20

How to improve the group exercise competences in Ph.D. stem cell course?

Abinaya Chandrasekaran

Department of Veterinary and Animal Science
University of Copenhagen

Background

Stem cell biology is a large and diverse subject, ranging from basic biology to practical application. A full understanding of it is a necessary factor in understanding the basics of cell biology and molecular biology, tissue structure and physiology to implement in medical and veterinary applications. An essential competence within stem cell biology is microscopy of cell samples, this skill helps in understanding the clinical pathology of disease mechanisms.

The present stem cell course is a 1-week intensive program for PhD candidates, postdoctoral researchers and technicians embarking on culturing of pluripotent stem cells with the application for neural cell studies, microglia studies and optic cups studies. The course consists of lectures, theoretical exercises, group exercises, microscopy exercises and laboratory exercises (course description is mentioned in Appendix A). By the end of each topic, we assess students with quiz questions to determine whether students understood the taught topic. The whole purpose of this course is to present students with 1) laboratory skills to develop pluripotent stem cells of their choice either with mutation or without mutation using CRISPR technology; 2) an approach to interpreting different cell types of the central nervous system; 3) and establishment of basic practical skills for preparation of microscopy of cells from human samples.

Problem Identification

The course is based on fundamental insights into cell biology and has a very practical approach. The main challenge of teaching this course is the wide-ranging educational background of the student in particular varying levels. Based on our experience we could also see that students are losing their competencies in basic cell biology techniques and molecular biology techniques such as microscopy, PCR analysis, and identification of cell structures, which is a major learning goal of this course. Moreover, based on the student's evaluation, we could see that the group exercise and practical exercise have quenched the performance of this course to a certain extent; therefore, extra attention is needed to improve the group exercise activity of the course.

Results and Discussion

Usefulness of the course

Meaningful input from students is essential for improving any course. One of the most common indirect course assessment methods is the course evaluation survey which enabled students to reflect and provide feedback on their own learning (Guder & Malliaris, 2010). Based on the student feedback from 2019 (n=15), 2021 (n=15) and 2022 (n=15) we could see that the participation rate of the course was high, thereby indicating that the course was a super hit since its launch. When asked students "to what extent do you feel the knowledge and practical skills you have acquired during the course will be useful for your future research"? Majority of them replied as very much useful. From the results, we could see that large number of them answered that the course was very useful and helpful; this signifies that the course was extraordinarily successful since its inauguration (Figure 1). In 2020, the course was suspended due to COVID 19 therefore; no data is available from that year.

Competence of the course

From Figure 2, we could perceive that the students learning objectives either in form of lectures or keynote lectures were very high, this reflects that the students gained important key competencies of stem cell biology

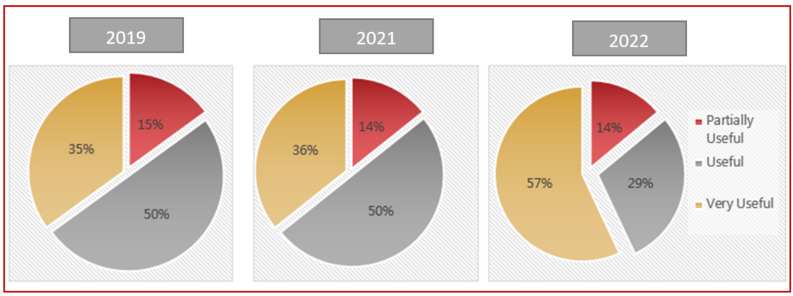

Figure 1. Evaluation of the course results from n=45 students over the period of 3 years (2019, 2021 and 2022). Answers of the categories: 'partially useful', 'useful', 'very useful'. Based on the results we could see a significant increase in the usefulness of the course in 2022 when compared to 2019.

through guest speakers and teachers. Another major positive point of this course was the general course structure in respect to the combination of preparation time, classic lectures, keynote lectures, board discussions, peer sessions, and practical exercises. In fact, we received good criticism about the course structure from the majority of students (attached feedback from students in Appendix B).

