Course analysis

BB2165 Biomolecular Structure and Function HT21-1

Course name: Biomolecular structure and function	Cycle: 2
Course code: BB2165	ECTS credits: 7,5
Term: HT21	Study period: P1
Course coordinator: Christina Divne	Examiner: Christina Divne
Number of new students 2021: 99	Passed students when the course ends: 94
Degree of examination: 97.1%	Answer frequency LEQ: 38%

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 range 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 2020 and pandemic)

- The weaknesses pointed out in the analsysi 2020 have been fixed.
- Implemented continuous examination including quizzes. A final larger exam at the end focusing on using knowledge rather than memorizing. The final exam is not in the format of open-book since that was not appreciated by the students last year.
- Complex thermodynamics equations of kinetics and probability removed.
- Exercise on homology modeling made more user-friendly and real-life oriented.
- One software (not several) for molecular graphics (KiNG).
- More study kinemages for self-study.
- Improved concretized learning outcomes for lectures, exercises, and project.
- More examples for the industrial biotechnology track (but mainly the project provides further specialization).
- On-campus this year instead of zoom - promotes more social and study interactions. Online learning only used for specific elements like course information and project presentations.
- Improved peer-review process.
- Other teachers have moved on to other courses and tasks. From 2021 only one teacher.

2. Summary of the course evaluation (LEQ) 2021

Based on both the statistical analysis of the LEQ and the comments, the 2021 course round was greatly appreciated and well received.

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
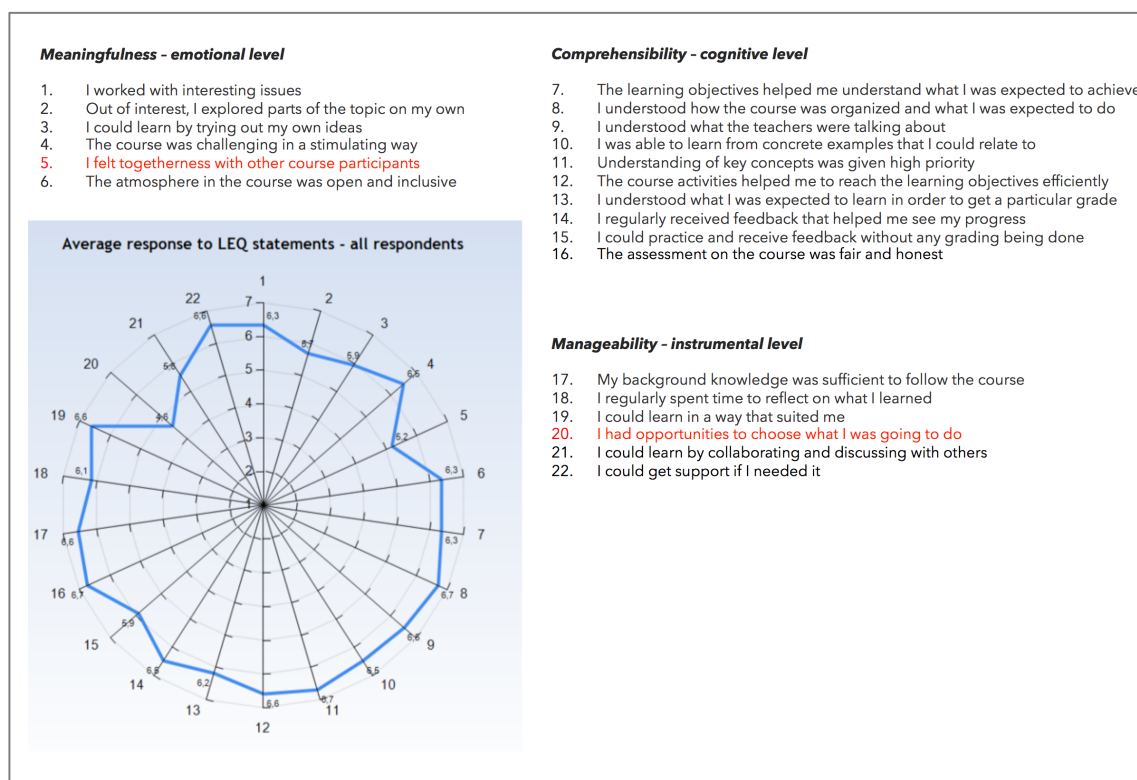22. I could get support if I needed it

Figure 1. LEQ questions and spider diagram for 2021.

