Sveučilište u Rijeci
University of Rijeka

BIOtech
Odjel za biotehnologiju
51000 Rijeka, Radmile Matejčić 2
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e-mail: ured@biotech.uniri.hr

Detailed implementation curriculum for the course:

Introduction to Research Methods

Academic year: 2023/2024

Program: Master Program "Biotechnology for the Life Sciences"

Course code: BLS101

ECTS credits: 9

Language in which the course is taught: English

Course teaching load: 90L +10 S + 16E

Prerequisites for enrolling in the course: none

Course teacher and contact information:

Assoc.prof. Rozi Andretić Waldowski, randretic@biotech.uniri.hr
Prof. Marta Žuvić, marta.zuvic@uniri.hr

Teaching staff

Assoc.prof. Rozi Andretić Waldowski (10L + 8S + 10E)
Prof. Marta Žuvić (60L)
Assist.Prof. Stribor Marković (9L)
Assoc.Prof. Nicholas Bradshaw (2L + 2X2E)
Assoc.Prof. Antonija Jurak Begonja (1L + 2X2E)
Assist.Prof. Milan Mesić (2L)

Consultation time: by appointment

Required reading:

1. B. Petz: Basic statistical methods for non-mathematicians, Naklada Slap, 2002.

A. Petrie, C. Sabin: Medical Statistics at a Glance, Blackwell Science 2000.

2. Kevin W. Plaxco: The Art of Writing Science, PROTEIN SCIENCE 2010 VOL 19:2261—2266
3. Introduction to Journal-style Scientific Writing, http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWgeneral.html
4. Other reading materials will be supplied during the class

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Recommended additional literature (optional):

1. Harvey Motulsky: Intuitive Biostatistics, Oxford University Press, 2018.
2. Vanja Pupovac:"Akademsko pisanje", http://akademsko-pisanje.sz-ri.com/
3. Matko Marušić i suradnici: Uvod u Znanstveni rad u medicini, Medicinska Naklada, Zagreb, 2013.
4. Mimi Zeiger: Essentials of Writing Biomedical Research Papers, 2nd edition, McGraw Hill, 2000.

Course description:

This course will give students the basic knowledge required for their future research work in research laboratories, which includes: preparing a hypothesis driven research plan based on scientific evidence in accordance with bioethical standards, and skills in presenting results of their work, writing a CV and project proposal.
In the bioethics part of the course students will learn: to distinguish scientific from non-scientific approaches, explain the characteristics of the scientific method and how it evolved from philosophy of science, understand the importance of ethical approaches in performing scientific research and objectively discuss ethical principles in modern bioscience.
In the science writing part of the course, students will learn to: independently search different literature databases, become proficient in the use of a reference management software, formulate a pertinent scientific question based on researched literature, formulate a hypothesis, understand the difference between different types of research methods, acquire skills in scientific writing, be able to write a Master thesis, research paper and be able to present their work in oral or poster form to either expert or lay audience.
In the statistics part of the course students will learn: the types of research and their characteristics with regard to sampling and features of new information provided by scientific research. Types of data and their relationships. Creating a database, creating a graphical way of displaying data and data distribution. Basic concepts of probability theory: random variable, probability distributions of random variable, central limit theorem and consequences. Concepts of populations and sample, type and characteristics of samples and of the concept of statistical hypothesis, null hypothesis and alternative hypothesis and the type of errors in statistical reasoning (errors of type I and II) and the relationship with the strength of the research. Correct formulation and testing of statistical hypothesis, selection of statistical test and statement, analysis and interpretation of results for: determination of difference of proportions, analysis of contingency tables, determination of data correlation measures, comparison of sample with given measure in population, comparison of central tendency measures of two or more samples,

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correlation of numerical data (single linear, nonlinear and multiple regression), correlation of numerical and categorical data (logistic regression and ROC analysis) and survival analysis.

