Course analysis

BB2165 Biomolecular Structure and Function HT20-1

Course name: Biomolecular structure and function	Cycle: 2
Course code: BB2165	ECTS credits: 7,5
Term: HT20	Study period: P1
Course coordinator: Christina Divne	Examiner: Christina Divne
Number of new students 2020: 86	Passed students when the course ends: 85
Degree of examination (%): 98.8	Degree of achievement (%): 98.1
Answer frequency LEQ (%): 46 (44 of 95 answered the LEQ)	

About the course

The course is the first course in the two master tracks "Medical Biotechnology", and "Industrial and Environmental Biotechnology". Structural biology of biomolecules is a cornerstone in modern biotechnology. Students are offered theoretical and practical knowledge and insight about the foundations of biomolecular structure, and how the structure relates to function. The contents ranges from fundamentals in structural biology to contemporary research, and the precise topics are subjects of change to appropriately reflect the research frontier. Instructive computer-based exercises and a "real-life" project based on contemporary cutting edge research offer a teaching concept that is highly interactive and practical in order to increase and deepen the perception and understanding of biomolecular structure-function relationships. The students acquire skills and tools to retrieve, use, understand, and validate structural biology information available in 3D structure databases. They acquire expertise about the interaction of biomacromolecules with ligands and how to predict the 3D structure of a protein with unknown experimental structure. The course has a high content of computer-based learning, and makes extensive use of the Canvas learning platform.

1. Changes made before this course offering (based on analysis 2019 and pandemic)
   - The molecular dynamics exercise removed and the computational modeling part updated to become more accessible (these were the parts that received most negative comments 2018 and 2019).
   - More scheduled time given for the project.
   - Project presentations in smaller groups and peer review of reports to reduce stress and to strengthen interaction between students.
   - All material online, including recorded lectures (adjustment to Covid-19 pandemic). Due to the naturally high content of computer-based learning, the process of online transition was relatively straightforward, however, the main issue was the very short notice from the program management level.
   - Knowledge that should be memorized examined by quizzes – no need to memorize things for the final exam. The final exam focuses on applying knowledge and critical analysis.
   - Digital exam during which the students can use all resources (notes, books, internet etc).
   - Exercises and project performed individually (previous years in groups of 2-3 students)
   - Peer review of project reports, online presentations in smaller groups (breakout groups) with one student acting as moderator

2. Summary of the student's course evaluations (LEQ) 2020

   Based on both the statistical analysis of the LEQ and the comments, this year's course was received more positive rating than the previous years since the start of the course in 2018. What lowered the students' overall impression of the course were two things - the perceived time constraint during the final examination (open-book exam), and the fact that online learning provided less opportunity for student-student and student-mentor interaction.

Despite the fact that one of the teachers had to quit the course just before the course started, the ongoing Covid-19 pandemic which forced us to go fully online on very short notice and 20% more students than 2019 (and 30% more than 2018), the results of the last-minute changes turned out quite well. Some of these changes clearly provided an enhanced pedagogical experience (e.g. pre-recorded lectures, online quizzes etc.).

Quantitative and qualitative aspects of the course evaluation (LEQ) are given in Appendix 1, including a selection of comments from the students. As responsible for the course and examiner I want to extend my deepest gratitude to the students for taking their time to provide such a wealth of constructive comments!

Something that touch me deeply was a personal email, received from one of the students long after the course had ended, which read:

"It has been a while since we have completed the course biomolecular structure, but none of the courses was as straight forward and nicely presented as your course. The discipline that you had in that course and the effort you all put in for our learning is something we all talk about from time to time. Thank you for that."

It is an amazing reward when the work that we as a team put in is positively acknowledged in a way that reflects that the students, despite the obvious hurdles, feel and understand that we, the mentors, truly care about their learning and well being.

