**AL-FARABI KAZAKH NATIONAL UNIVERSITY**
**Faculty of Biology and Biotechnology**
**Biotechnology Department**

**APPROVED by**
**Dean of Faculty**

**Kurmanbayeva M.S.** _____

**«05» 09 2024 y.**

# EDUCATIONAL-METHODICAL COMPLEX OF DISCIPLINE

**SB 2208 "Statistics in bioengineering"**
Educational program on specialty «6B05101 Biological Engineering»

Course – 3
Semester - 5
Number of credits -5
Lecture 1.70
Laboratory 0
Seminars 3.30
IWST 5

**Almaty, 2024**

The educational-methodical complex of the discipline is prepared by Senior Lecturer of the Biotechnology Department, PhD S.Sandybayeva.

Based on the working curriculum for the educational program "6B05101 Biological Engineering"

Considered and recommended at the meeting of the Department of Biotechnology from

"02" 09 2024 year, protocol № 1

Head of the Department _____ Kistaubayeva A.S.

**SYLLABUS**
**Fall semester 2024-2025 academic year**
**Educational program "6B05101 Biological Engineering "**

| ID and name of course | Independent work of the student (IWS) | Number of credits | | | General number of credits | Independent work of the student under the guidance of a teacher (IWST) |
|---|---|---|---|---|---|---|
| | | Lectures (L) | Practical classes (PC) | Lab. classes (LC) | | |
| SB 2208 Statistics in bioengineering | 5 | 15 | 15 | - | 5 | 5 |

**ACADEMIC INFORMATION ABOUT THE COURSE**

| Learning Format | Cycle, component | Lecture types | Types of practical classes | Form and platform final control |
|---|---|---|---|---|
| Offline | Professional mandatory disciplines | Presentations | Seminars, discussions, conferences | Writing exam (offline) |
| **Lecturer - (s)** | Sandybayeva Sandugash Kalzhankyzy | | | |
| **e-mail :** | Sandybayeva.s@kaznu.kz | | | |
| **Phone :** | +7 7751351015 | | | |

**ACADEMIC COURSE PRESENTATION**

| Purpose of the course | Expected Learning Outcomes (LO) * | Indicators of LO achievement (ID) |
|---|---|---|
| | 1. Students will be able to apply appropriate statistical methods to analyze and interpret bioengineering data, including descriptive statistics, hypothesis testing, regression analysis, and multivariate analysis. | 1.1 To know how to apply appropriate statistical methods to analyze and interpret bioengineering data, including descriptive statistics, hypothesis testing, regression analysis, and multivariate analysis. |
| | 2. Students will understand how statistical methods are applied to specific bioengineering problems such as clinical trials, genetic research, medical imaging, and biomechanics. Students will be able to design and implement experiments and studies in bioengineering, ensuring they are statistically sound and account for variables and potential biases. | 2.1 To know and to understand how statistical methods are applied to specific bioengineering problems such as clinical trials, genetic research, medical imaging, and biomechanics |
| | | 2.2 To design and implement experiments and studies in bioengineering, ensuring they are statistically sound and account for variables and potential biases. |
| | 3. Students will critically evaluate statistical findings and methodologies used in bioengineering literature, assessing their validity and relevance. Students will be able to solve complex bioengineering problems by selecting and applying appropriate statistical techniques and interpreting the results in the context of bioengineering applications. | 3.1 To critically evaluate statistical findings and methodologies used in bioengineering literature, assessing their validity and relevance |
| | | 3.2 To be able to solve complex bioengineering problems by selecting and applying appropriate statistical techniques and interpreting the results in the context of bioengineering applications. |
| | 4. Students will be skilled in creating and interpreting visual representations of data (e.g., graphs, charts) to convey statistical results clearly and effectively. | 4.1 To know and to get a basic knowledge of creating and interpreting visual representations of data (e.g., graphs, charts) to convey statistical results clearly and effectively. |
| **Prerequisites** | Biotechnology, Basics of Mathematics | |
| **Postrequisites** | Industrial or laboratory practice | |
| **Learning Resources** | **Literature:**<br>1. M. Islam • A. Al-Shiha. Foundations of Biostatistics. 2018. Springer. eBook. https://doi.org/10.1007/978-981-10-8627-4 / ISBN 978-981-10-8626-7.<br>2. Biostatistics - Open Learning Textbook.2023/ LibreTexts Project/ eBook | |

