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Congruence in a course in Nutrition Pathophysiology

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Background

Congruence describes the interrelationships between the intended learning outcomes (ILO's) and the strategies utilized to pursue them, and can be analysed specifically from the educational perspective regarding a specific educational program. It could be assessed from a course perspective and colleague perspective as well as from the students' perspective including the students' background, competences and preconditions (Hounsell & Hounsell, 2007; Rienecker, Jørgensen, Dolin, & Ingerslev, 2015). The concept of constructive alignment embodies the specific interrelationship of a course regarded as a teaching and learning system that functions optimally when the ILO's have appropriate high quality and align with the teaching and learning activities (TLA's) and the examination (Rienecker et al., 2015).

As course responsible and teachers in a newly introduced course, we have chosen to focus mainly on the course, students' and teachers perspectives of congruence in the 7.5 ECTS mandatory MSc course in Basic Nutrition Pathophysiology (BEP) during the first year of the 120 ECTS Clinical Nutrition (CN) educational program at Science, University of Copenhagen. One of the central modules of the course is the biochemistry module since it is the key topic in the two mandatory reports and integrates elements from some of the other course modules. In this assignment we therefore have evaluated congruence in relation to;

1. The "macro-perspective": How can the course conguence be enhanced?

2. The "micro-perspective": Can the students' ILO's in biochemistry be enhanced by increased knowledge about the students' background, competences and preconditions using a common screening tool before the course start?

The course have now been running for two years, and the congruence analysis in this report will therefore be based on the experiences of the teachers and evaluations provided by the students from the first course in 2016/2017 and the second 2017/2018. Further, we will address the potential focus points for future development of the course and suggestions for improving the congruence of the course in 2018/2019.

Construct of the MSc Clinical Nutrition Educational Program

Clinical Nutrition is about how food, nutrients and nutritional supplements are used in the treatment of diseased in order to shorten the periods and reduce the severity of illness, and to improve the rehabilitation. Hence, the educational program aims on a multidisciplinary basis to educate academics in the science of human nutrition (HN) and related areas concerning the nutritional impact of optimal function and treatment during diseases. The education qualifies to a variety of occupational functions and areas e.g. treatment and counselling of diseased in the primary and secondary sector, administration and management as well as research and teaching in the industry, government agencies, and research-and educational institutions.

Yearly, a maximum of 29 students can be accepted on the CN educational program. If the number of qualified students is exceeded, applicants with a BSc in clinical dietetics have first priority before BSc's in Food Science specialised in nutrition and health followed by BSc's in Natural sciences. The applicants with a BSc in Clinical dietetics or Natural sciences must have the following courses in their BSc educational program; 7.5 ECTS in biochemistry (including exercises), physiology, statistics and pathology and/or pharmacology, while applicants from Food Sciences must have the 7.5 ECTS course in pathology and pharmacology.

In 2017 there were 49 applicants. Twenty qualified applicants were accepted into the MSc program primarily from the BSc programs in Clinical nutrition or Food Science. Most of the students came directly from their BSc educational program whereas some of student, with a background as registered clinical dietitians with years of clinical experience.

The MSc program includes 60 ECTS mandatory courses in areas such as metabolism of nutrients, dietary habits and food culture, pathology and

nutrition physiology during illness, development of nutritional and diet plans for diseased, communication and behavioural therapy, evidence criteria in clinical nutrition, and quality assurance and management (Table 5.1). Furthermore, the program comprises of 15 ECTS in voluntary courses and finally a 45 ECTS MSc thesis.

Table 5.1. MSc Clinical Nutrition Educational Program

	Period 1	Period 2	Period 3	Period 4
Year 1	Nutrition Physiology	Evidence, Diet and Health	Nutrition Physiology During Illness and Disease and Nutrition Therapy	Quality assurance and Management
	Nutrition Related Diseases	Basic Nutrition Pathophysiology		Clinical Paediatric Nutrition
Year 2	Free courses	Thesis		
	Free courses			

Analysis

Construct of the course in Basic Nutrition Pathophysiology

The educational perspectives

Due to an extensive curriculum in the two initial courses the students' experience the workload in Period 1 as high. There are however no reports to deliver in these two courses and the TLA's are mainly classical lectures. Also the workload in Period 2 is high, but with quite different TLAs, due to multiple report deliveries (two in the BEP course) and several in the parallel "Evidence diet and health" course. However, according to the educational responsible for the two MSc programs in HN and CN Professor Susanne Bügel it is impossible to reorganising the order of the courses in Period 1 and 2 in order to modify the work load for the students due to the educational construct of the parallel HN program. The educational congruence will therefore not be discussed further in this report.

The course perspectives

The first BEP course located in Period 2, was held in 2016, with the perspectives to introduce the CN students to the thinking and practices of the

CN educational program, and to reduce the students' knowledge gap earlier experienced by the teachers, in the subjects organ and immune function, and the absorption, metabolism and excretion of nutrients, between the initial mandatory courses in Nutrition Physiology (7.5 ECTS) and Nutrition Related Diseases (7.5 ECTS) in Period 1 (Table 5.1), and the subsequent 15 ECTS CN course in Nutrition Physiology during Illness and Disease in Period 3.