Learning outcomes:

1. To gain general knowledge about the scientific method and hypothesis-driven research
2. To gain general knowledge about types of scientific investigation and example of scientific method applied during drug research development
3. To gain general knowledge about the characteristics and types of scientific literature
4. To gain practical skills related to using different search databases for literature searches and references management
5. To gain general knowledge about the elements and practical skills involved in formatting a Masters Thesis
6. To gain general experience about scientific writing
7. To gain specific experience in poster and oral communication
8. To gain general knowledge of bioethics as it applies to research work and publication
9. To gain specific experience about writing a project proposal
10. To gain general knowledge about communicating science to experts and lay audiences
11. To be able to express the types and forms of research and their characteristics with regard to sampling and the type of new information provided by scientific research.
12. To be able to distinguish data types and their relationships, correctly classify given data sets, create a database in an appropriate computer application, select and create an appropriate way of graphical data display and data distribution.
13. To be able to correctly interpret the basic concepts of probability theory, give an example of a random variable and how to quantify it, distinguish and determine the type of random variable, distinguish and explain probability distributions, correctly interpret the central limit theorem, make and analyse the probability distribution for selected random variables.
14. To be able to correctly interpret the terms population and sample and give an example, distinguish the types of samples and express their characteristics.
15. To be able to properly express the statistical hypothesis (null-hypothesis and alternative hypothesis), define and distinguish the types of errors in accepting or rejecting the statistical hypothesis and correctly interpret the relationship with the power of research.
16. To independently develop examples of setting and testing statistical hypotheses, differentiate and correctly select the appropriate statistical test with regard to data types, number and type of groups and successfully express, analyse and interpret results for: determining the difference of proportions, analysis of contingency tables, determining measures of categorical data, comparison of the sample with a given measure in the population, comparison of central tendency measures of two or more samples, correlation of numerical data (single linear, nonlinear and multiple regression), correlation of numerical

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and categorical data (logistic regression and ROC analysis) and survival analysis.

Detailed course content for part A (scientific method and communication):

A. Lectures

TITLE	HOURS & LECTURER
L1 Science vs pseudoscience	(1 H) RAW
L2 Introduction to scientific writing	(2H) CR
L3 Writing a research paper I	(2H) CR
L4 What is science	(1 H) SM
L5 History and philosophy of science	(1 H) SM
L7 Writing a research paper II	(2H) CR
L8 Scientific publishing process	(2 H) NB
L9 Preparing figures and legends	(2 H) RAW
L10 Critical reading – Journal club	(2 H) RAW
L11 Preparing a poster and oral presentation	(1 H) RAW
L12 Writing motivational letter and a CV	(1 H) AJB
L13 Research methodology in drug research and development	(7 H) SM
L14 Bioethics in research	(1 H) RAW
L15 Bioethics in publishing and communicating science	(1 H) RAW
L16 Writing a chemistry research paper	(2 H) TBD
L17 How to prepare a project proposal	(2 H) PK
L18 Science outreach	(2 H) RAW

B. Seminars

TITLE	HOURS AND LECTURER
S1. Chritical thinking vs pseudoscience	(1 H) RAW
S2. Writing a reserch paper	(2 H) CR
S3. Bioethics	(2 H) RAW
S4. Science outreach	(2 H) RAW
S5. Poster presentations	(3 H) RAW

C. Exercises

TITLE	HOURS AND LECTURER
E1 Writing a research paper	(2) CR

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E2 Literature search	(2x2) NB
E3 Mendeley reference manager	(1) RAW
E4. Figures and legends	(2) RAW
E5 Journal Club – critical reading	(2) RAW
E6 Results: description vs interpretation	(3) RAW
E7 Title abstract and aim	(1) RAW
E8 Editing	(1) RAW
E9 Writing motivational letter and a CV	(2 X 2) AJB

Required student's engagemend and scoring :

Classes are organized as a combination of lectures, exercises and seminars. Knowledge will be continuously assessed through: evaluations of seminar work, activity during exercise session and lectures and homework. Some seminars and exercises will be organized in small groups to increase group collaboration and ensure the development of practical skills.

Examination dates for part A:

The final exams will be on 30th October (part 1) and 27th November (part 2).
A second test date will be arranged if needed.
Additional test deadlines (maximum two, between January and June) will be arranged with students if needed.

