

Review



Tips for pharmacology teaching

Ahmad Mohammadi-Farani^{1,2*} 

¹Pharmaceutical Sciences Research Centre, Health Institute, Kermanshah University of Medical Sciences, Kermanshah, I.R. Iran

²Department of Pharmacology and Toxicology, Faculty of Pharmacy, Kermanshah University of Medical Sciences, Kermanshah, I.R. Iran

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Abstract

Pharmacology is a core and prerequisite course in major medical fields. In many academic centers, it is provided as a teacher-centered lecture course. In this article, I present twelve tips to help pharmacology teachers have more vital pharmacology classes. The tips are most useful for teachers who teach pharmacology as a traditional “preclinical” discipline and use lecturing as their main teaching method. Some of the tips presented can also be used for teaching in other lecture-based courses.

Background

Pharmacology is a basic medical science discipline that provides a scientific foundation for the next-coming therapeutic courses. It has intimate relations with other preclinical sciences like physiology, biochemistry and cellular biology.¹ Teacher-centered lectures are the core method for teaching pharmacology in medical schools around the world,² although lecturing is not the most effective form of teaching. This format is most often due to the large number of trainees, the great amount of information to be taught, and the limitation of time; thus, it remains the best option for most.³

For an effective presentation, teachers should organize educational content and use appropriate audiovisual aids to present their lecture. There are a lot of books and articles about the styles and skills of lecturing. Besides general requirements for lecturers, there are plenty of other strategies and actions that are obtained through experience. These help the lecturer present a more effective, vital and appealing lecture. The tips presented here are meant to help pharmacology teachers make their lectures more engaging and refreshing for students. Some of them are based on research on lecturing, and others are the authors’ personal viewpoints.

Tip 1: Avoid information overload

A serious challenge for many pharmacology teachers,

especially those who teach medical or pharmacy students, is that in every session they have to present a plethora of information for the students. It is beyond dispute that medical doctors or pharmacists should have a good grasp of the subject, but we should consider that an effective teacher is supposed to mine for their medical students the core concepts needed from the detailed voluminous and intimidating recommended textbooks intended for a wide range of health-related carriers.⁴ Moreover, consider that imposing an enormous amount of information on students does not guarantee they will leave the class with an in-depth knowledge of pharmacology and can contribute to confusing their selection of the basic material and/or push them into a feeling of helplessness among the huge torrent of information.⁵ According to Ogle, a competent academic is the one who “selects, integrates and teaches effectively those basic principles which are relevant to professional requirements”⁶

Tip 2: Provide handouts for the students

This is a simple and rather inexpensive tip that, according to research,^{7,8} has a positive impact on learning outcomes. Teachers who use PowerPoint slides in their lecture and are inclined to distribute handouts often use the printout of the slides as the format of the handouts. My own experience has shown that almost all students prefer to receive handouts. Those who take notes strongly

*Corresponding author: Ahmad Mohammadi-Farani, Email: amohammadifa@kums.ac.ir

support the idea and say that it is much easier for them to concentrate and learn the subject because the main headlines and framework of the agenda are in front of them, and they are less anxious about missing important points or being left behind while adding the details in their notes. According to Ian, a good handout should not be simply in the PowerPoint slide format because it may reinforce students' passivity. He believes that "a handout should be challenging and should complement rather than duplicate a PowerPoint presentation." He presents a few examples of how to make better handouts from PowerPoint slides.⁹ However, I believe that as far as a handout provides an agenda outline for the student, it is an educational assistance for both the trainer and the trainee in any format.

Tip 3: Open your lecture with a case scenario

Case presentation is a powerful pedagogical tool used by most clinical educators.¹⁰ In a preclinical pharmacology course it is often difficult for a teacher to make the most of a case presenting style, but based on my experience, it boosts students' motivation and captures their attention. Beginning a class with a case implies that whatever the educator is going to present will somehow be needed in near future. In other words, learners try to think about the clinical application of what they are learning. You can create a spirited discussion among students to promote engagement by asking appropriate questions about the best choices of drugs or possible adverse effects of medications in your presented case.

