Detailed curriculum for the course

Statistics and analysis of scientific data

Academic year: 2024/2025

Study programmes: graduate university studies: Biotechnology in medicine, Drug research and development, Medicinal chemistry

Course code: IRL201

ECTS credits: 4

Language: croatian / english

Teaching: 40 Lectures + 20 Sem (*online*, proportion 20/60 = 33%, via e-course on LMS Merlin)

Enrollment requirements: none

Course leader, contact:

prof. dr. sc. Marta Žuvić

Adress: Biotechnology dpt., room O-812 / University of Rijeka rectorate

tel: 051 406 522; 0914800225

e-mail: marta.zuvic@uniri.hr

Consultation hours: e-mailing contact always, personally after every lecture hour, or as agreed with the student

Course Assistants:

Zrinko Baričević, PhD

e-mail: zrinko.baricevic@biotech.uniri.hr

Literature:

1. B. Petz: Osnovne statističke metode za nematematičare, Naklada Slap, 2002.

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

Recommended additional literature:

1. Harvey Motulsky: Intuitive Biostatistics, Oxford University Press, 2018.

Course description:

The goal of the course Statistics and Analysis of Scientific Data is to provide students with the knowledge and skills in the field of understanding research types and their characteristics, data types and their relationships, database creation, graphical data representation, data distributions, types and characteristics of samples, hypothesis testing, types of errors in statistical inference and their relation to study power, appropriate selection of statistical tests, and analysis and interpretation of results for:

- determining proportion differences,
- contingency table analysis,
- determining correlation measures,
- comparing a sample to a given population measure,
- comparing measures of central tendency between two or more samples,
- correlation of numerical data (simple, non-linear, and multiple regression),
- correlation of numerical and categorical data (logistic regression and ROC analysis), and
- survival analysis.

Learning outcomes:

L1. Critically assess the research database, categorize the research, classify data types and their relationships, and present them using appropriate tabular and graphical formats.

L2. Formulate a research question into a statistical hypothesis (null and alternative hypotheses), critically evaluate types of errors in acceptance or rejection of the hypothesis, and assess the appropriateness of statistical procedures for testing or modeling.

L3. Independently formulate research questions, perform statistical hypothesis testing, and successfully analyze and interpret results for various statistical methods including proportion differences, contingency tables, central tendency measures, and regression models.

Detailed course content (topics/titles of lectures):

A. Lectures

Thematic Unit 1: Statistics in Scientific Research

P1. Introduction to the course, content, learning outcomes, methodology, and student evaluation.

P2. Statistics as a science. Data, facts, information, knowledge. Research design, analysis, and interpretation. Research design, sample size. Statistical methods.

P3. Types of data, databases, tabular and graphical data presentation. Population and sample. Sample characteristics. Random sample. Independent and dependent data groups.

Thematic Unit 2: Testing Statistical Hypotheses

P4. Statistical hypothesis and its testing.

P5. Parametric and non-parametric statistical tests. Output parameters of statistical testing. Type I and Type II errors.

Thematic Unit 3: Categorical Data Analysis

P6. Proportion of sample and population. Contingency tables.

P7. Test for differences in proportions. χ^2 test. Fisher's exact test.

P8. Measures of association for qualitative data. Relative risk and odds ratio. Association of qualitative variables in dependent samples. McNemar and Cochrane Q tests.

Thematic Unit 4: Simple Analyses of Numerical Data

P9. Student's t-test. Conditions for applying the t-test. Types of t-tests.

P10. Comparison of a sample with a given measure in the population (one-sample t-test). Comparison of means between two independent groups. Non-parametric alternative to t-test for independent groups – Mann Whitney U-test. Effect sizes and their interpretation.

P11. T-test for dependent data groups. Non-parametric alternative – Wilcoxon signed-rank test. Effect sizes and their interpretation.

Thematic Unit 5: Analysis of Variance (ANOVA)

P12. Analysis of variance. Conditions for applying ANOVA. Tests for homogeneity of variances. Post-hoc tests. Non-parametric alternative – Kruskal-Wallis ANOVA. Effect sizes and their interpretation.