The ILO's of the Period 1 course in Nutrition Physiology are e.g. that the students in detail should be able to reflect, describe and discuss the digestion, absorption, and metabolism of nutrients under normal physiological functions. The ILO's of the course in Nutrition Related Diseases are that the students should be able to describe the pathogenesis of the most important life style related diseases (i.e. the metabolic syndrome, type 2 diabetes and cardiovascular diseases), and describe the effects of life style on prevention and treatment of these diseases.

The subjects taught in BEP include absorption physiology, biochemistry, metabolism, immunology, and organ function, and the current ILO's are that the students should be able to:

Knowledge

1) Describe the absorption and metabolism of nutrients in the healthy body.
2) Describe the influences of pathological processes on organ function and the metabolism of nutrients.
3) Describe the immune system and explain the central immunological mechanisms during infections and apoptosis.

Skills

4) Communicate the basic features in cell functions and interactions with organ systems.
5) Describe and discuss disease related nutritional problems with peers and other health personal.

Competences

6) Integrated knowledge concerning the cell functions, the interaction between organ systems and disease related changes in organ functions in order to analyse and discuss nutritional consequences.

The teachers' perspectives

Some of the challenges while planning the BEP course are to balance the curriculum and aims in nutrition physiology between the "healthy, normal" and "pathological" state in order to fulfil all ILO's. Furthermore, to ensure a proper academic level, and to prevent too many repetitions from the earlier courses in Period 1 (Table 5.1) and at the same time prevent overlap with the subsequent course in Nutrition Physiology during Illness and Disease in Period 3 (Table 5.1), - aspects crucial for maintaining the students' learning motivation. It is therefore important for the course responsible of the BEP course to provide colleagues and invited teachers with sufficient information regarding the course objectives, the specific ILO's for the lecture and the students' background and knowledge, and to be the consistent teacher aligning the different modules with the report writing in order to prevent some of the course congruence challenges.

Biochemistry is one of the central and underlying teaching elements of the course. This subject is taught early on in the course, and combined with lectures in the different physiological systems, the students should gain an overview over; absorption, metabolism, transport, and excretion of the macronutrient components. The BEP course is, as earlier described, the first time that CN student have a specialized course directed solely at their educational program, and it is the first time that we, as teachers, stand in front of this student group. Although a 7.5 ECTS course in biochemistry is mandatory, the students within the program originate from diverse educational backgrounds and have varied professional experience, and therefore the level of biochemistry knowledge are varied.

The students' perspectives

The students in the CN educational program are few compared to those in the parallel HN program and the BEP course is the first course that the CN students' have on their own. The students' teaching environment therefore radically changes for the students coming from large anonymous classical lectures together with all HN students in Period 1 to an intimate and interacting- and thereby potentially more individually demanding teaching environment in the BEP course.

The course in Basic Nutrition Pathophysiology 2016/2017

The first BEP course in 2016 comprised of 10 two to four-hour sessions with mixed TLA's including lectures and within lecture group work, four discussion and compilation lectures together with the course responsible to improve course constructive alignment, and finally one in basic statistics together with the HN students (Appendix A). The students received a three hour lecture in biochemistry using a mix of TLA's including standard lectures and a small group assignment. The elements of the course were planned to appear in an order that would support the students in the parallel process of group-report writing e.g. the lectures in gastrointestinal and liver function and biochemistry were given during the first part of the course when the students were writing the first group-report concerning digestion, absorption and metabolism.

Further, the students had scheduled time to work on the two mandatory group-reports during the course. The subjects of the two group reports included an in depth description of the digestion, absorption, transport, metabolism and excretion of one macronutrient in the healthy normal state derived from a specific food component (carbohydrate, fat or protein), and potential changes due to a chosen disease. Report 1 included digestion, absorption and transport of the specific nutrient, whereas report 2 focused on metabolism and excretion including a brief description of the changes due the chosen pathology.

The examination assessment comprised of the writing- and approval of the two group-reports followed by a 30 minute oral examination starting with a 20 minute group-presentation of the two reports, and a 10 minute individual oral examination without aids assessed from the 7-level scale by two internal examiners. The individual examination typically comprised of two to three questions (including a relevant illustration) in regard to central physiological aspects related to the written report e.g. 1) describe the exogenous/endogenous transport of fatty acids including Apo lipoproteins,

enzymes and receptors involved, and 2) describe the transportation and excretion of CO2 from the cell to the lungs.

Evaluation 2016/2017

The evaluation is based on the feedback from students, teachers and the course responsible. The most relevant aspects of the online student evaluations are highlighted in Table 5.2.