However, over time we could see that the course performance has slightly reduced during recent times thus suggesting the course needs a bit of remodeling. Among the positive points, the major concern of certain students was the group exercise activity. In regards to this context, the majority of students appreciated the detailed instruction on what needs to be prepared under 30 minutes (attached is the old group exercise activity in Appendix C). However, to our surprise, the students did not respond that well to the group exercise. They felt that 30 minutes was not enough to make the group team exercise. The plausible reason could be due to diverse educational backgrounds and students could not make a concluding statement within the specified time. Several students were even more frustrated of not being able to accomplish the expected questions within 30 minutes. This feeling may compromise students' basic need to feel competent is compromised which may negatively affect their intrinsic motivation and interest (Ryan & Deci, 1985) and the course performance. As we are con-

stantly striving to improve our course. We would like to take new initiatives in restructuring the group exercise part using pedagogical aspects.

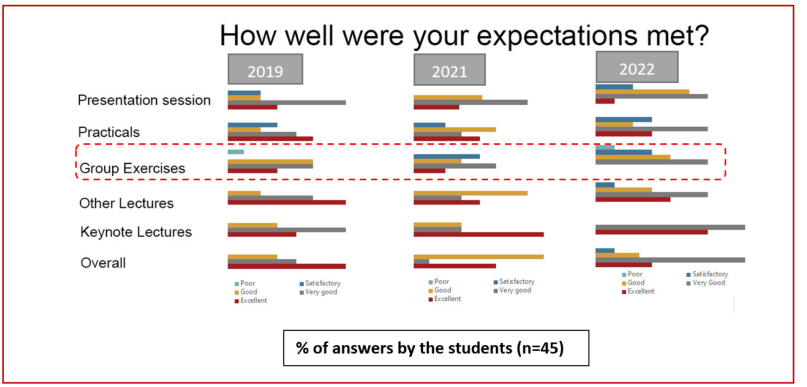

Figure 2. Reflection of questionnaire results from n=45 students over the period of 3 years (2019, 2021 and 2022). Questions are listed on the y-axis and the numbers of answers to the categories: 'poor', 'satisfactory', 'good', 'very good, and 'excellent' are listed on the x-axis.

New Aim

The new aim of this project is to (i) identify pedagogical aspects that could be improved in the PhD stem cell course and (ii) to develop a new student exercise that will substitute an existing exercise within the course (to be implemented in the course in May-Sep 2023).

Pedagogical Aspects

In this section, various pedagogical aspects of the PhD stem cell course will be discussed focusing on room for improvement.

Alignment

When considering the alignment of the course in relation to the group exercise, we could implement group assignments activity beforehand (i.e. right before the start of the course) allowing the students to practice their critical thinking, and self-directed learning and would increase the options for implementing formative assessment to a higher degree. In order to enhance the students with different scientific backgrounds, we could provide students with recorded lectures on the basics of cell biology before the start of the course.

Furthermore, the course could be improved by training the students in experimental design and scientific argumentation in order to support the learning of these general scientific competencies, which are very relevant for the educational programme and for science in general (Dahl & Troelsen, 2015). This could be easily integrated into the lab exercise that is already a part of the course.

Written Assignment

In the current format, the course contains no written assignments. One argument for introducing written assignments to the course is to align the course. The written assignments could be implemented as part of the group exercise or as an independent assignment. Ideally, this approach could be implemented in order to assist the students to obtain these competencies. This approach has also been discussed by (Christiansen et al., 2015), therefore we do not foresee any issues implementing this approach.

Creating success factors with this approach is possible by implementing peer feedback. One could use peer feedback as part of the feedback on the written assignment, alongside whole class feedback from the teacher. Using the peer-feedback approach enhances the active engagement of students with their studies and strengthens students' understanding of certain topics (Bloxham & West, 2010; Lou et al., 2016). This will give the teacher a qualified indication of the strengths and weaknesses of the students understanding of scientific concepts. This could also be blended into the course program.

New Plan for Student Group Exercise

In order to improve the student group exercise activity and simultaneously various pedagogical aspects of the course and new exercises will be developed. This approach will be implemented in 2023. The exercise consists of the following steps:

- Students identify a hypothesis-based problem from literature relevant to stem cell biology and disease modelling.
- Students draft an experimental design in form of a draft including a short scientific description (from home before or during the time of the course).
- Students present their experimental plan as a 5 minutes presentation round in class.