P13. ANOVA on dependent samples – repeated measures ANOVA. Non-parametric alternative – Friedman ANOVA. Effect sizes and their interpretation.

Thematic Unit 6: Correlation and Regression

P14. Association of numerical variables. Correlation and regression. Simple regression analysis. Correlation coefficient and its significance. Significance of the correlation coefficient. Regression line. Coefficient of determination and its interpretation.

P15. Multiple regression analysis. Partial and semi-partial correlation. Meaning of the coefficients. Conditions for application.

Thematic Unit 6: Non-linear Regressions

P16. Non-linear regressions. Logistic regression. Parameters of logistic regression. Assessment of the predictive value of a variable.

P17. ROC analysis. Parameters of ROC analysis and their interpretation. Sensitivity and specificity. Application of ROC analysis. Assessment of the predictive value of a variable.

Thematic Unit 7: Survival Analysis

P18. Survival analysis using the Kaplan-Meier method for constructing life tables. Analysis and interpretation of the life table. Median survival.

P19. Regression analysis for survival data – Cox regression and Cox proportional hazards model.

P20. Final lecture: Research design, analysis, and interpretation. Connecting analysis with research design and presenting research results. Instructions for the final exam.

B. Seminars (Reports)

S1. Data presentation. Tabular and graphical presentation of categorical data (frequencies, proportions, percentages) and numerical data (measures of central tendency and dispersion). Identification of outliers from the main dataset.

S2. Categorical data analysis. Estimation of true proportion in the population. Testing differences in proportions between independent groups (test of difference in proportions, χ^2 test) and dependent groups (McNemar test). Calculation of relative risk and odds ratio, and their statistical significance.

S3. Simple analyses of numerical data. Formulation of the research question, conducting statistical procedures with conclusions and answers to the research question (interpretation of results) for comparing a measure in a sample with a given measure in the population or a selected constant (one-sample t-test), applying the t-test – comparison of central tendency measures between two

independent samples (groups), applying the Mann-Whitney U-test, applying the t-test for dependent samples (data groups), and applying the Wilcoxon signed-rank test.

S4. Analysis of variance. Formulation of the research question, conducting statistical procedures with conclusions and answers to the research question (interpretation of results) for applying ANOVA testing (with appropriate post-hoc analysis), applying Kruskal-Wallis ANOVA testing (with appropriate post-hoc analysis), applying ANOVA for repeated measures, and applying Friedman testing.

S5. Correlation analysis. Formulation of the research question, conducting statistical procedures with conclusions and answers to the research question (interpretation of results) for applying simple correlation analysis (one example for num-num and num-ord variables), applying multiple regression analysis (identifying significant predictors for the selected dependent variable), conducting stepwise forward and stepwise backward models and their evaluation.

S6. Non-linear regressions and ROC analysis. Formulation of the research question, conducting statistical procedures with conclusions and answers to the research question (interpretation of results) for applying non-linear regression models, logistic regression models, and ROC analysis.

S7. Survival analysis. Formulation of the research question, conducting statistical procedures with conclusions and answers to the research question (interpretation of results) for applying survival analysis using the Kaplan-Meier method, comparing survival between different groups (based on a selected categorical variable), and analyzing the relationship between survival and selected factors.

Obligations, monitoring and evaluation of students' work

Students are required to independently complete 7 seminar reports, which are to be submitted for evaluation via the e-course platform by the deadlines specified for each seminar topic (S1-S7). The description of tasks and methods for solving them are provided within the relevant thematic unit. Each report is submitted as a file via the task submission activity on the e-course platform. Each report is graded with up to 10 points, and a total of 7 graded seminar reports can earn a maximum of 70 points. The assistant evaluates and grades the seminar reports.

Upon completion of the course, provided that the student has earned at least 50% of the possible points from seminar reports (at least 35 points in total), they are eligible to take the final exam (test), where they can earn up to 30 points. If the student is not satisfied with the grade achieved, they may request an additional oral examination during the exam period, which must be conducted no later than one day after taking the final test.