3. Wayne W. Daniel. Biostatistics. Foundation for Analysis in the Health Sciences/1995/ John Wiley & Sons. Inc.
4. Y. Singh. Fundamental of Research Methodology and Statistics. 2006 New Age International (P) Ltd. ISBN : 978-81-224-2418-8.
5. Basic Biostatistics & Research Methodology / Elena Raevschi, Olga Penina; Ministry of Health of the Republic of Moldova, Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova, Department Nicolae Testemitanu Social Medicine and Management. – 2nd ed. – Chişinău: CEP Medicina, 2023. – 141 p.
6. Myra L. Samuels. Statistics for the Life Sciences. Pearson Education Limited 2016, ISBN 10: 1-292-10181-4.

**Research infrastructure**

1. Classes of Biology and Biotechnology department of KazNU

**Internet resources**

1. http://elibrary.kaznu.kz/ru
2. MOOC / video lectures, etc.
3. Google Scholar
4. Sciencedirect.com
5. academia.edu
6. researchgate

| | |
|---|---|
| **Academic course policy** | The academic policy of the course is determined by the Academic Policy and the Policy of Academic Integrity of Al-Farabi Kazakh National University .<br>Documents are available on the main page of IS Univer .<br>**Integration of science and education.** The research work of students, undergraduates and doctoral students is a deepening of the educational process. It is organized directly at the departments, laboratories, scientific and design departments of the university, in student scientific and technical associations. Independent work of students at all levels of education is aimed at developing research skills and competencies based on obtaining new knowledge using modern research and information technologies. A research university teacher integrates the results of scientific activities into the topics of lectures and seminars (practical) classes, laboratory classes and into the tasks of the IWST, IWS, which are reflected in the syllabus and are responsible for the relevance of the topics of training sessions and assignments.<br>**Attendance.** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course. Failure to meet deadlines results in loss of points.<br>**Academic honesty.** Practical/laboratory classes, IWS develop the student's independence, critical thinking, and creativity. Plagiarism, forgery, the use of cheat sheets, cheating at all stages of completing tasks are unacceptable.<br>Compliance with academic honesty during the period of theoretical training and at exams, in addition to the main policies, is regulated by the "Rules for the final control" , "Instructions for the final control of the autumn / spring semester of the current academic year" , "Regulations on checking students' text documents for borrowings".<br>Documents are available on the main page of IS Univer .<br>**Basic principles of inclusive education.** The educational environment of the university is conceived as a safe place where there is always support and equal attitude from the teacher to all students and students to each other, regardless of gender, race / ethnicity, religious beliefs, socio-economic status, physical health of the student, etc. All people need the support and friendship of peers and fellow students. For all students, progress is more about what they can do than what they can't. Diversity enhances all aspects of life.<br>All students, especially those with disabilities, can receive counseling assistance by phone / e- mail amutovafb@gmail.com.<br>**Integration MOOC (massive open online course).** In the case of integrating MOOC into the course, all students need to register for MOOC. The deadlines for passing MOOC modules must be strictly observed in accordance with the course study schedule.<br>**ATTENTION!** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course, as well as in the MOOC. Failure to meet deadlines results in loss of points. |