3. Reflections on execution and results 2020

   a. *Strengths of the course:*

   - The students appreciate the course topics, and their continued constructive criticism paves the way for effective course development towards an improved learning experience.
   - The course's interactive setup with coupled lectures exercises and project.
   - Real-life practical training to understand (project), validate and use biomolecular structure data.
   - Close connection to the research front of the topics covered, and implementation in the project.
   - Study sheets and study kinemages.

   b. *Weaknesses of the course:*

   - Since the course started 2018, we have worked intensively to improve all aspects. This year was very special since the course had to move online on very short notice. This means many of the students' more negative comments may not apply when the course resumes on-campus teaching.
   - Almost all negative comments in the LEQ applied to the open-book online examination, and specifically lack of time. To relieve the impact from lack of time on the final exam, the students were given extra time, and a time-compensated weighting of grading, i.e. the three tasks were differentially weighted in the final grade. Basically, the first task (which was also most closely coupled to the learning objectives and course content) received the highest weight. Furthermore, the format of the online exam was changed for the re-examination in December, and the students appeared content with the changes. It should be emphasized that the students performed better on the open-book online exam than on the regular on-campus written exams from previous years, which suggests that the main problem was not the format, but 1) inexperience with the exam format in combination with not enough information from the examiner about the exam setup and expectations; and 2) too short time scheduled for the exam format.
   - If excluding the comments relating to the open-book online exam, other suggestions for improvement offer excellent ideas for further improvement of the course, and are outlined below in section 4.

4. Suggestion for changes for the next course offering fall 2021

   • Based on the experience from the adaptations for online examination during 2020, and assuming that we resume on-campus teaching, the examination module TEN1 can be revised such that the E-level is

fully digital through online quizzes in Canvas, and that a final written examination is only taken by students that want to try for a higher grade.

- The study kinemages and study sheets are only intended for the quiz-part, and this information should be emphasized early. Many students commented on the lack of connection between the study sheets/kinemages and the final exam.

- The examination module TEN1 needs to be explained more clearly, and earlier in the course.

- Complicated and time-consuming software can be replaced by more user-friendly online resources, which would be more relevant for the students' further studies.

- The teachers have always provided feedback on the project reports in the previous years, but 2020 we tested to instead activate the students by using peer review for this purpose. While the students appreciated this, they also want more feedback from the teachers on the final report. Next time, we will therefore both use peer review and the former practice of teacher feedback.

- The course content on structure-function relationship is highly valued by the students, however, students from the master's program in Industrial and environmental biotechnology feel that while interesting, there is a too strong focus on medical biotechnology applications compared with applications in industrial biotechnology. The assignment of project options was already taking the students master track into consideration, but next year more examples relevant to industrial biotechnology will be used in the lectures.

- When on-campus teaching resumes, it would be beneficial for the students to work in groups during the exercises, but individual reports will still be necessary for the purpose of examination of module LAB1.

- I am considering the possibility to keep the project presentations online, simply because the zoom format with breakout rooms allows parallel sessions, which is necessary when the number of students reach the level as they did this year (90).

- Not surprisingly considering the online format, students felt it was difficult to build a sense of togetherness and interaction with each other and the mentors. This will of course change when on-campus teaching resumes, however, if the pandemic continues and it is required that also the next course offering is given online, opportunities for group work during exercises and project need to be considered.

- Thermodynamics and probability will be removed since it is outside the current scope.

- Very good comments were given for how we can improve the examination format, for instance using a "blended" examination also in the future with online quizzes combined with a written on-campus exam. It should be noted that if open-book online exams are given in the future, the students will receive more information ahead of the exam (and test examples), and the time will be better adjusted.

5. <u>Aspects of online teaching 2020 - what was working well, and not so well?</u>

- The course is optimized for 60 students. This year, 2020, I had 50% more students than the ideal number. There has been a steady increase in the number of students since the course was launched in 2018: up by 10% 2019 and by 30% 2020 (from 2018). While this is overall positive, it does put considerable strain on everyone involved, especially since the increase in enrollment this year coincided with the transition to an online format. Nevertheless, with proper implementation of selected online elements, future on-campus course offerings should be able to handle up to 80, maybe 85 students.