Final exam dates (options)**:**

1. final exam date: 08 Nov 2024. starting at 12:00 and 13:30 (2 groups) in the classroom O-359.

2. final exam date in December 2024 according to the agreement with the students.

3. final exam date in June 2025. according to the agreement with the students.

Formation of the grade (according to the Study regulations of the University of Rijeka):

It is possible to achieve a maximum of 100 assessment points in the course. During the course, students can achieve a maximum of 70 assessment points through the assessment of completed assignments (seminar reports) and the remaining 30 assessment points through the final examination. Students are allowed to access the final exam if achieved at least 34,9 assessment points in evaluation of assignments.

At the final exam, the student must have a minimum success rate of 50% of the test (at least 15 assessment points). According to the total number of assessment points achieved in the course, the following final grades (sum of the assessment points obtained through assignments and on the final exam) are awarded:

% assessment points	ECTS grade	Numerical grade
90% - 100%	A	Excellent (5)
75% - 89,9%	B	Very good (4)
60% - 74,9%	C	Good (3)
50% - 59,9%	D	Sufficient (2)
Up to 49,9%	F	Insufficient (1)

Passing grades are excellent (5), very good (4), good (3) and sufficient (2).

Course schedule:

Date	Group	Time	# hours	Classroom (online*)	Titles	Course teacher
09.10.2024.	all	17-20 h	4	O-030	P1-P3	Prof. dr. sc. Marta Žuvić
16.10.2024.	all	16-20 h	5	O-030	P4-P8	Prof. dr. sc. Marta Žuvić
21.10.2024.	all	16-20 h	5	O-030	P9-P11	Prof. dr. sc. Marta Žuvić

25.10.2024.	all	17-20 h	4	O-030	P12-P13	Prof. dr. sc. Marta Žuvić
28.10.2024.	all	16-20 h	5	O-030	P14-P15	Prof. dr. sc. Marta Žuvić
30.10.2024.	all	16-20 h	5	O-030	P16-P17	Prof. dr. sc. Marta Žuvić
05.11.2024.	all	16-20 h	5	O-030	P18-P20	Prof. dr. sc. Marta Žuvić
16.10.2024.	all	23:55*	3	*online*	S1	dr. sc. Zrinko Baričević
21.10.2024.	all	23:55*	3	*online*	S2	dr. sc. Zrinko Baričević
24.10.2024.	all	23:55*	3	*online*	S3	dr. sc. Zrinko Baričević
28.10.2024.	all	23:55*	3	*online*	S4	dr. sc. Zrinko Baričević
30.10.2024.	all	23:55*	3	*online*	S5	dr. sc. Zrinko Baričević
05.11.2024.	all	23:55*	3	*online*	S6	dr. sc. Zrinko Baričević
08.11.2024.	all	23:55*	3	*online*	S7	dr. sc. Zrinko Baričević

The seminars are conducted as online learning activities on the Merlin system within the corresponding e-course.

*Deadline for submitting seminar reports.

Additional information:

All students are encouraged to participate in evaluating the quality of teaching by teachers and staff so that the teaching in this course can be improved based on the evaluations and suggestions. The evaluation of teaching through the ISVU system is done with the application "Studomat" on the form established at the level of the University of Rijeka, and the results are anonymous. Additional evaluation of L&T quality is done in the e-course on Merlin platform. More information about all aspects of this process can be found in the University of Rijeka Study Quality Manual.

Academic integrity

Students are obliged to observe the principles of academic integrity and refer to the University of Rijeka documents: Code of Ethics of the University of Rijeka and the Code of Ethics for Students.

Detailed curriculum for the course:

Introduction to the scientific method

Academic year: 2024/2025

Program: Master programs „Drug Research and Design", "Biotechnology in Medicine" "Medical Chemistry" and „The Biotechnology for the Life Sciences "

Code: IRL202

ECTS points: 5

Language of the course: English

Teaching hours: 28L+14S+8V

Pre-requisite for the enrollment: None

Course leader and contact information: Assoc.prof. Rozi Andretić Waldowski (11L + 14S + 2E)

Address: University of Rijeka, FABRI, Radmile Matejčić, tel: 584 553 e-mail: randretic@uniri.hr

Contact hours: Course leader is at the disposal for consultations any time during the working hours, with previous appointment.