The students could submit their drafted hypothesis on the 2nd day of the course when a supervisor will be present. During the planning session, they must refine their hypothesis. On the 3rd day of the course, they should finalize their experimental plan. The presentation will take on the final day of the course as a 1-hour session, where each student or group of students can present their work to one teacher.

Conclusion

The new student exercise is deliberate to give students scientific competencies within the discipline like scientific writing, data presentation and scientific argumentation. The exercise will further support study skills like evaluating their own work and peer work with a self-directed learning approach. Finally, we hope that these small changes in our PhD stem cell course could help us advance our course to the next level.

References

Bloxham, S., & West, A. (2010). Understanding the rules of the game: Marking peer assessment as a medium for developing students' conceptions of assessment. *29*(6), 721–733. https://doi.org/10.1080/02602930420002272 54

Christiansen, F. V., Harboe, T., Horst, S., Krogh, L., & Sarauw, L. L. (2015). Trends in the development of the Danish universities. In L. Rienecker, P. Jørgensen, J. Dolin, & G. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 17–41). Samfundslitteratur.

Dahl, B., & Troelsen, R. (2015). Lecturing. In L. Rienecker, P. Jørgensen, J. Dolin, & G. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 179–188). Samfundslitteratur.

Lou, Y., Li, Z., Gong, P., Liu, J., Lou, Y., Li, Z., Gong, P., & Liu, J. (2016). A study on guided peer feedback in group work to improve non-english-majored graduates' english writing in internet-based language laboratory. *Open Journal of Social Sciences*, *4*(10), 86–96. https://doi.org/10.4236/JSS.2016.410007

A Course Description

GRADUATE SCHOOL OF HEALTH AND MEDICAL SCIENCES
UNIVERSITY OF COPENHAGEN

The course description will be published in our online course catalogue and in the national database for PhD courses.

Course title

Induced Pluripotent Stem Cells, Gene-editing and Brain Cell Models

Learning objectives

A student who has met the objectives of the course will be able to:

Skills:

- Freeze and thaw human induced pluripotent stem cells
- Maintain and expand human induced pluripotent stem cells
- Generate iPSC via electroporation of episomal plasmids
- Differentiate human induced pluripotent stem cells into astrocytes, glia and cortical neurons
- Generate 3D cultures
- Analyze induced pluripotent stem cell-derived neural cells using different molecular methodologies
- Design CRISPRs guides and templates for gene-editing of pluripotent stem cells
- Perform nucleofection based CRISPR-Cas9 gene editing

Knowledge:

- Acquire a detailed understanding of the derivation of pluripotent stem cells
- Acquire a detailed theoretical understanding of the states of pluripotency
- Acquire a detailed understanding of early neural developmental processes and molecular cues that govern neural patterning
- Acquire a detailed understanding of the latest protocols for differentiation of iPSC into neural subtypes, astrocytes and microglia
- Gain detailed knowledge on state-of-the-art methods for culturing pluripotent stem cells
- Gain detailed knowledge on the latest methods for differentiating pluripotent stem cells into neural cell types (with focus on neurons, astrocytes) in 2D and 3D
- Gain detailed knowledge on the latest methods for differentiating pluripotent stem cells into microglia
- Gain expertise on use and application of CRISPR guides in gene-editing of pluripotent stem cells

Competences:

- Will be able to develop custom-designed experiments in their own lab pertaining to pluripotent stem cell culture and differentiation into neural cells, glia and microglia
- Will be able to custom-design CRISPRs for gene-editing of their own cell lines
- Will be able to perform iPSC reprogramming and CRISPR-Cas9 gene editing using electroporation based methods

Content

The course includes the following topics:

Pluripotent stem cell biology, Neural development and molecular patterning of the developing brain, Neural differentiation, Astrocyte differentiation, Microglia differentiation, Tissue culture of pluripotent stem cells, Tissue culture of different neural subtypes, astrocytes, 3D cultures, glia and microglia, CRISPR-Cas9 technologies and applications in pluripotent stem cells