- Recorded lectures and instruction videos online were greatly appreciated, and when asked if they wished any additional content recorded the consensus was that the existing material is fine and sufficient.

- Project meetings are suggested as possible online activities in the future, and while I think this is a good idea, they would benefit from enabling more student discussions. One issue is when students

ask questions. Some students enjoy hearing others' questions and the teachers' answers, while some feel that it impacts their concentration negatively. This can probably be fixed by slight changes in the zoom setup to allow some to work in breakout rooms and others in the main session. Something to think more about.

- The feeling of togetherness and interaction is mostly absent during online activities - students miss the opportunity to work in groups and discuss in real life. This can be partly remedied by more frequently using breakout rooms in zoom.

- Some suggested that exercises and project (or parts therefor) can be performed online from home also in the future, which I think is an interesting option, especially if the number of students is going to continue to increase, but also since the computer rooms at KTH are limited in number of computers, and some (especially at central campus) are very badly designed with poor air quality and light, which makes students and mentors become exhausted quickly. The one at Albanova (RB33) is considerably more well designed, but air quality is still poor when all computers are used, and the number of stationary computers is limited to 20.

Appendices:

Course evaluation (LEQ) 2020

1. Summary of quantitative aspects from the LEQ

Meaningfulness – emotional level

1. I worked with interesting issues
2. Out of interest, I explored parts of the topic on my own
3. I could learn by trying out my own ideas
4. The course was challenging in a stimulating way
5. I felt togetherness with other course participants
6. The atmosphere in the course was open and inclusive

Comprehensibility – cognitive level

7. The learning objectives helped me understand what I was expected to achieve
8. I understood how the course was organized and what I was expected to do
9. I understood what the teachers were talking about
10. I was able to learn from concrete examples that I could relate to
11. Understanding of key concepts was given high priority
12. The course activities helped me to reach the learning objectives efficiently
13. I understood what I was expected to learn in order to get a particular grade
14. I regularly received feedback that helped me see my progress
15. I could practice and receive feedback without any grading being done
16. The assessment on the course was fair and honest