Course perspectives

The lecture in cell biology was unnecessary since the student's had received a similar lecture with a higher academic level in one of the courses in Period 1. The lecture regarding kidney function was given to late in the course and did therefore not support the students at the proper time during the report writing. There was too much overlap in some of the lectures from the courses in Period 1. Besides cell biology the basics in immunology had already been included in the course of "Nutrition related diseases".

Teachers' perspectives

There was too much overlap in some of the lectures from the courses in Period 1. Besides cell biology the basics in immunology had already been included in the course of "Nutrition related diseases". The teachers' experiences from the first year were that the academic level in biochemistry was highly variable and to a large degree insufficient among the students.

Students' perspectives

In general the students´ feedback were positive. The students' initial academic level in biochemistry was highly variable and to a large degree insufficient. On that background both students' and the teacher pointed out the need for more lectures in biochemistry. In parallel, the possibility for participating in the whole statistical introduction course with the HN students was raised by the students (1 week instead of a three hour lecture). In general the students found the compilation lectures useful for aligning the different modules and providing them with the possibility for repetition and clarification. Furthermore, students wanted to include peer-reviewing of the reports in order to learn the metabolism of other nutrients than the one chosen in their own report. Finally, some of the students wanted the

exam to include questions in regard to the whole curriculum and not just the objectives of the reports.

Pedagogical conclusions and perspectives of the BEP course, 2016/2017

Exchange the cell biology lectures and the discussion and compilation lectures with more time for biochemistry, statistical week and peer-review of the reports. Focus on students' prior knowledge in the subject biochemistry.

Table 5.2. Course Development and Former Evaluations

Evaluation theme	Comments, course 2017	Comments, course 2018
Student's perspectives	Better information in regard to the formal demands to the two reports Examination in the whole curriculum and not only in the reports One report instead of two and counting 40% combined with an oral exam in the whole curriculum counting 60%	Self-made groups or better planning of the groups Team work was challenging Too much time used on report presentation and peer feed
Educational perspectives	Instead of Nutrition physiology in Period 1. Structure it better with other courses. Many repetitions from the last course. Many assignments also in the parallel course so no time to read.	Team work in two different courses making it difficult to structure the time
Course perspectives	One report instead of two Group-opponents Remove the pathogenesis from the reports and ILOs and save to Period 3. More small exercises to comprehend the different subjects better (besides metabolism). The specific lectures should be planned in regard to the reports e.g. kidneys parallel with report 2 (excretion) Split the lectures to avoid 6 h in the same subject	The feedback from the other groups was too close to the submission. Some TLAs during lectures in physiological systems were missing a "nutrition angle". The literature was too basic for some subjects.

The course in Basic Nutrition Pathophysiology 2017/2018

In the course 2017/2018, the modified BEP course comprised of 14 two to four-hour lectures with a mix of TLA's including lectures and within lecture group work, and two discussion and peer-review lectures (Appendix A). The lecture in cell biology and the compilation lectures were exchanged with more time for biochemistry, a statistical week and peer-review of the reports. The following changes were included:

a. The first week of the BEP course the student's participated in a basic statistical course together with the HN students.
b. The students received six hours lectures in biochemistry using a mix of TLA's including standard lectures and a small group assignment, and further awareness about the student's prior knowledge within the subject biochemistry was sought to further increase the alignment between student's prior knowledge and the course ILOs. Further, the aim was to facilitate this by congruence between the ILOs, the teacher's awareness about the student's prior knowledge and the TLAs. This was done by applying an online pre-test to analyze student's strong and weak points and to specifically identify knowledge gaps (see appendix A). This new screening tool gave the teacher the opportunity to "choose battles". Meaning, that the TLAs were directed towards the most key element and knowledge gaps of the biochemistry subject which gave students a better opportunity to go deeper instead of broader into specific subjects. Based on experience from the course in 2017, where student focused their written assignments on protein and fat, lectures were also focused much more on carbohydrate metabolism and the most central pathways, which "bind" biochemistry together, leaving the in-depth information on fat and protein metabolism for the students to obtain during the written course work.
c. The section about pathological changes during the process of absorption, metabolism and excretion of macronutrients were removed from the group-reports. The reason was to support the students in focusing on the specific details in absorption, metabolism and excretion in the healthy organism. Furthermore, to prevent overlap with the report regarding absorption and metabolism focusing on pathology that the students will be asked to write in the subsequent course in Period 3 (Table 5.1).
d. Peer-reviewing of the two reports were included to give the students the possibility to learn about the metabolism of another macronutrients

than what they had chosen for their own report, but also in order to increase their more informal learning outcomes and skillset with elements such as scientific report writing and oral feedback.

e. The examination assessment comprised of the writing- and approval of the two group-reports followed by a 20 minute group-presentation of the reports, and a 10 minute individual oral examination without aids assessed by the same two internal examiners. The individual oral examination comprised of two questions – the same to all students within the same theme of the reports e.g. protein in regard to a central physiological aspect related to the reports.

Evaluation 2017/2018

The evaluation is based on the feedback from students, teachers and the course responsible. The most relevant highlights from the online student evaluations are presented in Table 5.2.