**INFORMATION ABOUT TEACHING, LEARNING AND ASSESSMENT**

| Score-rating letter system of assessment of accounting for educational achievements | | | | Assessment Methods |
|---|---|---|---|---|
| Grade | Digital equivalent points | points, % content | Assessment according to the traditional system | **Criteria-based assessment** is the process of correlating actual learning outcomes with expected learning outcomes based on clearly defined criteria. Based on formative and summative assessment. |
| A | 4.0 _ | 95-100 | Great | **Formative assessment is** a type of assessment that is carried out in the course of daily learning activities. It is the current measure of progress. Provides an |

| | | | | |
|---|---|---|---|---|
| A- | 3.67 | 90-94 | | operational relationship between the student and the teacher. It allows you to determine the capabilities of the student, identify difficulties, help achieve the best results, timely correct the educational process for the teacher. The performance of tasks, the activity of work in the classroom during lectures, seminars, practical exercises (discussions, quizzes, debates, round tables, laboratory work, etc.) are evaluated. Acquired knowledge and competencies are assessed.<br>**Summative assessment** - type of assessment, which is carried out upon completion of the study of the section in accordance with the program of the course. Conducted 3-4 times per semester when performing IWS. This is the assessment of mastering the expected learning outcomes in relation to the descriptors. Allows you to determine and fix the level of mastering the course for a certain period. Learning outcomes are evaluated. |
| B+ | 3.33 | 85-89 | Fine | |
| B | 3.0 | 80-84 | | **Formative and summative assessment** — **Points % content** |
| B- | 2.67 | 75-79 | | Activity at lectures — 5 |
| C+ | 2.33 | 70-74 | | Work in practical classes — 20 |
| C | 2.0 | 65-69 | Satisfactorily | Independent work — 25 |
| C- | 1.67 | 60-64 | | Design and creative activity — 10 |
| D+ | 1.33 | 55-59 | Unsatisfactory | Final control (exam) — 40 |
| D | 1.0 | 50-54 | | TOTAL — 100 |

**Calendar (schedule) for the implementation of the content of the course. Methods of teaching and learning.**

| A week | Topic name | Number of hours | Max. ball |
|---|---|---|---|
| | **MODULE 1**<br>**FOUNDATIONS OF BIOSTATISTICS** | | |
| 1 | **L 1.** Introduction to basic biostatistics and research methodology field. Definition and scope of biostatistics. The role of statistics in biology and biotechnology<br>Key stages of statistical analysis | 2 | |
| | **PC 1**. Discussion on the importance of biostatistics in biology and biotechnology<br>Practical exercises: identifying statistical questions in research papers | 2 | 5 |
| 2 | **L 2.** Types of Data: Qualitative vs. quantitative data. Discrete vs. continuous data. Measurement scales: nominal, ordinal, interval, ratio. | 2 | |
| | **PC 2.** Group activity: Classifying different types of data. Exercises: Creating frequency tables and bar charts by hand | 2 | 5 |
| | **IWST 1.** Consultation on the implementation of IWS 1. | | 5 |
| 3 | **L 3.** Descriptive Statistics - Measures of Central Tendency | 2 | |
| | **PC 3.** Calculating Central Tendency: practice problems: Manual calculation of mean, median, and mode | 2 | 5 |
| | **IWS 1.** Exercises and tests | | 10 |
| 4 | **L 4.** Descriptive Statistics - Measures of Dispersion: Range, variance, and standard deviation. Calculation of variance and standard deviation. Interpretation of results | 2 | |
| | **PC 4.** Exercises: Manual calculation of variance and standard deviation<br>Group work: Interpreting the meaning of dispersion in datasets | 2 | 5 |
| 5 | **L 5.** Introduction to Probability. Basic concepts of probability Types of events: independent, dependent, mutually exclusive. Probability rules and their applications | 2 | |
| | **PC 5.** Probability exercises with dice and cards / Group activity: Solving probability problems in biological contexts | 2 | 5 |
| | **MODULE 2**<br>**PROBABILITY DISTRIBUTIONS AND INFERENTIAL STATISTICS** | | |
| 6 | **L 6.** Probability Distributions. Introduction to normal, binomial, and Poisson distributions Characteristics and applications of each distribution. Calculation of probabilities using binomial and Poisson distributions | 2 | |
| | **PC 6.** Exercises: Manual calculation of probabilities for binomial and Poisson distributions<br>Small group discussions: Real-world examples of distributions in biology | 2 | 5 |
| | **IWST 2.** Consultations on the implementation of **IWS 2.** | | 5 |
| 7 | **L 7.** Sampling and Sampling Distributions. Definition of sampling and its importance. Types of sampling methods. Central Limit Theorem and its significance | 2 | |
| | **PC 7.** Group discussion on different sampling methods and their real-world applications<br>Practical problems: Selecting appropriate sampling techniques for different studies | 2 | 5 |
| | **IWS 2.** Regression Models in Bioengineering: Simple and multiple linear regression models in biomechanical studies. | | 10 |
| | **Midterm control** | | 35 |
| **Midterm control 1** | | | **100** |