Manageability – instrumental level

17. My background knowledge was sufficient to follow the course
18. I regularly spent time to reflect on what I learned
19. I could learn in a way that suited me
20. I had opportunities to choose what I was going to do
21. I could learn by collaborating and discussing with others
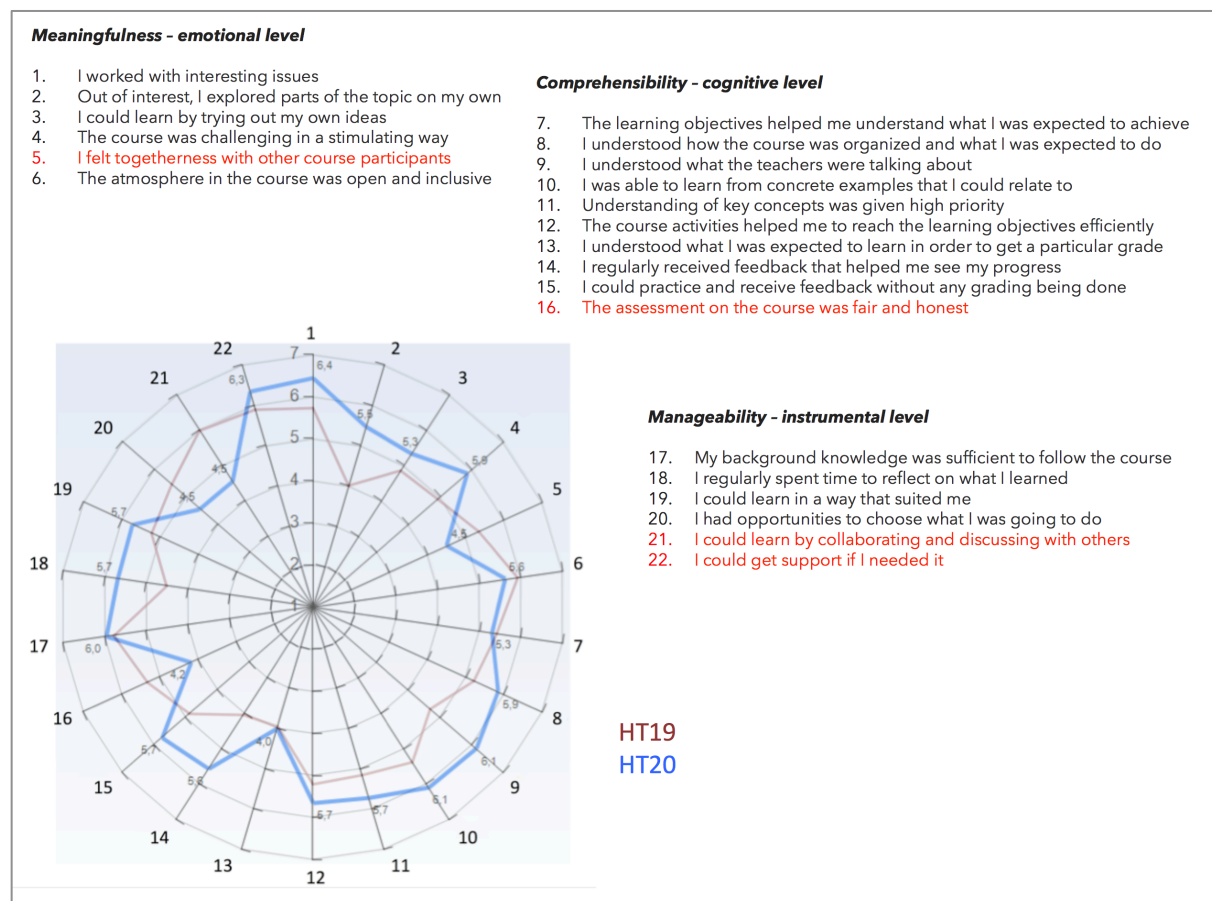22. I could get support if I needed it

HT19
HT20

Figure 1. LEQ questions and spider diagram. Comparison for HT19 (red) and HT20 (blue).

The Spider diagram shows the comparison of the quantitative evaluations of the learning environment between the fall 20189 (red) and this year, 2020 (blue). The differences are very interesting. All aspect are on the positive side (> 4), and almost all aspects are actually more positively, or considerably more positively, rated than last year - despite the pandemic and the entire course being given online.

There are only four aspects that are rated more "negatively" this year compared to 2019: 5, 16, 21 and 22 - all of which these are directly related to the limitations of online teaching

Aspects 5, 21 and 22 concern the difficulty to create meaningful interaction between students, and between students and teachers when learning online.

Aspect 16 concerns the online examination, which due to the requirement of adaptation to a format where it is difficult to cheat, needed to be crafted in a way that the students are not used to. More specifically, the questions were written to not require memorization of information (the students could use any available online material and notes), but instead targeted the ability to find information and to critically analyze and evaluate the information. It was not the precise questions that caused the problem, but the fact that the students not being used to the format and feeling that they did not have enough time to answer some questions. For this

reason, the students received additional time, but they still felt that this was a more stressful format compared with the usual written exam where they had to rely on memorized information.

Two interesting observations are noted. Firstly, the perceived stress did not manifest in worse outcome on the final examination, and secondly, the sentiment of stress was more pronounced for Swedish program students. International master students, contrary to the Swedish program students, felt very positive about this type of examination (Fig 2). This hints at a systematic difference in how Swedish master program students and international master students are taught to learn.