Tip 4: Arrange educational contents in graphical displays, review at the end

Students learn more efficiently when they know what they are supposed to learn. Teachers teach better as well. I think an experienced teacher should have a mental outline of the educational content and try to present the content in such a way that, if a student is taking notes, the notes will match the outline. When using PowerPoint slides to present a lecture, this outline can be shown to the students. Instead of using linear notes, the teacher can map out some information in the form of tree diagrams, tabular notes, line diagrams, etc.; the value of these graphical displays in teaching and learning is reviewed by Vekiri.¹¹

According to Madeline Hunter's "lesson plan model",¹² at the end of each lesson teachers should wrap up their lectures and make sure that students have grasped the big picture. Many teachers end their lectures suddenly and abruptly. But it seems that adding a summary slide is useful for learners especially if the subject is complex or if the teacher has had a long instructional period. Some pharmacology texts provide great insights for making a coherent ending for lecture slides.^{13,14}

Tip 5: Use more illustrations in your PowerPoint presentations

There are different types of visual aids with which to present a lecture. PowerPoint is the most commonly used software for presentations. Using good graphs or pictures in your PowerPoint presentation helps clarify concepts without long verbal explanations. Teachers often use illustrations selected from standard textbooks but these books can lack appealing pictures. Teachers can find clear, concise and engaging pictures from other written or electronic sources. It is also possible to blend pictures from different sources to get a complete view of the topic. If describing the adverse effect of, for instance, anti-muscarinic drugs, display an Internet search for each of the words (constipation, blurred vision, urinary retention, dizziness, increased intraocular pressure, etc.), and arrange the most vivid, descriptive and funny pictures on a single slide. I can say, from personal experience, that it is more memorable and persistent compared to displaying written words in a list. Besides countless online images, there are many helpful illustrated pharmacology books that can be used as reliable illustrative sources.¹⁵⁻¹⁷ Before using any images in your teaching material be sure not to violate copyright laws. The website (<https://www.copyrightlaws.com/legally-using-images>) can give you helpful advice on copyright issues. In internet searches, you can also specify usage rights to help ensure you are not violating copyright laws.

Tip 6: Try to interlink pharmacological concepts

Here the main idea is to use previous pharmacological knowledge to provoke pharmacologic thinking and reasoning. It helps students memorize and recall new topics. For example, when teaching adverse effects of drugs, we can always consider two categories of adverse effects: 1) those that result from known pharmacological consequences of drugs on different organs and 2) effects that do not result from known mechanisms of drug action. Teaching and learning the side effects of the first category is much easier through the interlinking strategy. Similar logic can be used for the concept of drug interactions.¹⁸

Tip 7: Use pathophysiological hints

In non-integrated discipline-based curricula, students often are required to pass basic courses such as physiology, biochemistry, microbiology, pathophysiology, etc before taking pharmacology classes. This means that the students should already know the fundamentals, and the educator can use the tools of higher learning levels of Bloom's taxonomy to teach pharmacological concepts to the learners. It means that the teacher should think of pharmacology as a higher-level skill (application of basics or analysis of relationships) to be introduced from lower-level skills (memorized facts and knowledge).¹⁹ This approach requires teachers to use frequent flashbacks

to learners' primary knowledge to refresh, expand and deepen their learning. Thus it is highly recommended to have an eye on basic principles like physiology and pathophysiology to teach pharmacology effectively. Based on this notion, the authors of some pharmacology books have tried to integrate pharmacological concepts with other fundamental medical sciences.²⁰⁻²³

Tip 8: Refer to evolutionary concepts

Evolution is a unifying theory in biological sciences and can be used as a framework in which biological information is arranged. Evolutionary principles may help medical students better understand health and disease.²⁴ Using evolutionary arguments to describe differences in drug response or receptor diversity is often very useful for postgraduate pharmacology students. An undergraduate pharmacology teacher can use relevant simplified evolutionary concepts as an opening or introduction to some subjects. Topics such as drug metabolism,²⁵ antibiotic resistance²⁶ and pharmacogenetics²⁷ are pharmacology subjects that can be easily intertwined with evolutionary explanations. Sometimes the teacher does not need to delve deeply into the subject, but this can open a new evolutionary viewpoint that will stimulate students' interest and invite enthusiasm and engagement. For example, when I am teaching the mechanism of action of pegloticase, a recombinant form of the enzyme uricase that converts the highly insoluble uric acid into more water-soluble and excretable 5-hydroxyisourate and is used in some patients with gout, having described that mammals in the ape family, including humans, are devoid of this enzyme and hence have higher serum uric acid levels and are more vulnerable to related health complications, I always bring up the question of the selective evolutionary advantages of this enzymatic defect in humans.²⁸ Generally, feedback shows that some students become very interested and have expanded their studies on this subject. In short, biological evolutionary issues can be used as incentives for additional readings on a pharmacological subject. Further readings often illuminate learning, invoke fresh interests and ideas and provide new angles for students to look at a topic.

