, this would mean that women could in principle reproduce without any help from men. Should this be allowed?

These questions can be used as an introduction about cell cloning and the process of it is given to students. By introducing the technique which involves several steps (Figure 1), students would learn many advanced techniques such as cell culture, cell selection, nuclear cell fusion, etc. which are widely used in modern cell biological researches nowadays. First, the donor cells are grown under special conditions in culture. In this way the number of cells can be increased by several orders of magnitude. It is also possible to make genetic modifications and to select just those cells in which the desired modification has occurred. The selected cells are then fused with an unfertilised egg from which the introduced nucleus can lead to the formation of an embryo. The embryos are then transplanted into female sheep and the lambs are born naturally. (Roslin Institute 1997)

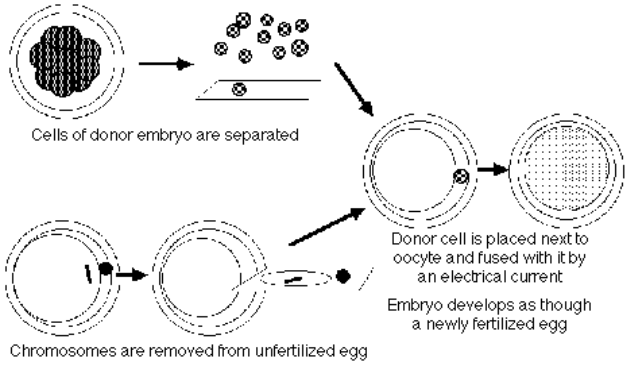


**Figure 1**. Cloning

After giving students the general principle of the technique, students can be left to work in groups to search for the answers. Students can then present their work in the next class and discuss it. Also students can be asked to discuss their own opinions on the future of this cloning technique.

## *Applications of teamwork – peer group activities*

It is well known that having students work in small peer groups, is one of the better ways to teach science (Webb 1989; Webb and Palincsar 1996) and this includes teaching science via case studies! The use of peer group learning scenarios helps to overcome any initial student reticence, fosters the development of good communication skills, and promotes positive social interactions within the peer group

Cooperative learning may occur in or out of class. In-class exercises may involve answering or generating questions, explaining observations, working through derivations, solving problems, summarizing lecture material, troubleshooting, and brainstorming. Out-of-class activities include carrying out experiments or research studies, completing problem sets or design projects, writing reports, and preparing class presentations. (Felder and Brent 1994)

## *Discussions in large classes*

Large group discussions can be an excellent learning tool, but how can we use them in a classroom? Most science teachers do not have the experience to run these types of classes. Preparation and control are the key ingredients. Teachers should use appropriate questions, body language, blackboard planning, and summarisation to make it all work. (Felder and Brent 1994)

A good example of this at the University of Sydney is the discussions held in large classes by Dr Peter McGee in the course Concepts in Biology. Peter's method is to give students a question during his lecture, and allow them to discuss amongst themselves for 10 minutes and then he lets students give their answers whilst he writes those he thinks are correct or relevant on to an overhead. He gives positive feedback and praise to the students and then finally gives a conclusion about the question.

Peter's method has advantages over just asking individual students a question. Asking students to generate answers in small groups, avoids the embarrassing silence of just asking one student, and makes classes much more enjoyable for both students and instructors. Most students – even those not doing much talking – will not feel threatened and are engaged in thinking about the question, instead of just mechanically taking notes from the slide.

Another example is to ask students to work in a team to generate questions and summarise the major points in a lecture. This is also a good way to encourage active learning in students.

## *Poster*

Poster work is another useful team activity for students. It is usually an out-of-class activity for a small peer group. Such activities help students to develop a deeper understanding of what they are learning, through cooperation with one another. In addition it helps them develop design skills and presentation skills.

There are other forms of teamwork like the peer group activity, e.g. by using interesting games to motivate students and generate active participation in learning and helping them to understand and consolidate what they have learned.

## *Use of concept mapping*

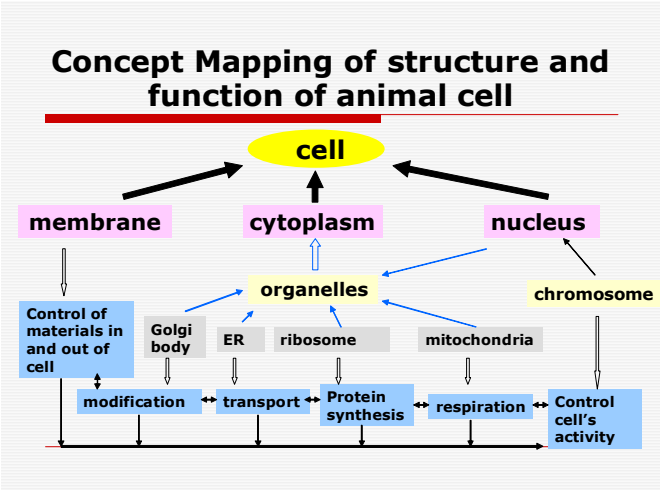


**Figure 2**. Concept map

Concept mapping is a technique for representing knowledge in a graphical way. There are many concepts in the course of cell biology. Students often get confused with the structures and functions of the different organelles in the cell, especially the relationship between them. Concept mapping is very useful teaching. It helps a teacher to work out what he or she wants the students to learn. Concept mapping can also be used by students to identify their level of understanding and promote deep learning (Novak and Gowin 1984).

Figure 2 is an example of concept mapping in cell biology: structure and function of animal cell. The map can be used by the teacher to indicate the various linkages between the content and concepts. Alternatively the teacher could ask the students to draw a concept map of the structure and function of an animal cell before the course and then again at the end of the course. This way the teacher can see how much the student has understood.

## Problems, challenges and possible solutions

To introduce changes into the teaching of cell biology may be difficult at first as there may be opposition to change. The challenge is:

- to get the staff to accept the new teaching direction;
- to introduce curriculum reform, especially methods of assessment; and
- to gain support and encouragement from senior management.

Firstly I will need to gain my colleagues' interest by giving seminars, talking and introducing what I have learned and seen in the University of Sydney so that together we can collaborate to new teaching methods. In addition we will need to review the curriculum and introduce changes that will enhance student-centred learning. Changes will need to be monitored by surveys, so that the feedback can be incorporated into the next changes. Most importantly, we need to get strong support and encouragement from senior management.

## Opportunity for the reform

Recently, the Ministry of Education launched the 'Higher Education Institution Teaching Quality and Higher Education Reform Project' aimed at upgrading the quality of higher education in China. It is a good chance for teachers and universities to consider introducing contemporary teaching strategies.

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