Course perspectives

The first week of the BEP course 2017/2018 was comprised of statistical lectures together with the HN students entailing a very brief course and reduced time for the initial group-work. The extra lectures in cell biology worked well as did advancing the lectures concerning respiration and kidney function in the second part of the course when the students were writing the group report focusing on excretion.

The TLA's included in the course to further support the students in the preparation for the exam (besides the lectures and writing of the group report) was a plenum group-presentations of the two reports, and providing peer-feedback to another groups reports. These elements gave the students the opportunity to practice the ability to discuss and to integrated knowledge concerning the various subjects from the course such as cell functions, metabolism and the interaction between organ systems.

Some of the teachers and students were displeased with the educational material, and that obtaining supplementary material was necessary in some subjects and especially in the group reports.

Teachers' perspectives

This year, an online pre-lecture test was applied before the lectures in biochemistry. In theory, this gave the teacher a "starting point" for the lectures;

however, in practice this worked both positively both also comprised some challenges. The test showed, as expected from the course year 2016/2017, that student's prior knowledge of the subject was diverse, and that a common "starting point" was quite difficult to identify. The pre-test also worked during the lectures as a "knowledge check-list", and was repeated after the 6 hours lectures in order to visualize for the students the expected minimum knowledge level.

According to the course responsible for the subsequent course "Nutrition Physiology during Illness and Disease" in Period 3 the perspective of the BEP course to prepare the students and reduce the students' knowledge gap has not been fully successful in regard to the level of physiological comprehension. A re-ordering of the themes starting with the major physiological areas such as blood circulation, and re-introduction of the discussion and compilation lectures were suggested for aligning the different modules and providing the students with the possibility for repetition and clarification.

A revision and more narrow and specific set of ILOs will improve the teachers' possibility to include more relevant TLAs.

Students' perspectives

The students' feedback of the initial week of basic statistics varied depending on the different BSc background. Most of the students' found the lectures helpful and needed while some of the students with BSc in food science thought the lectures were too basic and some of the students with BSc in clinical nutrition thought the academic level and pace were too high.

The students' feedback on the 6 hours of biochemistry was positive and gave them the opportunity to go in-depth with the most central pathways, and providing them with a solid ground for the group reports.

The congruence of feedback and assessment were good in terms of the ILO's 1, 4 and 6 (partly) since they were included and assessed during the group-report writing in terms of peer feedback during the oral presentation and group-opponent exercise. Also the oral exam was again mainly focusing on assessing the same ILO's. There were however a minimum of feedback and assessment focusing on the ILO's 2, 3 and 5, although they were included in the lectures to some degree as preparing students to the following course in Period 3 (Table 5.1). It is therefore understandable, that some of the student's again this year objected to primarily being evaluated only in certain aspects of the ILOs. Furthermore, the students asked for on-

line access to questions in order to prepare for the oral exam. This year, the assessment scheme was presented in the course description and orally to the students in the beginning and the end of the course, in order to give them a better understanding of the assessment format. The peer-feedback of the reports worked well and was well accepted by the students.

The students pointed at some disharmony in the group formation and pointed towards either making "self-made groups" or more strategic planning of the groups as strategies to improve this point. This has been discussed as an additional focus point for the course year 2018/2019, where we suggest basing group formation on different educational backgrounds, professional experience and specific competences within different subjects.

Pedagogical conclusions and perspectives

Based on the evaluation from the students in the BEP course 2017/2018 and experiences by the teachers and course responsible, some further modifications have been discussed. These include:

a. Reformulation of the ILOs (will be implemented for the course 2018/2019)

   We suggest modifying the ILO's in order to avoid overlap and distinguish between the BEP course and the course in Nutrition Physiology During Illness and Disease and Nutrition Therapy in period 3. Furthermore, to narrow and specify the ILO's to better reflect the actual learning focus and outcome of the course and thereby enhance the course, students, and teachers impression of constructive alignment.
   The modified ILO's are as follows:

   Knowledge

   1) Describe and explain the absorption, metabolism and excretion of macronutrients in the healthy body.
   2) Describe organ functions in relation to absorption, metabolism and excretion of nutrients.
   3) Describe cell, organ and immune functions and mechanisms of cell death in the healthy body and relate to basic pathological processes.

   Skills

4) Communicate, describe and discuss cell, organ and immune functions and mechanisms of cell death in the healthy body with peers and other health personal and relate to basic pathological processes.
5) Communicate and discuss absorption, metabolism and excretion of macronutrients through cells and organ systems with peers and other health personal.