Tip 9: Spice up your lecture with related historical anecdotes

Good lecturers should master a level of enthusiasm and motivation in their presentation.²⁹ One way is to spice up individual lectures through the inclusion of appropriate historical stories about different aspects of pharmacological topics. Probably almost every single sentence in a textbook of pharmacology, as in any other scientific textbook, has a deep history behind it. Sometimes these histories are both informative and entertaining and help take the "boring" out of your lecture. They also contain interesting clues about the importance of certain medications and how they have saved countless

people from death, improved our quality of life and helped us lead a happier and healthier lives. In addition, such stories can help students memorize drug applications or adverse effects. There are many books and articles from which you can find fascinating stories about drugs. Here are some examples of stories that I use in my lectures that have positive impressions on my students: (a) the story of penicillin discovery,³⁰ (b) the story of sulfonamide discovery and dawn of chemotherapy,³¹ (c) the history of thalidomide teratogenicity,³² (d) the story about digitalis-induced xanthopsia in the Dutch postimpressionist painter, Vincent van Gogh,³³ and (e) a short review of the scientific life of Alfred Goodman Gilman (Nobel prize laureate and one of the editors of the definitive textbook "*The Pharmacological Basis of Therapeutics*").³⁴ Have fun through exploring other medical history books which can give you countless other drug-based stories.³⁵⁻³⁸

Tip 10: Suggest mnemonic devices, use generic name stems, and other creative tips for better learning

In talking to my colleagues, some of them believe that mnemonics and other similar ways are out-of-context learning strategies that should not be offered by teachers in classrooms because it may lead students to a superficial learning style. It may be true if you try to use mnemonics as a shortcut to understanding the concepts. However, there is no harm in using MONA (morphine, oxygen, nitroglycerin, and aspirin)³⁹ to memorize the initial management of patients with suspected acute coronary syndrome when you understand the underlying cause of their usage. Sometimes you can search the Internet to find creative examples of mnemonics. You can also come up with your own silly or clever types.

Generic names of drugs usually indicate the class of drugs to which they belong.⁴⁰ For many drugs, considering generic name stems is a good way to facilitate memorizing drug names and differentiating their classes. For a full list of drugs and their stems, refer to the National Library of Medicine Drug Information Portal (<https://druginfo.nlm.nih.gov/drugportal/jsp/drugportal/DrugNameGenericStems.jsp>). Due to the shortage of time and the large volume of other necessary information, stems are useful for those drugs that may be confused with other sound-alike and/or look-alike drugs.

About the extent of using suggestions under this tip, I believe that we should neither forget about nor overindulge in using them in our lectures.

Tip 11: Use available social media

Along with theories and strategies of learning, educational tools are also changing. A teacher needs to learn about them and implement them for the benefit of the students.⁴¹ Even for a lecture-based discipline, social media can be used in a variety of ways to engage students and create a more active learning environment. As a very simple personal experience, I have created a group chat in

Telegram and added all my students to the group. Here are some examples of easy, provocative activities in this group: the night before each lecture I post the title of the next day's lecture. Sometimes I draw their attention to specific subjects by putting appropriate questions or presenting real cases to them and ask them to discuss it. I use the platform to send tips for better learning or memorizing pharmacology topics. I send links to proper movies, articles and educational sites.

Based on the teacher's creativity and tastes many other educational activities can be done in such a group but from my own experience, it should be done in such a way that it does not require a long investment of time each day to keep it more practical and durable.

Tip 12: Be a Lifelong Learner

This is not moral advice but an educational tip that applies to all trainers. It is also an old cliché that we as teachers have probably recounted to our students numerous times. We know for certain that we have to practice it ourselves, otherwise we would be left behind. Being a teacher, in contrast to being a lab researcher, for instance, we should keep ourselves updated with the latest developments in our field and also be aware of related areas of knowledge. At times in my own classes, under certain interactive situations with my students, I feel the need to be a psychologist. I always think of how the knowledge and skills of a showman or an actor could help me present a lecture with more enthusiasm and vitality, how I could improve my PowerPoint slides, how lively and engaging my speech would be if sometimes I could switch from an inert, jargon-ridden, boring style to a belletristic one. This list can go on and on, based on our expectations from teachers. We need not to be a "Jack of all trades" if we want to be a good teacher but this should not prevent us from visiting other realms of arts and sciences. Perhaps you may have experienced that even if what you learn is completely irrelevant to what you teach, it increases your enthusiasm and passion in life and that undoubtedly reflects in your teaching experience.

