Egenevaluering MOL222 spring 2022

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MOL222 was created in 2015 based on MOL202, re-developed in 2018 by AEL and further remodeled by EO over 2021 and 2022.

Course objectives and content:

MOL222 is an advanced practical course in molecular biology in the 4th semester of MOL Bachelor program. The course builds upon learning outcomes from both theoretical subjects (MOL100, MOL201, KJEM100, MOL200) and practical subjects (MOL221) in MOL Bachelor program. MOL222 develops practical competences in molecular biology that are necessary to qualify for further studies at the master's level. The course also provides background for advanced practical courses in the master's program such as MOL300.

MOL222 provides theoretical and practical training in the most common molecular biology lab techniques including molecular cloning, DNA gel-electrophoresis, spectrophotometry, PCR, DNA sequencing, plasmid propagation in bacteria, plasmid purification, restriction digestion, overexpression of genes in mammalian cells, microscopy, microscopy image analysis. The course also provides hands-on experience from modern bioinformatics tools: molecular cloning environment *Benchling*, *NCBI* sequence analysis tools, image processing with *FIJI*, *EndNote*. Second pillar of the course is training in scientific communication skills including documentation of experimental procedures, experimental results, study background information in a standard IMRaD format. The course also conveys modern practices of collaborative work by enforcing group work both at the lab level and on written assignments.

Following are the specific learning outcomes of MOL222:

Student's knowledge

- can explain the principles of molecular cloning and PCR, cell transfection and Western blotting
- knows the structure of a scientific report and the way experimental results are presented in a scientific communication
- knows the general safety routines for laboratory work in molecular biology

Student's skills

- can prepare plasmids for transfection of cultured cells and analyse protein expression by means of fluorescence microscopy and Western blotting
- can use instrumentation and gene technology methods for separation and analysis of proteins and nucleic acids
- can interpret and report data both qualitatively and quantitatively
- can follow general safety routines for laboratory work in molecular biology
- can plan experimental work based on a protocol
- can critically evaluate and discuss experimental results
- can critically evaluate and correctly cite literature
- can write scientifically

Student's general competence

- can apply protocols for basic experimental work within the field of molecular biology and biochemistry
- can properly communicate experimental procedures as well as critically evaluate and discuss obtained experimental results within the field of molecular biology and biochemistry

To meet the declared learning objectives MOL222 includes computer-based tasks, lab practical work, theory lectures, written assignments and interactive QA sessions. All these activities are organised as a "research project" where course participants are brought through all common steps of research work starting with the experimental planning and wet lab work, and finalizing with experimental data collection, interpretation and documenting the research work. The written article-style reports in an IMRaD format are developed during the course and constitute the basis of knowledge evolution which is graded (A-F).

The course program includes the following specific items:

- One day workshop in computational design of molecular cloning projects using *Benchling* web-based project design environment.
- Four lectures 2 academic hours each describing (i) principles of main molecular cloning methods; (ii) the structure of *IMRaD*-style research papers; (iii) principles of cell biology-, immunolocalization- and fluorescence microscopy techniques used in the analysis of protein localization; (iv) basics of microscopy image processing using *FIJI* and principles of analysis of imaging data.
- Three days of lab practice in molecular cloning techniques where candidates construct and sequence reporter-coding genetic constructs.
- Three days of lab practice in mammalian cell transfection, immunolocalization and fluorescence microscopy where candidates implement results of the cloning work to study the relevant biomolecule localization phenomena in mammalian cells.
- Two mandatory intermediary report assignments that develop competences in documenting research work performed in the lab. The assignments are followed by detailed written feedback from the course staff but are not graded.
- Two interactive QA sessions discussing the intermediary report outcomes and associated difficulties.
- Exam task of compiling a IMRaD-style report based on the intermediary reports which is graded.

Course implementation

MOL222 theoretical lectures are given in a flipped format by the course leaders. The video recorded materials for each lecture are provided in advance via mitt.uib interface while physical lecture slots are used for interactive QA sessions on the lecture materials. The lectures complement lab compendia introducing and discussing the aspects of the upcoming lab exercises, such that the students are theoretically prepared for the lab work. The students are also provided in advance with online feedback forms on each lecture which are used to create agenda for the QA sessions on lecture materials and to improve the lecture quality.