Overall, the international students rated the course more positively.
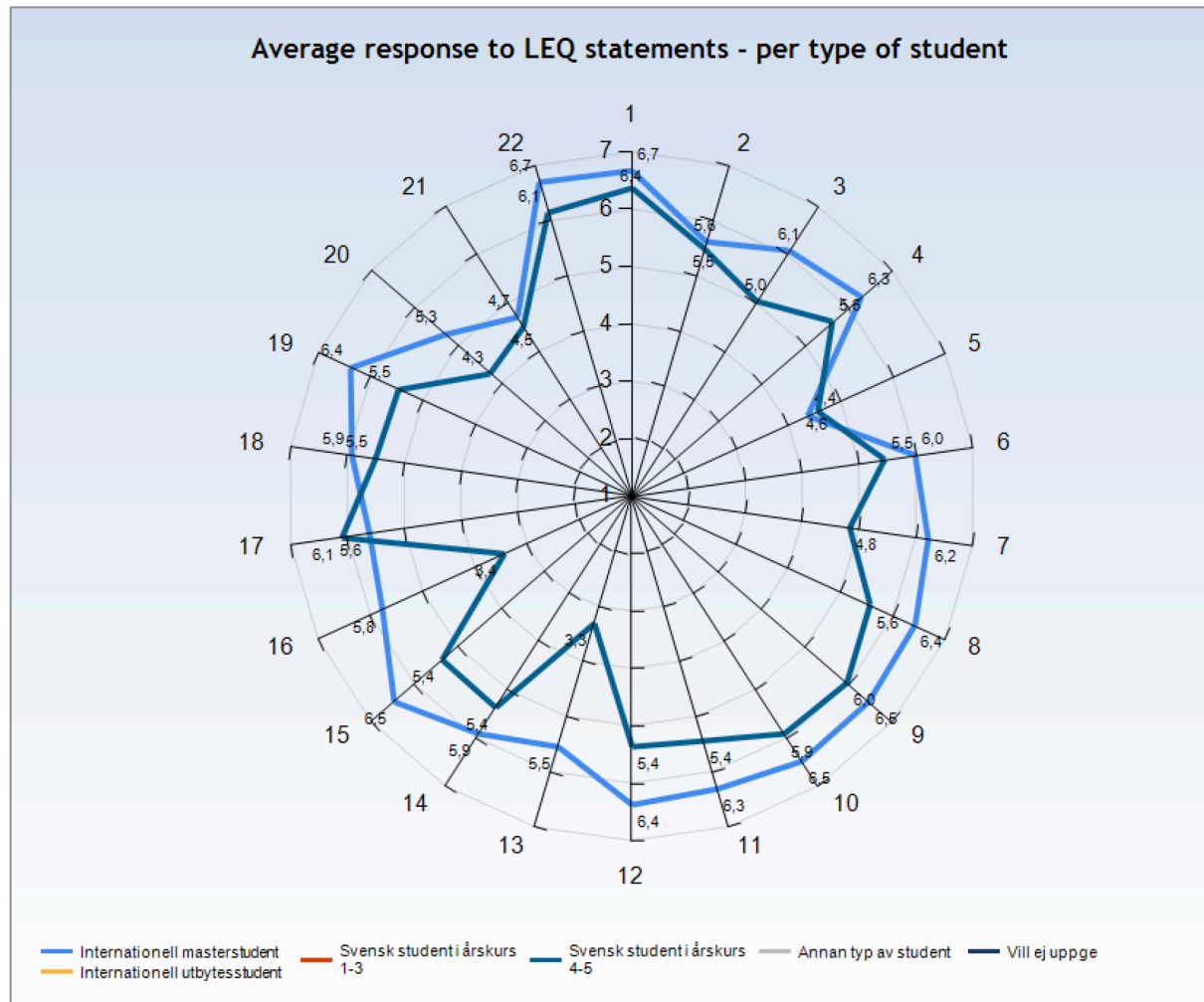
Figure 2. Note the difference for aspect 16 between Swedish program master students and International master students.

2. Summary of qualitative aspects from the LEQ - student comments

This year we received some 20 full pages of constructive comments!, most of which were redundant (especially regarding the open-book exam). I have therefore put together a selection of comments that frames the consensus, however, all comments are available upon request.