Qualification and grades (according to Pravilnik o studijima Sveučilišta u Rijeci):

Assessment during the course (70%)
Students are going to obtain scores during the course, in the following areas:
Seminars (30%) – Students will be assessed based on their contributions to the S1 debates: 10 %. For S3 poster: content of their presentations (6 %), content and appearance of the poster (9 %) and their involvement in both asking and answering questions during the discussion phase (5%).
Continuous grading (**40%**) – Students will be assessed based on the quality of their homework. There will be 4 homeworks. Some assignments will be done in pairs and others individual. Homework will include: generations of Figures and legends, Scientific writing, Description and interpretation of results and Project proposal. 5% will be assigned for overall participation and activity during the entirety of the course.

Final exam (30%)

The final exam will consist of problem solving/ essay questions and multiple choice questions. Eligibility to take the final exam will be based on scores achieved during the course (out of a maximum of 70%).
Students scoring between 0 and 34.9% will not be allowed to attend the final exam.
Students scoring above 35% will be allowed to take the final exam.

Detailed course content part B (statistics and analysis):

Lectures:

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L1. Introduction to the course, contents and learning outcomes, work methodology and evaluation of student work.
L2. Statistics as a science. From data and facts to information and knowledge. Statistical methods. Types of research and data collection.
L3. Database design. Data entry method, formatting and verification of input accuracy.
L4. Types of data and ways of presenting them. Qualitative and quantitative data. Nominal, ordinal, interval and ratio variables. Tabular and graphical presentation of categorical data.
L5. Numerical variables and description using central tendency measures and scatter measures.
L6. Probability and statistics. Random variable. Types of random variables. Binomial distribution.
L7. Normal distribution. Moments of distribution. Central limit theorem.
L8. Population and sample. Sample characteristics. Random sample. Independent and dependent data groups.
L9. Statistical hypothesis and its testing. Parametric and nonparametric statistical tests. Output parameters statistical testing.
L10. Simple analyses of qualitative data. Display of qualitative data - frequencies, proportions and percentages shares. Proportion of sample and population. Testing the differences in the proportions of independent samples.
L11. Contingency tables. $\chi 2$ - test. Conditions for application of $\chi 2$ - test. Fisher's exact test.
L12. Measures of connection of qualitative data. Relative risk and odds ratio (chances). The connection of qualitative variables in dependent samples. McNemar and Cochrane Q test.
L13. Student's t-test. Conditions for applying the t-test. Types of t-tests. Comparison of the sample with a given measure in the population (sample t-test). Comparison of arithmetic means of two independent groups. Non-parametric version of the t-test for independent groups - Mann Whitney U-test. Effect sizes and their interpretation.
L14. T-test for dependent data groups. Non-parametric version - Wilcoxon paired values test. Size effects and their interpretation.
L15. Analysis of variance. Conditions for the application of analysis of variance. Homogeneity tests of variance. Post-hoc tests. Non-parametric version of the test - Kruskal Wallis ANOVA. Effect sizes and their interpretation.
L16. Analysis of variance on dependent samples - ANOVA for repeated measurements. Odd metric version – Friedman ANOVA. Effect sizes and their interpretation.
L17. Relationship of numerical variables. Correlation and regression. Single regression analysis. Correlation coefficient and its meaning. Significance of correlation coefficient. Regression direction. Coefficient of determination and its interpretation.
L17. Relationship of numerical variables. Correlation and regression. Single regression analysis. Correlation coefficient and its meaning. Significance of correlation coefficient. Regression direction. Coefficient of determination and its interpretation.
L18. Multiple regression analysis. Partial and semi partial correlation. Meaning of coefficients.

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Conditions for application.
L19. Nonlinear regressions. Logistic regression. Logistic regression parameters. Estimation of predicative value variables.
L20. ROC analysis. ROC analysis parameters and their interpretation. Sensitivity and specificity. Application of ROC analysis. Estimation of the predictive value of a variable.
L21. Survival analysis. Kaplan-Meier method of constructing life tables. Life table analysis and interpretation. Median survivor.
L22. Regression analysis for survivor analysis data - Cox regression and Cox proportional hazard model.
L23. Research design, analysis and interpretation. Linking the analysis to the research design.
L24. Research design. Calculating the required sample size. Strategies for analysis.