The computational molecular cloning workshop and introduction to other software is implemented remotely via zoom and/or via video tutorials. Arising questions are then discussed during the relevant QA sessions.

All MOL222 lab exercises are conducted by PhD teaching assistants, 4 and 2 PhD-students (from BIO and SARS) for the molecular cloning and microscopy parts respectively. All course participants are split into 4 groups where each group is tackled on separate days to cope with the teaching lab capacity. As such, all exercises repeated by the TAs 4 times.

Scientific writing practice is implemented as two intermediary reports reflecting in IMRaD format upon the aspects of experimental lab work. This includes documenting the experimental procedures in a "materials and methods" format, the experimental outcomes in "results" format, "figures/figure legends" and "tables" and a discussion plan. The two reports cover molecular cloning part and cell biology part of the exercises, respectively. The reports are written by course participants in pairs according to their binning in the lab. The reporting is done according to the formal instructions on IMRaD-based paper structure provided to the students and discussed over the QA sessions. The assignments are followed up by detailed feedback from the course leaders (EO and AL) including textual corrections and physical QA sessions.

To further aid the development of research communication skills the course participants are provided with extra subject-related materials such as the topic-related research articles, textbook references on the relevant topics covered in preceding courses MOL201 and MOL200 theoretical, and materials on scientific writing such as Chapter 4 ("Step-by-step instructions for preparing a laboratory report or scientific paper") from "A student handbook for writing in biology, 5th edition" book by Karin Knisely.

The course exam is implemented as a portfolio assessment in format of IMRaD scientific report which is developed individually on the basis of the intermediary reports and according to the formal guidelines provided both to the candidates and to censors. Each report is evaluated by two censors, altogether involving 4-6 graders.

Assessment of conformity between the subject's learning outcome description and teaching, learning and assessment methods

Development of written research communication skills being critical aspect of MOL222 justifies the principal course organization in a form of coherent research workflow form tool development to collecting and interpreting the experimental data. This is considered an optimal solution allowing not only to learn relevant methods but immerse course participants into the actual researchers working practices and to allow them learning scientific writing skills based on their own lab experience.

As compared to previous evaluation period the theoretical part of the course was rewired introducing training in modern computational tools for conducting molecular and cell biology experiments (e.g. Benchling platform, FIJI). The emphasis was made on the utility of the respective tools for the actual lab work. Another ultimate novelty is introduction of the group work on the intermediary course assignments as opposed to completely individual work in the previous years. This choice was initially motivated by increase in the course capacity (from 30-40 to 45-50 and maybe 60 next years) and concomitant shrinkage in the available teaching workforce. Yet, this choice turned out to be successful allowing for the development of modern collaborate work practices and showcasing the advantages of web-based tools such as Google Docs in collaborative work.

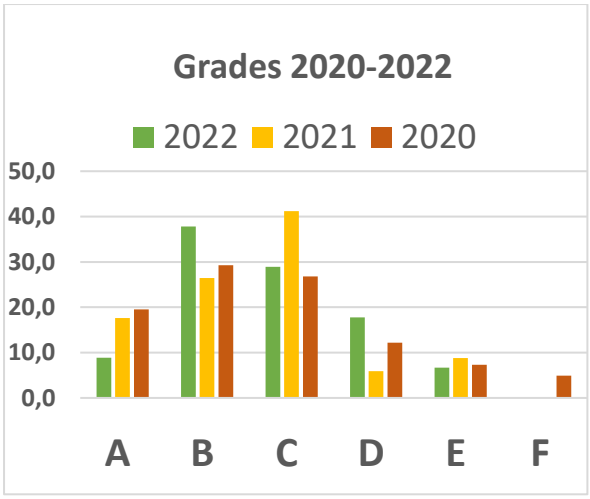
Other notable changes included introduction of flipped lectures, video tutorials and lecture feedback forms initially motivated by COVID restrictions but now also considered successful. Specifically, these changes allow for continuous accessibility and scandalization of learning materials and allowing learning in a more flexible manner.

The portfolio-based assessment in the form of IMRaD report is considered optimal for testing both the understanding of experimental techniques and the ability to convey results of experimental work according standards accepted by research community.

Couse participation and course grade dynamics.