Comments on positive aspects of the course:

- I think the course was great all the way through! The lectures were interesting and the exercises and lectures combined really prepared me for both the project and the exam. The quizes were perfect to just recap what the key concepts of the lecture were so keep those on canvas in the future. I also loved the structure of the exam! The problems were super interesting and I loved that there wasn't any "memorizing" involved only problem solving. It really felt like we had practised and learned a new skill/way of solving problems during the course and now we got to really put them to use. So the best aspect of the course is that I truly feel like I've acquired a new skill for the rest of my life!

- The overall structure/organization of the course as well as the continuous and constant feedback. It allowed enough freedom for me to fully accomodate my own study technique while still being very clear what I was expected to do and when. The feedback was top-tier level and by far one of the absolute strongest points of the course. Even the quizes had really good feedback so I never felt like mistakes or "wrong" answers felt like wasted time. Quite the opposite. We hade another course parallel with this that had really poor usage of the quizes, so it take this to heart when I say that you actually made those useful! Kudos for awesome quizes and exercises!

- The best thing about the course was that it was interesting to know about structural biology since we have not encountered it much before. The exercises were good for understanding and it was fun to try out different programs for different things (like KiNG and PyMol). The project was also interesting and it was good that it was quite "free" so that everyone could do as much as they felt was appropriate for their level.

- The focus on practical analysis of structures FROM THE START was very good, in my opinion. Theoretical concepts were overviewed quickly, which is a good thing since it would have taken about four times as much lecture time to explain them in detail.

- I really enjoyed the computer exercises and the project. It was really helpful and a good way to actually use the knowledge from the lectures. I think it was really good that we had three different schedules project meetings, because it gave us plenty of time to ask the lecturers about the projects, and also helped me space out my own work. Also, I think that the lecturers did a good job throughout the course of emphasising the importance of the strcuture-function relationship, and pointing out what are specific examples and what are general concepts.

- I liked that the course included different learning activities such as the exercises and the project. The course covers an interesting topic. The instructions during the course were very clear. The canvas page had a very good layout, everything was easy to find. Good that lectures were recorded so they could be rewatched.

- The excersies! They were great to implement the knowledge from the lectures and I thought it went very smoothly remotely + we got feedback on what we wrote very fast which was great so that we could reflect and add things to our mind before the exam. The quizzes were great cause they forced me to go through each lecture and ska notes, which made it easy to pass the quizzes, and then benefitted me in the exam as well.

- The content of the course was very very interesting and important to our education. I think the lecture recordings were key to my understanding of the course, as I was able to learn at my own pace and choose to rewatch the lectures when I was most productive. I find that the quizzes were very helpful to know our progress in the course and I appreciate them so much. The project was also enjoyable and a nice change of learning method. The exercises were great too! All around, it was a really great course!

- The best aspect was allowing students to chose a study and write a project report about it. I liked that we were given options and digging into a specific subject made learning the course more interesting and relevant- relating it to real world science and issues. I also thought that each lecturer was very clear and had very well classes!

- I would like to add that there were very little aspects of the course that needed improvements and the course was splendid! I very much appreciate the time and effort that the teachers have put on the course. It was very evident to me as a student how much the teachers invested in this course. Thank you so much for teaching us all these tools and all this knowledge! It is guaranteed to help us achieve whatever goals we may have in this field! :)
- I really enjoyed the kinemages and the project. The kinemages and the project allowed me to explore course elements on my own, "play around" with different structures and actually seeing real examples of what we learnt in the lectures.
- The professors were available at any moment for clarification and help during the entire course. I personally liked the exam typology, which allowed us to test our abilities on practical analysis.