Competences

6) Integrated knowledge concerning the cell, organ and immune functions in order to analyze and discuss macronutrient metabolism in the healthy body and relate to basic pathological processes.
7) Integrated knowledge concerning the regulation and effects of supply of blood and oxygen on cell, organ and immune functions.

b. The week course in statistics was cancelled by NEXS, Frederiksberg Campus educational board, and therefore 12 lectures were "returned" to the BEP course providing more time for introduction, group formation and group work.
c. The individual oral exam will besides the questions related to the reports also include one question on the course curriculum.
d. The text book in Medical Physiology will be exchanged in the course 2018/2019 with the same one used in Period 3. Further, the relevance and necessity of including supplementary materials for example during report writing will be highlighted verbally and in writing during the course to make the students aware of their responsibility to perform relevant literature search.
e. The themes will be re-organized starting with the major physiological areas. The course responsible will give a brief oral feedback of the first report, and only one group presentation and peer-review session of the reports will be included. Discussion and compilation lectures have been re-introduced to improve course alignment and the students' understanding (Appendix A).
f. The biochemistry "pre-test" used 2017/2018 to evaluate the students' pre-requisitions will be combined with a guideline for the basic academic entry level supplemented and relevant YouTube videos (Appendix C) to provide the students the ability to pick up lacking knowledge. Furthermore, an on-line study questionnaire will be developed in all modules to match the students' and teachers' academic expecta-

tions, and to provide the students' with subject specific study questions to be used before and after lectures as well as for repetition before the oral exam (see example Appendix D).

Appendixes

A Lecture plans for 2016/2017, 2017/2018 and 2018/2019.

B-C The biochemistry questionnaire used in 2017/2018, and the suggested changes in the course 2018/2019.

D On-line questions to specific modules.

References

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A

Appendix 1 Course plan 2016-2017, 2017-2018 and 2018-2019

	2016-2017	2017-2018		2018-2019	
	Theme				
	Kursus introduction				
1	**Basal cellebiologi** At den studerende kan beskrive opbygning og funktion af celler, samt basale cellebiologiske processer herunder transportmekanismer	1-20	**Statistik**	1-4	**Kursus introduktion,** gruppedannelse, introduktion til Temaopgave 1 og 2 samt mundtlig fremlæggelse og gruppe-opponering.
2-3	**Basal cellebiologi** At den studerende kan beskrive opbygning og funktion af celler, samt basale cellebiologiske processer herunder transportmekanismer			5-8	**Respirationsfysiologi** At den studerende kan beskrive respirationsfysiologien i den raske organisme, samt hvordan lungefunktion påvirker metabolismen af næringsstoffer.
4	**Gruppedannelse og introduktion til temaopgave 1**			9-12	**Gruppearbejde**
5-6	**Absorptionsfysiologi** At den studerende kan beskrive og relatere digestion og absorption af næringsstoffer og metabolismen heraf i den raske organisme			13-20	**Hjerte/kredsløb fortsat** At den studerende kan forstå og redgøre for hvordan hjerte-kredsløbet sikrer transport af næringsstoffer og metabole affaldsprodukter til og fra celler.
7-10	**General introduction to statistical analysis** At den studerende kan forstå teorien bag og anvendelsesområdet for de grundlæggende statistiske analyser			21-24	**Gruppearbejde**
11-12	**Immunologi** At den studerende kan forstå og beskrive immunforsvarets opbygning og funktion			25-28	**Absorptionsfysiologi** At den studerende kan beskrive og relatere digestion og absorption af

					næringsstoffer og metabolismen i den raske organisme.
13-14	**Centrale immunologiske processer ved infektion og celledød** At den studerende kan forstå og beskrive immunforsvarets opbygning, redegøre for immunologiske mekanismer ved bl.a. infektion og celledød			29-32	**Lever, opbygning, funktion, metabolisme** At den studerende kan forstå og beskrive leverens opbygning og basale funktioner samt metabolisme.
15	Diskussion/opsamling af cellebiologi og immunologi, relation til KE			33-35	**Øvelse: Cirkulation, absorption og levermetabolisme** At den studerende kan forstå og beskrive hvordan næringsstoffer fra et måltid absorberes samt transport til og metabolisme i leveren.
16-18	**Lever, opbygning, funktion, metabolisme** At den studerende kan forstå og beskrive leverens opbygning og basale funktioner samt metabolisme			36-43	**Den intermediære metabolisme introduktion** At den studerende kan beskrive og redegøre for metabolismen af næringsstoffer i den raske organisme.
19	Diskussion/opsamling, absorptionsorganer, relation til KE			44-47	**Arbejde med temaopgave 1** **Sende temaopgave 1 (e-mail: kursusansvarlig) for feedback**
20-27	Arbejde med temaopgave 1		**Kursus introduktion, gruppedannelse og introduktion til Temaopgave 1 og 2**	48-50	**Øvelse: Cirkulation og metabolisme** At den studerende kan forstå og beskrive hvordan næringsstoffer fra et måltid absorberes, transporteres og metaboliseres i forskellige væv.
28-30	**Den intermediære metabolisme** At den studerende kan beskrive og redegøre for metabolismen af næringsstoffer i den raske	20-26	**Den intermediære metabolisme** At den studerende kan beskrive og redegøre for metabolismen af næringsstoffer i den raske	51	**Feedback temaopgave 1**