The reception of the course round 2021 has improved considerably since 2020 (Fig. 2). I am very happy about the improvement regarding comprehensibility aspects, and particularly impressed by the increase in the students' perception regarding their understanding of what they were expected to learn to get a particular grade (aspect 13) and fairness of the assessment (aspect 16), which both increased from about 4 to 6-7. This shows that the information, concretized learning outcome and form of assessment (continuous examination) have provided important development in the positive direction.
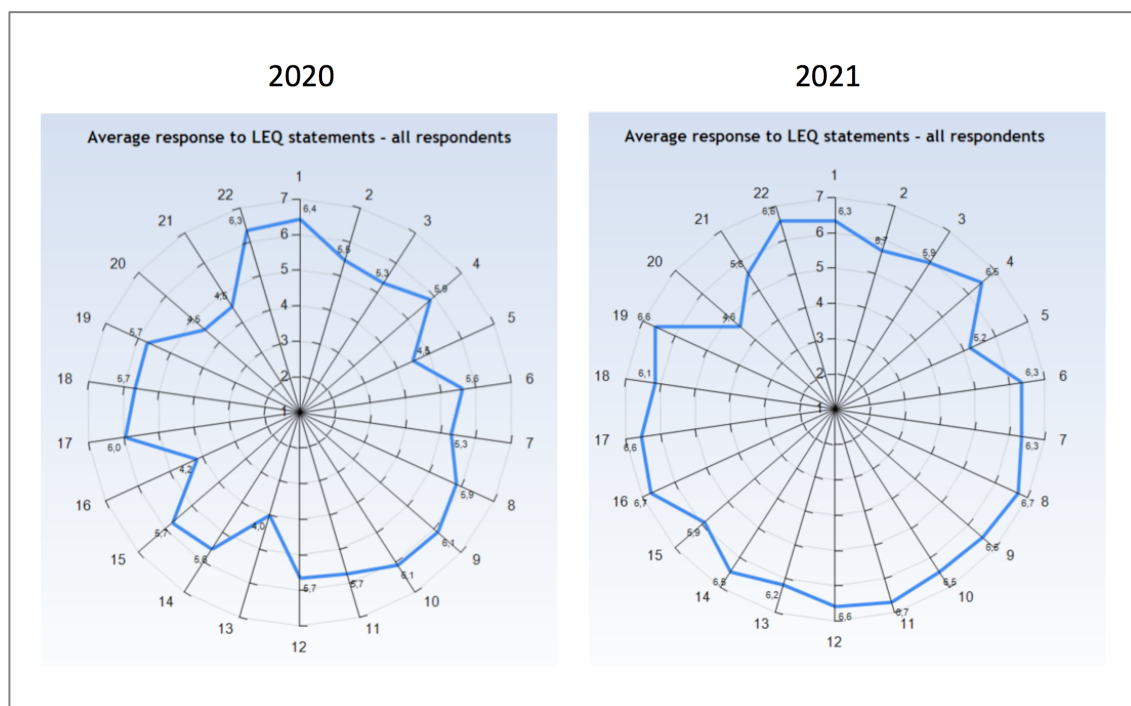

Figure 2. Comparison LEQ statistics 2020 and 2021.