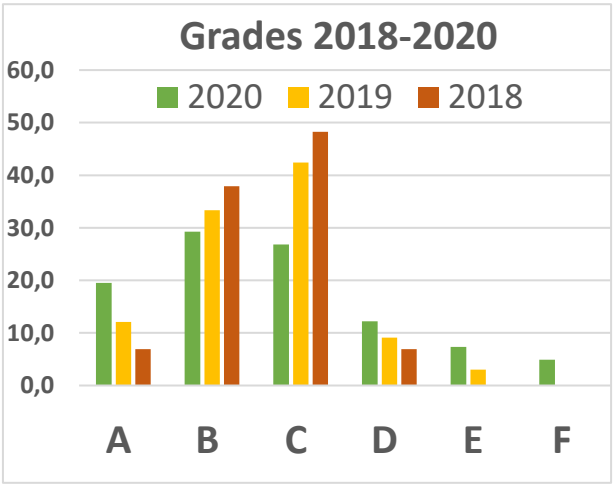
Current 3-year evaluation period:

Grade Year	A	B	C	D	E		Gjennomsnitts karakter	Total # student
2022	4 (8.9%)	17 (37.8%)	13 (28.9%)	8 (17.8%)	3 (6.7%)	0 (0%)	C	45
2021	6 (17.6%)	9(26.5%)	14 (41.2%)	2 (5.9%)	3 (8.8%)	0 (0%)	C	34
2020	8 (19.5%)	12 (29.3%)	11 (26.8%)	5 (12.2%)	3 (7.3%)	0 (0%)	B/C	41



Previous available evaluation report:

Grade Year	A	B	C	D	E	F	Gjennomsnitts karakter	Total # student
2020	8 (19.5%)	12 (29.3%)	11 (26.8%)	5 (12.2%)	3 (7.3%)	2 (4.9%)	B/C	41
2019	4 (12%)	11 (33%)	14 (42%)	3 (9%)	1 (3%)	0	B/C	33
2018	2 (7%)	11 (38%)	14 (48%)	2 (7%)	0	0	C	29



It could be noted that over the 3-year evaluation period and compared to the pervious evaluation period the grade outcomes remained rather stable showing a similar percentage distribution, while course participation displayed overall positive dynamics.

Student evaluation and suggested measures to improve course quality

Most recent student's survey is from 2021 but it might be considered a reasonable proxy considering highly similar teaching practices and course staffing over the evaluation period. The survey was undertaken by 15 students (~40% of course participants). Overall, the students were satisfied with the course contentment, the way it was delivered and evaluated (70%-100% either highly positive or positive). Main lines of criticism included insufficient amount of lab practice which could be reasonably explained by COVID restrictions in 2021. This is further reinforced by student's feedback on specific modules where molecular cloning modules that retained actual practice in the lab were met much more positively than cell

biology parts delivered only in a theoretical form (70%-90% of positive and highly positive vs 10%-45%). Release of COVID restriction is expected to naturally resolve this bias.

Another important point of criticism is computer exercise where many course participants could not properly follow upon the tasks in design of a molecular cloning project. This issue was noted also in the previous evaluation report and seems likely due to overloaded content of this module. This is supported by the feedback from both TAs and the students. As such it is reasonable to reduce information content of this part in the next years.

Lastly, many respondents reflected upon insufficiently good alignment of the course contents between MOL221 and MOL222 e.g. repeating similar techniques. Partially it is a consequence of COVID restrictions where the 50% MOL222 methods implemented in the lab are the ones that significantly overlap with MOL221. Nevertheless, the partitioning of the experimental techniques between these courses is a subject of ongoing discussion and already resulted in shifting of one of the MOL222 modules (western blotting) to MOL221. Ongoing discussion is also taking place on better alignment of reporting styles between the two courses.

Feedback of the course teaching staff

According to informal conversations the teaching process is considered rather well organized and teaching workload considered fair by the TAs.

Peer review

Not available.

An assessment of whether progress and planning for the subject is in accordance with the set objectives for the subject and programme.

The placement of the course is well aligned within the Bachelor MOL program requiring good theoretical background in molecular biology as perquisites and equipping students with essential practical laboratory skills and basic understanding of scientific writing to continue with the master's degree.