	organisme		organisme		
30-36	**Hjerte/kredsløb** At den studerende kan redgøre for hjerte-kredsløbets basale opbygning og funktion, samt eksempler på hvordan sygdom kan påvirke den normale regulering	27-31	**Centrale immunologiske processer ved infektion og celledød** At den studerende kan forstå og beskrive immunforsvarets opbygning og redegøre for centrale immunologiske mekanismer ved bl.a. infektion og celledød	52-55	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering.
37-40	Fremlæggelse af temaopgave 1, diskussion i plenum	32-36	**Lever, opbygning, funktion, metabolisme** At den studerende kan forstå og beskrive leverens opbygning og basale funktioner samt metabolisme	56-59	**Arbejde med temaopgave 1** **Sende temaopgave 1 (e-mail: kursusansvarlig) for feedback**
	Aflevering af temaopgave 1 (aot@nexs.ku.dk)	37-40	**Absorptionsfysiologi** At den studerende kan beskrive og relatere digestion og absorption af næringsstoffer og metabolismen heraf i den raske organisme	60-62	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering.
40-42	Diskussion/opsamling af metabolisme i relation til KE	41-44	**Arbejde med temaopgave 1**	63-65	**Øvelse: Metabolisme og ekskretion** At den studerende kan forstå og beskrive hvordan næringsstoffer fra et måltid absorberes, transporteres og metaboliseres samt hvordan metabole restprodukter udskilles.
43-44	**Respirationsfysiologi** At den studerende kan beskrive respirationsfysiologien i den raske organisme, samt eksempler på hvordan sygdom kan påvirke den	45-52	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og	66-70	**Centrale immunologiske processer ved celledød** At den studerende kan forstå og redegøre for centrale immunologiske mekanismer ved celledød.

	normale regulering		metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering		
45-46	Gruppevis feedback på temaopgave 1 + introduktion til temaopgave 2	53-56	**Fremlæggelse af temaopgave 1** samt aflevering til opponentgruppe At den studerende mundtligt kan redegøre for hovedindholdet i Temaopgave 1 (15 + 5 min). At den studerende aktivt tager del af undervisningen i form af konstruktiv tilbagemelding på øvrige gruppefremlæggelser	71-74	**Gruppefremlæggelse af temaopgave 1 & 2 med feedback**
47-50	Arbejde med temaopgave 2	57-60	**Respirationsfysiologi** At den studerende kan beskrive respirationsfysiologien i den raske organisme, samt eksempler på hvordan sygdom kan påvirke den normale regulering.	75-78	**Arbejde med temaopgave 2** **Aflevering af temaopgave 1 & 2 til opponent + assisterende gruppe**
50-53	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende kan forstå og beskrive nyrernes basale opbygning, funktion og metabolisme	61-64	**Gruppe-opponering** (20 min per gruppe) At den studerende aktivt og konstruktivt tager del af en anden gruppes Temaopgave 1 i form af mundtlig opponering.	79-82	**Gruppe-opponering** (10 min feedback fra hovedopponentgruppen + 5 fra assisterende gruppe). At den studerende aktivt og konstruktivt tager del af en anden gruppes temaopgaver i form af mundtlig opponering.
54-58	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering	65-71	**Arbejde med temaopgave 1**		**Spørgetime og kursusevaluering**
59-60	Fremlæggelse temaopgave 2 med diskussion		**Aflevering temaopgave 1 (aot@nexs.ku.dk)**	83-90	**Arbejde med temaopgave 2** **Aflevering af temaopgave 2 (e-mail: kursusansvarlig)**

61-62	Arbejde med temaopgave 2	72-78	**Hjerte/kredsløb** At den studerende kan redgøre for hjerte-kredsløbets basale opbygning og funktion, samt eksempler på hvordan sygdom kan påvirke den normale regulering		
63-70	Arbejde med temaopgave 2	79-90	**Arbejde med temaopgave 2**		Eksamen (20 min gruppefremlæggelse + 10 min individuel eksamination)
	Aflevering af temaopgave 2 (aot@nexs.ku.dk) Spørgetime og kursusevaluering	91-94	**Fremlæggelse af temaopgave 2** samt aflevering til opponentgruppe At den studerende mundtligt kan redegøre for hovedindholdet i Temaopgave 2 (15 + 5 min). At den studerende aktivt tager del af undervisningen i form af konstruktiv tilbagemelding på øvrige gruppefremlæggelser.		
71	Gruppevis feedback på temaopgave 2	95-97	**Gruppe-opponering** (20 min) At den studerende aktivt og konstruktivt tager del af en anden gruppes Temaopgave 2 i form af mundtlig opponering		
	Eksamen		**Spørgetime og kursusevaluering** **Aflevering af temaopgave 2 (aot@nexs.ku.dk)**		
			Eksamen		