Comments on aspects that can be improved:
- Most of the criteria were well understood, including structure validation and analysis, and researching about a protein's characteristics. However, complex thermodynamics equations of kinetics and probability seem absolutely out of the scope of the course.
- Extremely many deadlines with the quizes, exercises and project. Think that should actually give an "E" since you did it individual.
- I like that the exam was in the open book format, but like my peers has already said, I am not at all happy with the time limit. From when I read what was asked of me until the very end, I was a bit panicked and jumped between questions frenetically since I did not want to spend too much time on one question and not having time with the others. At least for my part, that got me to work in a very unorganized way. I appreciate that you listened to our concerns and added half an hour to the time, but I would still have liked more time and to know the "real" time limit from start.
- I think the exam tested our ability to answer the questions as quickly as possible rather than our understanding of the course. It would have been better if we had more time.
- Maybe one smaller writing task to prepare the student for future exams? From my perspective, one of the most subtle problems, but also one of the most impactful ones, was that it was really hard to prepare oneself for the exam. The time constraints has already been adressed so I won't rant about those, but by adding and/or replace a quiz with a written home assignment for investigating a particular enzyme, the students would have been a bit more prepared for how the digital distant exam was designed.
- I know it was a new concept with the exam but it felt so unfair and every single one I have talked to in the class feels the same. Task 1 was fully reasonable and expected but task 2 a bit too long but task 3 just a joke with super long instructions and so many questions. Also if she want to focus such a huge part on the topics discussed (not shown on old exams so really unexpected) she should hand out examples before hand so we can practice the calculations. The lecture she held of it was really unstructured and hard to follow.

Some of the students' advice to future course participants (CD: the comments are truly excellent! - couldn't have said it better myself):
- Follow the course from the start, it follows a red line very well.
- Scan the canvas well in advance. that will help you understand the course better.
- Pay attention, do the quizzes on time, and be prepared for lab courses.
- Revise concepts early on - it's so much easier later in the course if you know how to recognize basic motifs!
- Start early with the project; it doesn't take that much time and effort if you do it little by little.
- To pay attention in each lecture because the teaching is really good
- Start reading your project straight away because you'll get much information to reflect thought the lectures and also the knowledge you'll get from the labs contribute towards the project quite a lot.
- Spend less time learning theoretical examples and more time self-reflecting on how to apply information in concrete examples.

- Always watch the videos and read the instructions thoroughly before an exercise because this will really get you started quickly and most difficulties/questions will vanish.
- Make sure that you look at all the requirements and take a look at the stuff of the labs before you join the zoom call.
- Keep up with the course, listen to the lecturers, don't be afraid to ask for help neither from other coursemates or the teachers, the earlier chapters of the book is really good complement to the lectures but the latter chapters are way to detailed to be really useful, don't be discouraged by failiure and trust your own competence
- Start work on the project early (I did, but then I left it sitting for too long), pay attention in the lectures and try to download and check the software well in advance.
- There is a lot of content right from the start of the course, but try to keep up from the start. It will make it a lot easier when it's time for the
- Try to focus on the structure-function relationship!
- When it comes to the project, try to start working on it or at least thinking about it early on in the course. Already in the first weeks, the lectures
- Go through ED maps and model validation, so you can start looking at that in the project already instead of leaving it until the end of the course
- As always, start studying when the course starts. Be prepared that both the exercises and the exam may take longer than you think.
- Start reading the article for the project as soon as possible. In case of open-book exam, It is important to have the ability to quickly browse through articles and pick out the text you want. This could be practiced through maybe reading Wikipedia casually?
- Do the study sheets from day one, and start with the project early on.
- Study continuously throughout the course and focus on understanding the different principles and how to apply the knowledge.
- Make sure that you understand all central concepts and make sure to always ask yourself "why". Like, why does this structure look like this, why do we need to validate that... etc.
- Stay on course with the lectures! It is very easy to fall behind, but by taking notes and reflecting on each lecture, the examination becomes a lot more easy. Also, reflect on the exercise questions!
- Watch the lectures. Take good notes. Read the reading material. The kinemages are helpful for understanding so don't forget to review them.
- Study for the quizzes but don't forget to reflect on the concepts as a whole. When working on the project, focus on the parts that are relevant for the course.
- Watch the tutorials on how to use King etc properly before you take other peoples time on the computer lab sessions.
- If you have time, please read all the material the teacher recommended.
- Start with the project in time, it is more fun to have time to think about the project when introduced to new areas to explore during the lectures and thus get a deeper understanding about the new areas, since you already have a real-life example.