Teaching staff: Assist.Prof. Christian Raynolds (4L+3E)

Assoc.Prof. Nicholas Bradshaw (2L + 2X2E)

Prof. Antonija Jurak Begonja (1L + 2X2E)

Assit. Prof. Stribor Marković (4L)

Assit. Prof. Danijela Kalafatović (3L)

TBD (3L)

Required reading:

1. Required reading materials will be supplied during the class
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

Suggested reading

1. Vanja Pupovac: "Akademsko pisanje", http://akademsko-pisanje.sz-ri.com
2. Matko Marušić i suradnici: Uvod u Znanstveni rad u medicini, Medicinska Naklada, Zagreb, 2013.
3. 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 work in research laboratories, which includes: preparing a hypothesis-driven research plan based on scientific evidence and skills in presenting the 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, types and ethical use of AI platforms in scientific work, about ethical approaches in 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 reference management software, acquire skills in scientific writing, be able to write a Master thesis, research paper, project proposal, and science outreach article and be able to present their work in oral or poster form.

Learning outcomes:

1. Form an opinion on the use of appropriate scientific methodology
2. Critically judge the quality of scientific publications
3. Support the importance of bioethics in the implementation of the scientific approach
4. Self-evaluate the quality of scientific writing
5. Support the importance of clear, audience-friendly scientific communication

Detailed course content:

A. Lectures:

TITLE	HOURS AND LECTURER
L1 Scientific method and experimental design	**3 H / RAW**
L2 Introduction to scientific writing	**2 H / CR**
L3 Writing a research paper I	**2 H / CR**
L4 Elements of a research article	**1 H /RAW**
L4 Ethical use of AI in the scientific research and publishing	**3 H /**
L5 Figures and legends	**1 H /RAW**
L7 Result description and interpretation	**1 H /RAW**
L8 Writing motivational letter and a CV	**1 H / AJB**

L9 Editing	**1 H / RAW**
L10 Literature search	**1 H / NB**
L11 Preparing a poster and oral presentation	**1 H / RAW**
L12 Writing a research proposal	**1 H / RAW**
L13 Writing a science outreach article	**1 H / RAW**
L14 Publishing a scientific article	**2 H / NB**
L15 Bioethics in publishing	**1 H / RAW**
L16 Writing a chemistry research paper	**3 H / DK**
L17 Methodology in drug research	**4 H / SM**

B. Seminars:

TITLE	**HOURS AND LECTURER**
S1 Scientific method and experimental design	**1 H / RAW**
S2 Elements of a research article	**1 H / RAW**
S3 Figures and legends	**2 H / RAW**
S4 Results description and interpretation	**1 H / RAW**
S5 Science vs. pseudoscience	**1 H / RAW**
S6 Journal club	**3 H / RAW**
S7 Bioethics in publishing	**1 H / RAW**
S8 Science outreach article	**2 H / RAW**
S9 Project proposal	**2 H / RAW**

Excesizes:

TITLE	**HOURS AND LECTURER**
E1 Introduction to scientific writing	**2H / CR**
E2 Writing a research paper I	**1H / CR**
E3 Writing motivational letter and a CV	**2 x 2 / AJB**

E4 Editing	**2 / RAW**
E5 Literature search	**1 x 2 / NB**

Schedule of classes:

DATE	GROUP	TIME	HRS IN CLASS	CLASS ROOM	CONTENT	LECTURER
01.10.2024.	all	14:30-18:00	3L 1S	030	Scientific method and experimental design	Assoc.Prof R.A.Waldowski
02.10.2024.	all	14:00-18:00	2L 2E	030	Introduction to scientific writing	Assist.Prof.C.Reynolds
03.10.2024.	all	14:00-19:00	1L 1E 1L 1S	030	Writing a research paper Elements of a research article	Assist.Prof. C.Reynolds Assoc.Prof R.A.Waldowski
04.10.2024.	all	14:00-17:00	3L	030	Ethical use of AI in scientific research and publishing	
07.10.2024.	1	13:00-18:00	2L 3S	030	Figures and legends Description and interpretation	Assoc.Prof R.A.Waldowski
08.10.2024.	1 2	11:00-12:00 12:00-13:00 13:00-14:30 14:45-16:15	1L 1L 2E	030 030 339 339	Editing Writing a motivational letter and CV Mot. letter and CV	Assoc.Prof R.A.Waldowski Prof. A. Jurak Begonja Prof. A. Jurak Begonja