B

Appendix 2 Biochemistry Questionnaire (pre-test), 2017-2018

1. Hvordan bedømmer du selv dit kendskab til biokemien? (a.Intet kendskab; b. begrænset kendskab, c. Middel kendskab; d. jeg kan teorien fuldstændigt, men har begrænset praktisk viden; e. jeg er skarp både teoretisk og praktisk).
2. Beskriv dit kendskab til biokemien – og evt. tidligere kurser. Beskriv gerne evt. mangler/svagheder og styrker i din viden, så vi kan tilrettelægge undervisningen efter det. Endvidere kan du her stille specifikke spørgsmål til forelæsningen, som du gerne vil have, at vi tager fat på.
3. I hvilket kompartment i kroppen er kalium højest (a. extra-cellulært; b. intracellulært; c. Der er ligevægt mellem de forskellige kompartments).
4. Hvad er pH i det raske individ (a. pH 7.35-7.45; pH 7.75-7.80; pH 6.05-6-15).
5. Hvilke ”pumper” er med til at opretholde membranpotentialet i kroppen (a. Calcium-pumpen; b. adrenalin-pumpen, c. Na/K-pumpen).
6. Hvilket molekyle er det mest energirige i kroppen? Og hvor mange phosphatgrupper indeholder det? (a. ATP, 3 phosphatgrupper; b. ATP, 2 phosphatgrupper; c. ADP, 2 phosphatgrupper).
7. Hvad er forskellen på en co-faktor og et co-enzym? (a. Co-faktorer er organiske/in-organiske dele af enzymet (eks. Hæmoglobin, myoglobin etc.). Co-ezymer er organiske, ikke permanent bundne ”bærere” (eks. Jern, zink); b. Co-faktorer er organiske/in-organiske dele af enzymet (eks. Specifikke aminosyrebestemte bindingssites). Co-ezymer er organiske, ikke permanent bundne ”bærere” (eks. Jern/zink); c. Co-faktorer er organiske/inorganiske dele af enzymet (eks. Jern og zink). Co-enzymer, er organiske, ikke permanent bundne ”bærere” (eks. NAD+)
8. Indsæt de manglende ord i den nedenstående tekst: Hydrogen/elektronbærere (/) afgiver som driver en pumpe, der pumper hydrogen ioner over den indre membran. Dette resulterer i en proton-gradient, der driver via ”lollipop”-princippet til at omdanne til . (a. NADH/FADH, elektroner, mitochondria, ATP-synthasen, ADP til ATP; b. ATP/ADP, protoner, mito-

chondria, ATP-synthasen, NADH til FADH; c. NADH/FADH, kalium, mitochondria, natrium/kalium-pumpen, ADP til ATP).

9. Hvad er den primære "lager-form" for glucose? (a. Fedt; b. Glycogen, c. glucose).
10. Kan fedt omdannes til glucose? Og hvis ja, hvordan (beskriv)? (a. Ja, omdannelsen er reversibel, b. Nej, ensymet der omdanner pyruvat til acetyl-CoA er ikke reversibelt, c. Nej, ikke direkte, fedt omdannes via Krebs cyklus til glucose).
11. Hvilke er de 3 hoved-pathways, der er involveret i omdannelse af glucose til energi? (a. glycolysen, krebs cycklus, oxidativ phosphorylering; b. Glyconeogenesen, oxidativ phosphorylering og respirationskæden; c. Glycolysen, Krebs cyklus, respirationskæden).
12. Glykogenlageret i musklerne er større end i leveren. Bidrager muskelglycogen depoterne tilsvarende til opretholdelse af blodsukkeret? (a. Ja, begge depoter bidrager lige meget; b. Nej, leveren er det primære organ i forhold til blodsukker-regulering. Glykogendepoterne i muskulaturen bruges primært i forbindelse med fysisk aktivitet; c. Depoterne i musklerne bidrager mere til opretholdelse af blodglucose, da de er direkte relateret til musklernes metabolisme i forbindelse med fysisk aktivitet).
13. Hvilket enzym er ansvarlig for at splitte et C-6 molekyle til 2 C-3 molekyler i glykolysen (a. aldolase; b. Triose-phosphat-isomerase; c. phosphorfructokinase-1).
14. Fruktose indgår også i glucolysen. Hvorfor afviger metabolismen af dette molekyle fra glykose? (a. Fruktose omdannelsen er "billigere" end glucose; b. Fruktose indgår efter pkt. 3 i glycolysen og springer derfor de to første ATP-krævende trin over; c. Fruktose metabolismen er modsat glukose metabolismen ikke en reversibel proces).
15. Hvor meget ATP dannes der ud fra 1 mol glukose i glykolysen (a. 4 ATP (2 NADPH); b. 2 ATP (2 NADPH); c. 2 ATP (4 NADPH).
16. I hvilket væv er pentose-phosphat pathwayen vigtig? (a. Fedtvæv og røde blodlegemer; b. Fedtvæv og hjernen; c. fedtvæv og hjertemuskulaturen).
17. Hvor finder Krebs-cyklus sted (a. Ribosomerne; b. Cytosolen; c. mitochondria matricen på undtagelse af enzymet succinat dehydrogenase).