Comments on aspects of gender, equality, disability, and work load
- My gender did not matter in this course, all were treated equally. I am very happy to have had two female teachers in the same course, you guys are smart and powerful women and great role models for us newcomers in the field. Thomas you were great too, I enjoyed your lectures very much. But a special thanks to Christina and Lucie for doing what you are doing and paving a way for the rest of us girls in tech.
- I did not sense that my gender made a difference for my experience during the course everything is great. gender neutral.
- Never reflected upon this (gender) at all, so I think it's good? The focus was always on the subject. I like that both the book and lectures described scientific endevours by people of both sexes.
- I felt that I could ask questions anytime

- Sometimes it felt like questions was not appreciated and that some questions were perceived as not relevant enough. I understand the frustration when people ask on stuff that is clearly stated on Canvas however.
- Due to the school's registration policy, I had to come to Sweden, but so far I have been taking online classes. It seems like I can participate the course in my country. As an international student, listening and speaking are the problems I have to face. No other problems. Teachers are so nice.
- Jag brukar inte använda mitt FUNKA stöd eftersom det aldrig tidigare behövs men den här gången ångrar jag verkligen att jag inte utnyttjade utökad provtid.
- The workload was too big for the time given and I only guess that everyone would like to put down as much knowledge they have on the topic given. Every small detail takes quite a bit of time when doing a report on computer, like for example the citing is time consuming itself.
- The course was demanding but all the subjects were interesting and up to date with modern science which made it a lot easier to keep up. For me, the 4 hours assigned for computer labs was not sufficient. It took me couple of hours extra to finish and formulate the answers. It was good we had extra project time this year (compared to last), but regardless I spend a lot of extra time for project.
- I think the amount of work was perfectly reasonable and I loved that all the lectures were filmed and uploaded on canvas because this made it possible to rewatch parts that I might have missed or misunderstood. Even if the lectures will be given on campus in the future I think it's great to have them recorded as well.
- The workload during the course was just enough, not too much not too little.
- The most time-consuming activity of the course was probably the project, which felt unsurmountable at one point, but wasn't as bad in the end, thanks to the leeway allowed by the teachers to go in-depth according to one's ability, rather than a fixed number of requierements.
- I think that the workload in the is appropriate for the amount of Högskolepoäng, it's just a bit of a chock that the tempo feels quite high the first two weeks or so. However, this is good since it prepares you for the rest of the course and the project, and it works really well if you keep up with the lectures and the reading from the start.

Student comments "making my day" as a course organizer and mentor:

- It was nice. Swedish biostudents at KTH aren't really spoiled with good teacher-student communication like this (especially the earlier years)
- Thank you for a super fun course!
- Pedagogical teachers and the fact that the subject as a whole is very interesting and important was the best things.
- Extra thank you for all teachers for making this corse interesting.
- Thank you for a really interesting course! :)
- Thank you for a nice course!
- I particularly enjoyed the Lab courses. We utilized all the theoretical knowledge which allowed me to get a better understanding of both theory and applied techniques.
- I really enjoyed the kinemages and the project. The kinemages and the project allowed me to explore course elements on my own, "play around" with different structures and actually seeing real examples of what we learnt in the lectures.
- Thanks a ton for returning me back my love for the subject.
- The professors were always there for us and I am grateful for that
- The professors were available at any moment for clarification and help during the entire course. I personally liked the exam typology, which allowed us to test our abilities on practical analysis.
- The teachers were good at explaining. teachers are kind and support help if I needed it.
- Great teachers who knows their subject very well