Obligations, method of monitoring and evaluation of students:
Students are expected to attend classes regularly and have an active attitude towards classes. The obligation of students in the course is to independently create 9 assignments that are submitted for assessment via e-course by the corresponding date (table).

Task	Deadline for submitting the task
Homework 1.	Data display - 06.11.2023 at 23:55
Homework 2.	Binomial and normal distribution - 08.11.23 at 23:55
Homework 3.	Normality of data distribution - 10.11.23 at 23:55
Homework 4.	Simple analyses of categorical data - 12.11.23 at 23:55
Homework 5.	Simple analyses of numerical data - 14.11.23 at 23:55
Homework 6.	Analysis of variances - 17.11.23 at 23:55
Homework 7.	Correlation analysis - 19.11.23 at 23:55
Homework 8.	Nonlinear regressions and ROC analysis - 21.11.23 at 23:55
Homework 9.	Survival analysis - 24.11.23 at 23:55

Task descriptions and task creation databases are available in the e-course, and data processing is performed using Excel, Statistica, GraphPad Prism and MedCalc software packages. The completed tasks are submitted to form a file named VJ_N_surname.doc (alternatively as a pdf file) via submit activity assignments in e-course. Each task is graded with a maximum of 10 points, and brings a total of 9 graded tasks maximum 70 grade points. Upon completion of classes, provided that 50% of possible grade points are achieved (a total of at least 35 grades), the student takes the final exam in the form of a test, on which can gain a maximum of 30 grade points. If the student is not satisfied with the grade achieved, he can request additional oral examination at the examination period, which must be performed no later than one day after taking the final test.

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Exam dates for part B:
1st exam will be held on 27.11.2023 at 12:00 and 13:00 in computer classroom O-359 (two groups of students).
2nd exam will be held on 11.12.2023 as agreed with the students.
The 3rd exam will be held in June 2024 as agreed with the students.
Qualification and grades (according to Pravilnik o studijima Sveučilišta u Rijeci):
It is possible to achieve a maximum of 100 grade points in the course. During continuing education, students can acquire a maximum of 70 grade points through the assessment of completed assignments, and at the final exam the remaining 30 grade points.
Students who achieved at least 35 grade points during the continuous part of the course may take the final exam. At the final exam, the student must have a minimum grade of 50% of the test (at least 15 points). According to the achieved total number of grade points in the course, the final grades are awarded.

Schedule of classes:

Date:	Group	Time	Hours in class	Class-room	Content	Lecturer
3.10.23	All	11:00-12:00	1L	269	Introduction Assignments L1A Sci vs Pseudosci.	Assoc.prof R.A.Waldowski
3.10.23	All	13:00-17:00	2L 2L	Online	L2A Intro to sci. writing L3A Writing a res. paper	Assist.Prof. C.Reynolds
4.10.23	All	8:30-12:00	1L 1L	269	L4A Science L5A History & Philosophy	Assist.Prof. S. Marković
5.10.23	All	8:30-12:30	2L 2E	Online	L7A Writing a res. paper E1A Writing a res. paper	Assist.Prof. C.Reynolds
9.10.23	1 All 2	11:30-13:00 13:00-14:00 15:15-16:45	2E 1L 2E	339 269 339	E2A Lit search L8A Sci publishing E2A Lit search	Assoc.Prof. N. Bradshaw
10.10.23	All	12:00-16:00	1S 1E 2L	268	S1A Pseudosci E3A Mendeley L9A Fig nad leg	Assoc.prof R.A.Waldowski
11.10.23	All	10:00-12:00 14:00-16:00	2L 2S	269 Online	L10A Journal club S2A Writing res. paper	Assoc.prof R.A.Waldowski Assist.Prof. C. Reynolds
12.10.23	All	9:00-13:00	2E	269	E4A Figures and legends	Assoc.prof

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			2E		E5A Journal club	R.A.Waldowski
16.10.23	All	9:00-12:00	2E 1L	269	E6A Results L11A Poster and oral pres.	Assoc.prof R.A.Waldowski