The positive development is further highlighted by the many positive comments and constructive suggestions from the students for further improvement (see Appendix 1). The process of continuous examination is pictured below in Figure 3.
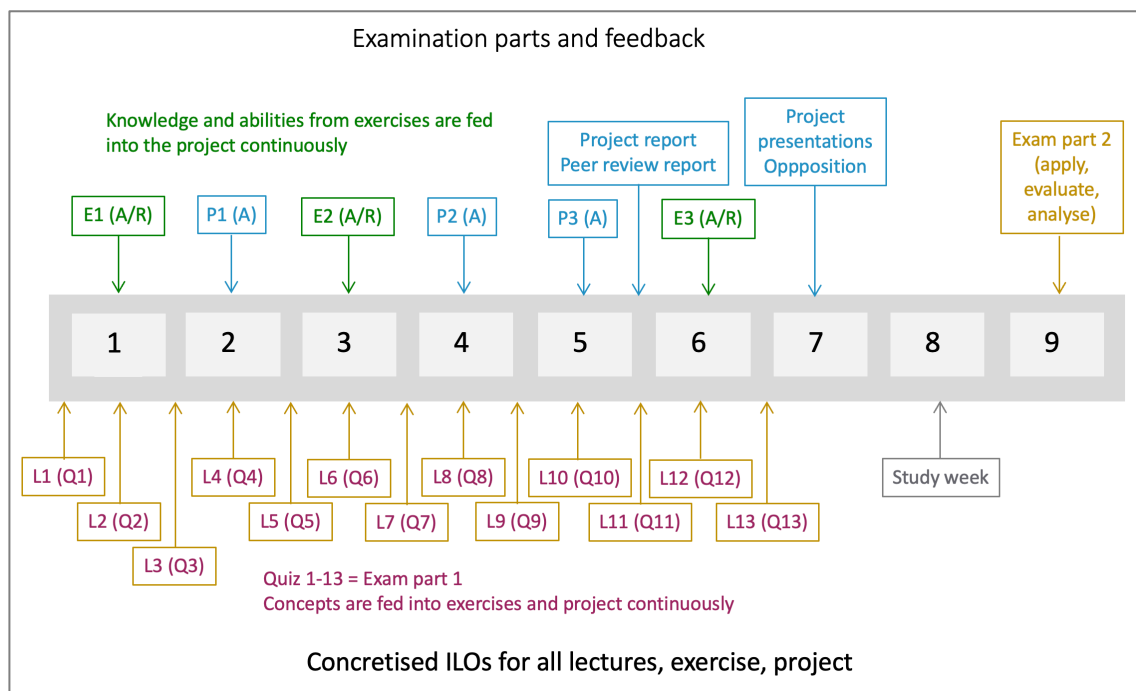

Figure 3. Scheme showing the process of continuous examination. The course weeks are numbered and examination activities indicated by arrows. L=lectures, Q=lecture quiz, E=exercises, P=project. All examination activities have concretized intended learning outcomes that align constructively with the course's ILOs.

3. <u>Reflections on execution and results 2021</u>

   a. *Strengths of the course:*
      - Most of the strengths were mentioned also previous years but the students 2021 proved to be overall more positive – particularly regarding improvements in assessment-related elements (continuous examination, concretized learning outcomes etc).
      - Continuous examination was greatly appreciated (see Fig. 3). All elements (lectures, exercises, and project) have concretized learning outcomes.
      - 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. *What to improve in the course for next course round 2022 (based on student suggestions):*
      - A distinct improvement for 2021 was that all lectures were recorded (in addition to given "live" on site) and this will remain also in the future.
      - A few students mentioned the planning of the project as a point of improvement, to enable students to work in groups and provide more information early in the course. The students were allowed to work in groups during the 2021 course round but to examine this module the projects need to be individual, which means that the project topics still need to be individual even if

students work together. However, for next course round in 2022, the project will be described in more detail already during the first week.

- The suggestion to move exercises earlier in the course is understandable but problematic since also the theory needs to be covered and the project started, and importantly, the large number of students requires that all exercises are run in four batches which pose scheduling challenges. Possibly the exercises can be moved somewhat earlier and combined with the project sessions to also justify the project sessions as mandatory.

- We had some issues with the software not working properly. The reasons for this are twofold, firstly the IT support that had removed the Java software during the summer which required cause unnecessary problems, and secondly, a subset of students running certain OS on their laptops found that their Java applications were not compatible with their OS. There were more than 100 students all running on different platforms and OSs, and it's impossible for KTH to guarantee that all personal computers will be fully compatible with the software. I was clear on the fact that the computers in RB33 are those to be used. It is unclear how to solve this but for 2022 additional measures will be taken to make sure the installations in RB33 work and that those are used throughout the course. It will be on the students' own responsibility to approach the IT support for help with their own laptops.

- Regarding course topics the students are satisfied and find then relevant. One student suggested that we could expand on AI and machine learning. While these topics are not fully within the scope of the course, the course content relating to AI-based structure prediction is likely to be gradually expanded as the softwares develop with time.

- Most suggestions concerned the wish to have more example exams and example problems to work on as study material during the course. This will be accommodated in the next course round.

- The suggestion to open the quizzes in the morning is not a good idea. We had that earlier but since most students have lectures and practical in other courses during the day they were not able to devote time on the quizzes. I therefore decided to open the quizzes at 17 and keep them open for 48 hours.

- Something to be implemented in the future is a partially flipped course format. Of the lectures probably half will be flipped where the time on campus is used to dwell deeper into the topics (interactive student discussions etc.). Depending on the possibility to book suitable rooms, this will probably be tested for one or two lectures during 2022.

Appendix 1: Student comments 2021

Comments on "What was the best aspects of the course?":

- The course was very organised!