Participants

PhD students, postdoctoral researchers and technicians embarking on culture of pluripotent stem cells with application for neural cell studies, microglia and optic cups

Relevance to graduate programmes

The course is relevant to PhD students from the following graduate programmes at the Graduate School of Health and Medical Sciences, UCPH:

All graduate programmes

Neuroscience

Molecular Mechanisms of Disease

Language

English

Form

Lectures, keynote lectures, group exercises, practical laboratory work, student presentations

Course director

Kristine Freude, Associate Professor, Dept. of Veterinary Clinical and Animal Sciences, kkf@sund.ku.dk

Teachers

Kristine Freude, Associate Professor, University of Copenhagen

Agnete Kirkeby, Associate Professor, University of Copenhagen

Morten Meyer, Associate Professor, University of Southern Denmark

Abinaya Chandrasekaran, Assistant Professor, University of Copenhagen

Henriette Haukedal, Postdoc, University of Copenhagen

Dates

May 6-12, 2022 (incl.)

Course location

Frederiksberg Campus, Grønnegårdsvej 7

Registration

Please register before August 15, 2021. Seats to PhD students from other Danish universities will be allocated on a first-come, first-served basis and according to the applicable rules. Applications from other participants will be considered after the last day of enrolment.

B Feedback from Students

Course Evaluation for "Human induced pluripotent stem cell culture, neural differentiation and gene-editing: in theory and in practice"

1) What were your expectations prior to the course?

- learn, how to culture iPSC and differentiate into neurons
- learn, how to introduce gene knockout with CRISPR-Cas9.

2) How well were your expectations met?

Not Met	Partially Met	Expectations Met	Expectations Exceeded
○	○	○	✓

3) Overall how would you rate the following aspects of the course?

	Poor	Satisfactory	Good	Very Good	Excellent
Overall	○	○	○	○	✓
Keynote Lectures	○	○	○	○	✓
Other Lectures	○	○	○	○	✓
Group Exercises	○	○	○	○	✓
Practicals	○	○	○	○	✓
Poster Session	○	○	○	○	✓

4) To what extent do you feel the knowledge and practical skills you have acquired during the course will be useful in your future research?

Not Useful	Partially Useful	Useful		Very Useful
○	○	○	X	○

5) Are there any topics/techniques you were hoping would be covered in the course that weren't?

No

6) Please identify area(s) where you think the course could be improved and explain how.

I was happy with everything.
Thank you for the nice course.

Course Evaluation for "Human induced pluripotent stem cell culture, neural differentiation and gene-editing: in theory and in practice"

1) What were your expectations prior to the course?
a lot of lab work. Introduction to and theory to all the steps in the differentiation process of iPSC

2) How well were your expectations met?

Not Met	Partially Met	Expectations Met	Expectations Exceeded
○	○	○	✓

↳ also a lot of knowledge about CRISPR — That was nice

3) Overall how would you rate the following aspects of the course?

	Poor	Satisfactory	Good	Very Good	Excellent
Overall	○	○	○	✓	○
Keynote Lectures	○	○	✓	○	○
Other Lectures	○	○	○	✓	○
Group Exercises	○	○	○	✓	○
Practicals	○	○	✓	○	○
Poster Session	○	○	○	✓	○

4) To what extent do you feel the knowledge and practical skills you have acquired during the course will be useful in your future research?

Not Useful	Partially Useful	Useful	Very Useful
○	✓	○	○

5) Are there any topics/techniques you were hoping would be covered in the course that weren't?

6) Please identify area(s) where you think the course could be improved and explain how.
The first lecture on Monday ~~was not~~ lacked some step-by-step go-through. He assumed we knew more than we did.

C Course Description

Group Exercise

- Group 1: Amyotrophic lateral sclerosis (ALS)
- Group 2: DEVELOPMENTAL AND EPILEPTIC ENCEPHALOPATHY 1
- Group 3: Sporadic AD with APOE 4/4

- What types of neurons are you aiming to differentiate?
- What about astrocytes and microglia?
- Develop a differentiation protocol for your choice of cell?

- You have 30 minutes group work to develop the protocol and address questions Each group should present their case (max 5 min presentation for each group) followed by a common discussion regarding the choice of protocol and pros and cons.