Conclusion

The ultimate goal of all teaching techniques is to enhance the learning of the students. There are many books and articles on how to present a good lecture as a teaching method.⁴² Besides valuable general tips, there are many others that are applicable for special lecture topics. The 12 tips presented here are based either on evidence from literature or on student feedback I have received. A number of these tips are general to all lecture topics. Implementation of some tips may require the teachers to boost their knowledge in other non-pharmacological fields; some simply need a small change in teachers' mindsets.

Ethical issues

Not applicable.

Competing interests

The author reports no conflicts of interests

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References

1. Gwee MC. Teaching of medical pharmacology: the need to nurture the early development of desired attitudes for safe and rational drug prescribing. *Med Teach.* 2009;31(9):847-54. doi: 10.1080/01421590903168119.
2. Kwan CY. Learning of medical pharmacology via innovation: a personal experience at McMaster and in Asia. *Acta Pharmacol Sin.* 2004;25(9):1186-94.
3. Brown G, Manogue M. AMEE Medical Education Guide No. 22: refreshing lecturing: a guide for lecturers. *Med Teach.* 2001;23(3):231-44. doi: 10.1080/01421590120043000.
4. Achike FI, Ogle CW. Information overload in the teaching of pharmacology. *J Clin Pharmacol.* 2000;40(2):177-83. doi: 10.1177/00912700022008838.
5. Dornhorst AC. Information overload: why medical education needs a shake-up. *Lancet.* 1981;2(8245):513-4. doi: 10.1016/s0140-6736(81)90894-1.
6. Ogle CW. Medically qualified preclinical academics. *Br Med J.* 1979;2(6199):1226. doi: 10.1136/bmj.2.6199.1226-a.
7. Marsh EJ, Sink HE. Access to handouts of presentation slides during lecture: consequences for learning. *Appl Cogn Psychol.* 2010;24(5):691-706. doi: 10.1002/acp.1579.
8. Zahedi Avval F, Jarahi L, Ghazvini K, Youssefi M. Distribution of handouts in undergraduate class to create more effective educational environment. *Int J Educ Res.* 2013;1(12):1-6.
9. Ian K. Developing PowerPoint handouts to support meaningful learning. *Br J Educ Technol.* 2006;37(4):647-50. doi: 10.1111/j.1467-8535.2006.00536.x.
10. Onishi H. The role of case presentation for teaching and learning activities. *Kaohsiung J Med Sci.* 2008;24(7):356-60. doi: 10.1016/S1607-551X(08)70132-3.
11. Vekiri I. What is the value of graphical displays in learning? *Educ Psychol Rev.* 2002;14(3):261-312. doi: 10.1023/A:1016064429161.
12. Johnson AP. It's time for Madeline Hunter to go: a new look at lesson plan design. *Action Teach Educ.* 2000;22(1):72-8.
13. Neal MJ. *Medical Pharmacology at A Glance.* Hoboken, NJ: Wiley-Blackwell; 2020.
14. Simmons MA. *Pharmacology: An Illustrated Review.* New York: Thieme; 2012. p. 414.
15. Lüllmann H, Mohr K, Hein L. *Color Atlas of Pharmacology.* 5th ed. Stuttgart: Thieme; 2018.
16. Whalen K, Finkel R, Panavelil TA. *Lippincott Illustrated Reviews: Pharmacology.* 7th ed. Philadelphia, Pa: Wolters Kluwer; 2018.
17. Raffa RB, Rawls SM, Beyzarov EP, Netter FH. *Netter's Illustrated Pharmacology.* Philadelphia, PA: Saunders/Elsevier; 2014.
18. Frishman WH. Beta-adrenergic receptor blockers. Adverse effects and drug interactions. *Hypertension.* 1988;11(3 Pt 2):II21-9. doi: 10.1161/01.hyp.11.3_pt_2.ii21.