- The continous learning of the quizzes

- To work on the project and that the quizzes during the course covered the general facts

- The project was very helpful as an exercise in consuming and evaluating scientific literature

- The teacher was great! She really took her time to answer any questions and prepared a lot of relevant material for studying. The fact that we had continuous examination during the course was also great!

- The exercises and project. It gave me a lot of time to practice and get feedback as well as giving me a deeper interest in the subject.

- It was nice to have the quizzes after each lecture since it made sure that I was following along with the material.

- The exam structure and the hands-on modeling experience.

- I really liked the pre-recorded lectures. It helped me a lot to be able to pause and rewind, if something was difficult to understand and to have time to write at the same time. I understand it isn't very fun for the teacher, since some students probaby didn't attend the lectures because of that reason, but it was really good from a learning perspective. Also the quizzes and the excersises was a good way to implement the things you learned during the course, and studying for the exam was much easier since you automatically had kept up during the whole course!

- Excellent course and one of the best courses I have had. very well-structured and interesting. Instructions, teaching and general communication was great.

- The overall course experience! The content, structure, availability of the teacher, it all made the learning and experience much easier.

- The project, where I could work on my own and apply all the knowledge I had gained

- Good lectures + lecturer! Knowledge seems very usable

- I liked the problem solving aspects. It truly felt like an engineering course rather than a pure biology course. I was able to APPLY prior and new knowledge in a way that was very satisfying.

- The computer labs followed well the concepts in the lectures. The quizzes were very good idea, since not so many things needed to be memorised for the final exam. Except for folds and secondary structures.

- I found the best aspect of the course to be with the exam focused on applying concepts instead of memorizing information. This makes it more fun and also more useful in the future. I think this way of learning helps you to remember things longer instead of the short term memorization

- I enjoyed doing the quizzes and presenting the results of my project.

- I think it was good that the focus not was on memorising details, but to investigate and think to be able to solve more complex questions. Also I really like that the lectures are prerecorded so you can pause and go back, making it is easier to learn.

- As a student, a course is most often as good as the lecturer giving it. This course was very, very good, and that much thanks to Christina. I really felt that she put the time to give us the best possible opportunities to learn and to understand the course. Also, I really enjoy that we were given the choice to either attend lectures in achool or online via recordings.

- The course is challenging in a good way. It gives a lot of real life exampels, and you learn a lot. It applyes the knowlege and the computer labs are fun as well.

- Your personal comments after each exercises and after the project were really important and gave me extra motivation. It showed you cared about us learning well.

- It was a really interesting course. I believe the computer exercises were really good and they helped me understand the concept better. I also liked the quizzes because then I got a check on if I understood the lecture or not and what I had to go through again.

- The whole course was a great experience. The topics were really interesting, the course is designed and structured in a way that we appropriate the knowledge that is shared during the lectures, but what I really would like to highlight is the teaching methodology that Christina uses. She was very organized and clear about the topics and instructions for the activities during the course, and always shared practical examples to understand significantly the theory in practical scenarios. It was remarkable her passion and experience in this field and how she transmitted that in each lecture and activity. I could say that this course motivated me a lot and boost my decision to pursue my studies after coming from far away. I always received her feedback on my assignments, which contributed to improve my understanding of the topics. Another relevant aspect is that during our assignments we could associate the topics of the course with the sustainable development goals and it drove me to develop more critical thinking and solve-problem skills, which I am really thankful for that.

- The best aspects were the continuous examinations thorough quizzes, exercises and project. This lead to the exam being more "open" and it did not have to include memorisable information, such as was examined in the quizzes. The exam tested the students knowledge in a more fair way, than if memorisable information had been part of the exam. Being able to apply the knowledge aquired during the course is by far the best way to allow a student to show that they really understood the content of the course.

- Everything was very interesting and I like that the projects were individual instead of in groups, I feel like it helped me learn more and work better. I also liked the quizzes since it was a good way to see how much you had learned from the lecture and what you needed to study a bit more.

- I just want to thank you for an amazing course where I really felt that I have learnt a lot and I have a new found interest for structural biology!

- Great course! It was fun to take part of and I learned a lot. Christina is a great lecturer.

- The canvas page was so so so good!!

- Fantastic start to the master program! :)

- A very fun and great course.

- Thank you for making this course both fun and interesting, while maintaining a perfect level of challenges. I think the way this course was set up the topic more appealing to me than it otherwise would have been.