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17.10.23	All	9:00-12:00	1E 1E 1E	269	E6A Results E7A Title abs aim E8A Editing	Assoc.prof R.A.Waldowski
18.10.23	All	9:00-10:00 10:00-11:30 11:30-13:00	1L 2E 2E	269 339 339	L12A Writing mot.let. & CV E9A Writing mot.let. & CV E9A Writing mot.let. & CV	Assoc.prof A. Jurak Begonja
19.10.23	All	8:30-12:30	4L	269	L13A Research methodology in drug research and development	Assist.Prof. S. Marković
23.10.23	All	8:30-11:30	3L	269	L13A Research methodology in drug research and development	Assist.Prof. S. Marković
24.10.23	All	12:00-16:00	1L+1S 1L+1S	268	L14A+S3A Bioetics in res. L15A+S3A Bioetics in publishing	Assoc.prof R.A.Waldowski
25.10.26	All	12:00-14:00 14:00-16:00	2L 2L	268	L17A Writing project proposal L16 Writing chem. paper	Assoc.prof R.A.Waldowski Prof. M.Mesić
26.10.23	All	8:15-11:00	1L+2S	269	L18A+S4A Science outreach	Assoc.prof R.A.Waldowski
27.10.23	All	9:00-12:00	3S	268	S5A Posters	Assoc.prof R.A.Waldowski
30.10.23	All	11:00-12:30	2	030	PART A EXAM	Assoc.prof R.A.Waldowski
02.11.23	All	15:00-18:00	4L	O-030	L1B, L2B	Prof. dr. sc. Marta Žuvić
03.11.23	All	15:00-18:00	4L	O-030	L3B, L4B, L5B	Prof. dr. sc. Marta Žuvić
06.11.23	All	15:00-18:00	4L	O-030	L6B, L7B	Prof. dr. sc. Marta Žuvić
08.11.23	All	15:00-18:00	4L	O-030	L8B, L9B	Prof. dr. sc. Marta Žuvić
10.11.23	All	15:00-18:00	4L	O-030	L10B, L11B, L12B	Prof. dr. sc. Marta Žuvić
13.11.23	All	15:00-18:00	4L	O-030	L13B, L14B	Prof. dr. sc. Marta Žuvić
15.11.23	All	15:00-18:00	4L	O-030	L15B, L16B	Prof. dr. sc. Marta Žuvić

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17.11.23	All	15:00-18:00	4L	O-030	L17B, L18B	Prof. dr. sc. Marta Žuvić
20.11.23	All	15:00-18:00	4L	O-030	L19B, L20B	Prof. dr. sc. Marta Žuvić
22.11.23	All	15:00-18:00	4L	O-030	L21B, L22B	Prof. dr. sc. Marta Žuvić
24.11.23	All	15:00-18:00	4L	O-030	L23B, L24B	Prof. dr. sc. Marta Žuvić
27.11.23	1 2	12:00 13:00		O-359	PART B EXAM	Prof. dr. sc. Marta Žuvić

Additional information:
All students are asked to respond to the evaluation of the quality of teaching in order to be able to improve the teaching of this course on the basis of assessments and suggestions. The evaluation of teaching through the ISVU system is carried out with the application "Studomat" on the form defined at the level of the University of Rijeka, and the results are anonymous. More information on every aspect of this process can be found in the Priručnik za kvalitetu studiranja Sveučilišta u Rijeci (Handbook for the quality of studies at the University of Rijeka).

Academic integrity
Students are required to respect the principles of academic integrity and are referred to University documents: Etički kodeks Sveučilišta u Rijeci (Code of Ethics of the University of Rijeka) and Etički kodeks za studente (Code of Ethics for Students).

Final grades:
The following grades will be awarded based on the sum of achieved scores:
Percentage score, ECTS grade, (Numerical grade)
90% to 100% A Excellent (5)
75% to 89.9% B Very good (4)
60% to 74.9% C Good (3)
50% to 59.9% D Satisfactory (2)
0% to 49.9% F Unsatisfactory (1)
The final grade is based on the sum of percentage points accumulated during the course and on the final exam. Passing grades are excellent (5), very good (4), good (3) and satisfactory (2).