18. Hvad er målet med Krebs cyklus? (a. at generere energiholdige forbindelser til elektrontransportkæden, at fraspalte to c-atomer – og at regenerere oxaloacetat; b. At omdanne fruktose til oxaloacetat; c. at omdanne Acetyl-CoA til glucose).
19. Hvorfor er der forskel i ATP udbyttet på NADH genereret I cytosolen og mitochondria matricen (beskriv)?
20. Pyruvat kan omdannes videre af 4 pathways under forskellige omstændigheder. Hvilke og hvornår (beskriv)?

C

Appendix 3 Suggested changes for the lectures in biochemistry, 2018-2019

Students will prior to the lectures be made aware of the expected knowledge basic. This is done by providing them with a table (see below), which highlights the most important aspect of the intermediate biochemistry and additional source of knowledge, if they believed their knowledge to be insufficient:

You are expected, prior to arriving at the lecture in biochemistry, to be able to know/do the following:

Ability/knowledge	I believe I have the appropriate knowledge level. (Yes/no)	Supplementary knowledge Source
You should know the purpose (what is the physiological aim), the cellular location and the regulation of the following "biochemistry cycles" 1. Glycolysis 2. Gluconeogenesis 3. Krebs Cycle 4. Electron transport chain 5. Glycogen metabolism 6. Pentose phosphate pathway 7. Urea cycle/N-amino acid catabolism 8. Beta-oxidation/fatty acid synthesis 9. Oxidative phosphorylation 10. Ketogenesis 11. Triacylglycerol synthesis		Basics of metabolism https://www.youtube.com/watch?v=wQ1QGZ6gJ8w Krebs cycle/cellular respiration https://www.youtube.com/watch?v=juM2ROSLWfw Glycolysis https://www.youtube.com/watch?v=ArmlWtDnuys Regulation of glycolysis and glyconeogenesis https://www.youtube.com/watch?v=7fuLw031H-g Electron transport chain https://www.youtube.com/watch?v=mfgCcFXUZRk Oxidative phosphorylation https://www.youtube.com/watch?v=J30zpvbmw7s Pentose Phosphate Pathway https://www.youtube.com/watch?v=EP_E-7jPnNs Amino acid metabolism https://www.youtube.com/watch?v=l0V-Xmps1mE Fat and protein metabolism https://www.youtube.com/watch?v=GnXNTC3EyWg&list=PLbKSbFnKYVY0IFIZQsDo8ZfAq8oq8cgxg

You should be able to write down/draw the different intermediate steps (molecules) and the converting enzymes in the following "biochemistry cycles" (without using aids). 1. Glycolysis 2. Gluconeogenesis 3. Krebs Cycle		See overview on Absalon
You should be able to describe how the metabolic pathways of carbohydrate, fat and protein metabolism are linked and interacting.		Anabolism and catabolism https://www.youtube.com/watch?v=ST1UWnenOo0 Fat and protein metabolism https://www.youtube.com/watch?v=GnXNTC3EyWg&list=PLbKSbFnKYVY0IFIZQsDo8ZfAq8oq8cgxg Tissue specific metabolism https://www.youtube.com/watch?v=l_e1jq_I3sY
You should be able to describe and classify different types of enzymes,		Enzymes: https://www.youtube.com/watch?v=G7ZAwUdBNFE
their activities, and co-factors in the central metabolism. Further, you should know the basic principle of free energy differences in relation to spontaneous – or non-spontaneous running reactions.		&list=RDG7ZAwUdBNFE
You should and describe the basic physiological principles of cellular compartments, osmosis, pumps i.e. Na/K-pump), energy generation, and forms of energy (ATP, ADP etc.)		Osmosis https://www.youtube.com/watch?v=rCNlG_j_gSM Pumps (Na/K) https://www.youtube.com/watch?v=C_H-ONQFjpQ ATP https://www.youtube.com/watch?v=PK6HmIe2EAg

D

Appendix 4 On-line questions to specific modules, 2018-2019

1. Forklar hvordan triglycerid absorberes – fra tarm lumen til optag på den basolaterale side af enterocytten. Hvilke enzymer er involveret og hvordan reguleres disse?
2. Forklar omsætningen af fedtsyrer i enterocytten.
3. Beskriv den exogene og/eller den endogene pathway for fedtsyreomsætning.
4. Beskriv protein fordøjelse og absorption. Hvilke fordøjelsesenzymer er involveret og hvorledes reguleres disse?
5. Forklar mekanismen bag frigørelse af insulin fra pancreas.
6. Forklar hvordan henholdsvis syre- og bikarbonatproduktionen reguleres i forbindelse med fordøjelse af makronæringstoffer?
7. Beskriv absorption af triglycerier.
8. Forklar hvordan saltsyreproduktionen foregår og hvordan den styres i parietalcellerne.
9. Hvordan reguleres kroppens pH - hvilke af kroppens organer er hovedsageligt involverede og hvilke er de vigtigste buffersystemet?
10. Beskriv glukose-alanin cyklusen.