- I really enjoyed the dedication and the joy of our teacher regarding this course. Thank you Christina!

- Thank you for a very good and learning course.

- Thank you for the supervision of this course. It is the first time I have a teacher that is that much implicated in a course. It made it so much more efficient in my way of learning.

- The exam was also really intense but it is the kind of exam where we need to be creative which I really appreciated.

- Very good that you were super clear with how things work, for example, the exam. I think this was really helpful for all students that were new to KTH.

- I would be really happy that my next courses will be designed and structured like this one. How the information and material were organized in

- Canvas was really friendly in the course.

Comments on aspects that can be improved:

- While I see the importance of the different course activities. It might get to hectic from a student point of view. Therefore I would suggest that at least two students work on the project activity.

- I felt that the quizzes took up a lot of mental bandwidth over the course, which there might not be anything to be done about, as I thought they were a preferable method of testing memorization compared to having it come up on a written exam.

- More discussion sessions on various examples where a model or a map is shown and it is discussed in class with the validation and some questions to be answered, giving a more practical approach other than in exercises.

- The ability to further discuss core concepts and explore different parts of the course. Maybe changing out one of the exercises for a seminar where we discuss the questions?

- Maybe to give more information about the project earlier on in the course. As we could not always see beforehand what would be the main goals of each project session it was not always possible to be ahead in the project. For me the project finally clicked between the second and third session which made it a bit stressfull, even though I turned the project in on time I would have liked to be a bit more ahead of it and I feel like I couldn't be that. After the first session it felt like there was not much more you could do except read about the protein, but nothing about the validation. I understand that this probably has to do with the fact that the validation lectures comes later in the course but I think it would be good to explain this a bit more to the students so that they don't freak out early on in the project. Maybe show the example reports earlier or something.

- I think it would be better if the project sessions did not have mandatory attendance since it feels a little unneccesary to go to them if you did not need help or have questions.

- I hope, for next years students, that pre-recorded lectures are still provided. They were absolutely super for learning!

- KiNG had issues sometimes which did take up some time that could have been used elsewhere.

- Please please hire more teachers to this course so that Christina doesn't have to do it all on her own! It's been amazing and she's really good in her teaching, but it is not reasonable for her to manage all lectures, exercises, grading, and being available in a course with 100 people alone. That being said, she was amazing!!

- Some lectures (in particular, the immune system one) felt highly specific in a way were I didn't feel it was that connected to the rest of the course, which in contrast gave us general, useful tools for protein design and analysis. The immune system lecture felt more like some interesting but not very useful facts.

- Include a bit more on machine learning and artificial intelligence when it comes to protein folding prediction, since these are the methods of the future.

- For the exercise sessions, I would have liked there to be a longer introduction to the software and the tasks. This would be preferable to only having a video tutorial available.

- The quiz format. At times, you expected there to be a certain number of answers causing you to redo a question multiple times only to find out that you didn't choose enough answers. I think one would save more time if, in questions with many options, one could know how many answers there are.

- This is just a minor thing, and it is mostly related to the exam. I would have liked more chances to study molecules and being assessed on those studies. Like having an exercise where a few molecules with certain motifs were presented and thereafter discuss those.

- The project was very overwhelming at first and I felt left alone. It took me quite a while to find the information i needed to unterstand what I had to do. with time i found all the information, wich was actually there, but just in different places in canvas. Its probably had to improve this issue, but because the prodject is just a lot, but in a good way. But just maybe a thing to be aware of

- The critic I could have is that, in the end, we had very little time to analyze our paper and to write the report because the needed tools are introduced maybe a bit late...

- If the exercise session were earlier in the period, we could have had more time to analyze our structure and to write the report.

- Maybe, during the first lectures, you could have been more precise about the different deadline because for a first time in KTH, it wasn't easy to understand all those deadlines things and to understand how canvas worked...

- Regarding the project, it would have been nice to get all information about it (and the example reports) and the mandatory sessions (what we were going to do at them) at the beginning of the course. I was a bit stressed about the project because I felt like I did not have it under control because I did not know what I was supposed to do for a long time. I mainly thought the project was way larger/heavier than it actually was which stressed me in the beginning.