19. Adams NE. Bloom's taxonomy of cognitive learning objectives. *J Med Libr Assoc.* 2015;103(3):152-3. doi: 10.3163/1536-5050.103.3.010.
20. Katzung BG, Trevor AJ. *Basic and Clinical Pharmacology.* New York: McGraw-Hill; 2017.
21. DiPiro JT. *Pharmacotherapy: A Pathophysiologic Approach.* 11th ed. New York: McGraw-Hill Medical; 2020. p. 668.
22. Golan DE, Armstrong EJ, Armstrong AW. *Principles of Pharmacology the Pathophysiologic Basis of Drug Therapy.* Philadelphia: Wolters Kluwer; 2017.
23. Ritter J. Rang and Dale's *Pharmacology.* Edinburgh: Elsevier; 2020.
24. Stearns SC. Evolutionary medicine: its scope, interest and potential. *Proc Biol Sci.* 2012;279(1746):4305-21. doi: 10.1098/rspb.2012.1326.
25. Nebert DW, Dieter MZ. The evolution of drug metabolism. *Pharmacology.* 2000;61(3):124-35. doi: 10.1159/000028393.
26. Davies J, Davies D. Origins and evolution of antibiotic resistance. *Microbiol Mol Biol Rev.* 2010;74(3):417-33. doi: 10.1128/mubr.00016-10.
27. Fuselli S. Beyond drugs: the evolution of genes involved in human response to medications. *Proc R Soc Lond B Biol Sci.* 2019;286(1913):20191716. doi: doi:10.1098/rspb.2019.1716.
28. Kratzer JT, Lanaspas MA, Murphy MN, Cicerchi C, Graves CL, Tipton PA, et al. Evolutionary history and metabolic insights of ancient mammalian uricases. *Proc Natl Acad Sci U S A.* 2014;111(10):3763-8. doi: 10.1073/pnas.1320393111.
29. Brigley S. How to ... Spice up your lectures. *Educ Prim Care.* 2009;20(4):322-3. doi: 10.1080/14739879.2009.11493805.
30. Ligon BL. Penicillin: its discovery and early development. *Semin Pediatr Infect Dis.* 2004;15(1):52-7. doi: 10.1053/j.spid.2004.02.001.
31. Ellis H. Gerhard Domagk: a Nobel laureate pioneer of chemotherapy. *Br J Hosp Med (Lond).* 2014;75(4):231. doi: 10.12968/hmed.2014.75.4.231.
32. Vargesson N. Thalidomide-induced teratogenesis: history and mechanisms. *Birth Defects Res C Embryo Today.* 2015;105(2):140-56. doi: 10.1002/bdrc.21096.
33. Gruener A. Vincent van Gogh's yellow vision. *Br J Gen Pract.* 2013;63(612):370-1. doi: 10.3399/bjgp13X669266.
34. Watts G. Alfred Goodman Gilman. *Lancet.* 2016;387(10022):938. doi: 10.1016/s0140-6736(16)00575-4.
35. Gerald MC. *The Drug Book: From Arsenic to Xanax, 250 Milestones in the History of Drugs.* New York, NY: Sterling Pub; 2013. p. 528.
36. Sneader W. *Drug Discovery: A History.* Hoboken, NJ: Wiley; 2005.
37. Lesch JE. *The First Miracle Drugs: How the Sulfa Drugs Transformed Medicine.* Oxford: Oxford University Press; 2007. p. 364.
38. Tone A, Watkins ES. *Medicating Modern America: Prescription Drugs in History.* New York: New York University Press; 2007.
39. de Alencar Neto JN. Morphine, oxygen, nitrates, and mortality reducing pharmacological treatment for acute coronary syndrome: an evidence-based review. *Cureus.* 2018;10(1):e2114. doi: 10.7759/cureus.2114.
40. Naming drug substances at the national level: mainly in the United Kingdom and the United States. *Prescrire Int.* 2012;21(132):279.
41. Kind T, Patel PD, Lie D, Chretien KC. Twelve tips for using social media as a medical educator. *Med Teach.* 2014;36(4):284-90. doi: 10.3109/0142159x.2013.852167.
42. Lenz PH, McCallister JW, Luks AM, Le TT, Fessler HE. Practical strategies for effective lectures. *Ann Am Thorac Soc.* 2015;12(4):561-6. doi: 10.1513/AnnalsATS.201501-024AR.