09.10.2024.	2	13:00-14:30 14:45-16:15	1L 1x2E	339	Literature search	Assoc.Prof. N. Bradshaw
10.10.2023.	all	10:00-15:00	3L 1S 1E	030	Writing a project Preparing a poster Science outreach Science/Pseudoscience Editing	Assoc.Prof R.A.Waldowski
15.10.2024.	all	16:00-18:00	2S	030	Journal Club	Assoc.Prof R.A.Waldowski
21.10.2024.	all	11:00-15:00	2E 1L 1S	030	Sci. publishing Bioethics in sci. publishing	Assoc.Prof. N. Bradshaw Assoc.Prof R.A.Waldowski
22.10.2024.	all	14:00-17:00	3L	030	Writing a chemistry article	Assoc.prof.D.Kalafatović
23.10.2024.	all	16:00-18:00	2S	030	Writing a science outreach article	Assoc.Prof R.A.Waldowski
24.10.2024.	all	17:00-19:00	2S	030	Writing a project proposal	Assoc.Prof R.A.Waldowski
25.10.2024.	all	12:00-15:00	3L	030	Methodology in drug research	Assoc.Prof S.Marković
28.10.2024.	all	11:00-13:00		030	FINAL EXAM	Assoc.Prof R.A.Waldowski

Required student's engagement 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 pairs or small groups to increase group collaboration and ensure the development of practical skills.

Examination deadlines:

The final exam will be on Monday 28th of October 2024.

A second test date will be on Friday 17th of November 2023.

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):

Students will be graded continuously during the class for their participation, activity and quality of their work assignments during the course (max 70% of the grade) and for the grade on the final exam (max 30% of the grade).

Students must attain a minimum of 35% of the grade during the continuous grading to be allowed to take the final exam.

Continuous grading (70%) consists of the following elements:

Homework 1 – Influence of bad science on public opinion (5%)

Homework 2 – Misuse of AI in science (10%)

Homework 3 – Preparing figures with legends and result description and interpretation (15%)

Homework 4 – Short project proposal (10%)

Homework 5 – Short science outreach article (10%)

Activity during class stems from the read materials that will be given as a preparation for the class, followed by short presentations, discussions, and debates will be graded 5% for the following topics: Figures and legends, Journal club, project proposal, and Science outreach.

Final exam (30%)

The final exam will consist of problem-solving / essay questions and several multiple-choice questions.

Final grades:

The final grade is based on the percentage points attained during the continuous grading and on the final exam. 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)

Passing grades are excellent (5), very good (4), good (3) and satisfactory (2).

Additional information:

Academic integrity

During the class and the exam, students are expected to behave according to the highest standards of integrity and ethical behavior some of which will be discussed in this class. In addition, students can refer to the documents: Etički kodeks Sveučilišta u Rijeci and Etički kodeks za studente.

During classes, students are expected to show fairness in interactions, respect for each other's effort, and fair acknowledgment of the contributions of others. In their homework assignments, students should strictly avoid any form of plagiarism, should properly cite sources they used for their work, and have to present data truthfully. Academic dishonesty, such as presenting the work of others as the student's own, use of AI-generated content without proper acknowledgment, and material produced in collaboration with others (unless explicitly permitted), will be punished by no grade for the given assignment and the breach of ethical conduct will be reported to the Ethical Committee of the FABRI.

Questionnaire at the end of the class:

All students are requested to fill out the questionnaire about their satisfaction with the content of the course and the course leader **to improve the future quality of the course**. Valuation is anonymous and is done using ISVU system with the „Studomat" application. The questionnaire is defined at the level of the University.

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