- Regarding the exam. It was a really good exam with good questions but I felt like I did not get the chance to show what I had learned during the course since there were so few and broad questions. This was probably because I did not really know how to study for this exam. I went through the lecture slides, my notes, the learning outcomes, the study kinemages, the exercises, my project and read the book. From this, I learned a lot but I was not really working on applying that knowledge to new problems. So, when I got the exam I felt like I had studied too much for the exam and that I probably would have been able to answer the questions without all that studying. I feel like it would have been better to study by working on questions/problems, like the "example exam questions". I, therefore, believe it would be helpful with more questions like that, and on more of the concepts/subjects.

- I would have liked to receive more personalized feedback about the oral presentation of the project, but it was understandable taking into account the number of students that were taking this course.

- More example answers to exam questions, for instance an answer from a student at all levels (A;C;E;F)

- Nothing

- Open the quizes directly after the lecture. When they open at 17 it feels like I have to do them when they open but the school day ends in theory at 17. Or open them the morning after the lecture.

- More problem solving and similar to the exam questions.

- It was a lot of work and I often felt stressed so it would be nice with a little less work, but at the same time I think I learned a lot from all the activities.

Students' advice to future course participants:

- Be active during the study period!

- You'll have quizzes after each lecture which is good and makes you not able to fall behind!

- Use the exercises as a guide to understanding your chosen study during the project

- Focus on the project and the labs, that will make the exam easier.

- Follow key concepts very nicely and keep track of what is being taught in class. You don't need to memorise a lot of stuff in the course.

- Focus on the exercises and the project. Read a bit every week in the book.

- Really take your time with the post-lecture quizzes. They are an amazing learning opportunity and if you start in time you won't have any problem finishing them on time, but don't wait too long, they are trickier than you think they will be!

- Read ILOs, ask questions if you have any, discuss with friends

- Start early with the project!

- Make sure you have the time to participate in the intended way. If you have a tight schedule or a lot to do, you will suffer from the strict deadlines.

- Keep up during the whole course (which is quite easy because of the quizzes and the exercises, where you get to implement the things you learn at the lectures) and start with the project on time!

- It feels a bit overwhelming at first with all the different deadlines and such but just be structured and it will be no problem.

- Keep up with the lectures for your own sake, the exercises become much easier. Also begin with the project early and try to match the pace with the exercises. Make sure to understand the project and exercises since they make up for the fundamental understanding of the final exam.
- Brush up on biochemistry and thermodynamics, so it'll be much easier to follow the key aspects.
- Understanding the general concepts of the course is the most important. If you were able to explain what the course is about to someone outside of this field, then you're on the right track!
- Finish the quizzes as soon as possible and work continuously with your project.
- Start with your project right away, and follow along the lectures given. This will give you a deeper understanding of the lecture, as you apply the theory yourself.
- The lectures in this course is super good, attend them!
- Whenever yoiu dont unterstand the comuter assignements or the prodject, try seaching through canvas first. Christina provides a lot of information on how to do something, even with videos. So often it helps to just check if the answer to your question is alredy explained on canvas.
- Organize your time well, especially be aware of every deadlines.
- Don't start things late... Things take time but you will be fine if you start in advance because the teacher and other students will be happy to help if your not running late!
- Many of the examples and images from the lectures can be found in the book, so if you don't understand the concepts during the lectures the book can be super helpful!
- Start on the project early on.
- Check the learning outcomes before each lecture and assignment (this is valuable information and is always available)
- Start working on the project since the beginning of the course.
- Plan your schedule and consider carefully the deadlines for the assignments and the quizzes
- Discussing the topics, exercises and lectures with your classmates contributes enormously to prepare for the exam and reinforcing your knowledge
- Start with the project in time, and get used to the course page on canvas. The course page can be very useful when you get used to navigating it.
- Take your time with this course, it will be useful at the exam to have done studying on KiNG models and create your own project based on validation techniques.
- Don't spend too much time on details. Instead, focus on trying to understand the underlying concepts that are being presented. And really take your time with the project and try to understand the article to the best of your abilties. The work with the project was of great help on the exam. Also, discuss concepts with your classmates, as everyone has different projects, you can all learn form each other.
- Put in the hours to understand the basics.
- The book was not that useful to read, skimming it is perfect and then focusing on the material from class (the lectures are fantastic).
- Start working with the project early and make sure you understand everything after each lecture in order to better understand the next one.
- Read the Learning objectives to understand the level of knowledge you need to know after each lecture.

Comments on aspects of gender, equality, and disability
- I am on the autism spectrum, and the fact that the course was very well structured with all the information to find on canvas, helped me a lot. Additionally, it was nice to get concrete examples, of what was taught, in the structures using KiNG.
- I really enjoyed the course.