| | | | |
|---|---|---|---|
| 8 | **L 8.** Confidence Intervals: Concept of confidence intervals and their interpretation. Calculation of confidence intervals for means and proportions. Understanding margin of error | 2 | |
| | **PC 8.** Practice: Manually calculating confidence intervals for means and proportions. Class discussion: Interpreting confidence intervals in research studies | 2 | 5 |
| | **IWST 3.** Consultations on the implementation of **IWS 2** | | 5 |
| 9 | **L 9.** Hypothesis Testing – Basics: Null and alternative hypotheses.Type I and Type II errors P-values and significance levels (α) | 2 | |
| | **PC 9.** Exercises: Framing null and alternative hypotheses for biology and medical problems Practice: Calculating p-values manually for given data | 2 | 5 |
| | **IWS 3.** Experimental Design in Bioengineering Research: Factorial design analysis for optimizing biological processes | | 5 |
| 10 | **L 10.** Hypothesis Testing for Means. One-sample t-test: assumptions and manual calculation. Two-sample t-test: independent and paired samples. Interpretation of test results | 2 | |
| | **PC 10.** Practice problems: Manual calculation of one-sample and two-sample t-tests Group activity: Interpreting the results of t-tests | 2 | 5 |
| | **IWST 4.** Consultation on the implementation of **IWS 3** | | 5 |
| **MODULE 3 ADVANCED STATISTICAL TECHNIQUES IN BIOSTATISTICS** | | | |
| 11 | L 11. Chi-Square Tests: Chi-square test for independence. Assumptions and applications Manual calculation using contingency tables | 2 | |
| | **PC 11.** Exercises: Manually constructing contingency tables and calculating chi-square Class discussion: Interpreting chi-square test results in biological studies | 2 | 5 |
| | **IWS 4.** Statistical Quality Control in Biomedical Manufacturing: Reliability testing and life data analysis for biotechnological products. | | 5 |
| 12 | **L12.** Analysis of Variance (ANOVA): Understanding ANOVA for comparing more than two groups. Assumptions of ANOVA. Manual calculation of F-statistic and interpretation | 2 | |
| | **PC 12.** Practice problems: Manually calculating F-statistic for three groups. Group activity: Discussing when and how to use ANOVA in research | 2 | 5 |
| 13 | **L 13.** Correlation and Simple Linear Regression: Concept of correlation: Pearson's and Spearman's coefficients. Interpretation of correlation coefficients | 2 | |
| | **PC 13.** Practice: Manual calculation of correlation coefficients Exercises: Calculating regression lines by hand and interpreting the results | 2 | 5 |
| | **IWST 5.** Consultation on the implementation of **IWST 5.** | | 5 |
| 14 | **L 14.** Introduction to survival analysis in medical studies. Concepts: survival function, hazard function, censoring | 2 | |
| | **PC 14.** Group activity: Interpreting life tables and survival curves without software Practice problems: Calculating survival rates using the Kaplan-Meier estimator | 2 | 5 |
| 15 | **L 15.** Ethical Considerations in Biostatistics. Ethical issues in data collection and analysis Informed consent and data privacy. Avoiding biases and misinterpretation of results | 2 | |
| | **PC 15.** Class debate on ethical issues in biostatistical research/ Group work: Identifying biases and ethical concerns in real-world studies | 2 | 5 |
| | **IWS 5.** Examples of exam practical exercises. | | 5 |
| | **Midterm control 2** | | 30 |
| **Midterm control 2** | | | **100** |
| **Final control (exam)** | | | **100** |
| **TOTAL for course** | | | **100** |

**Dean** _____ **Kurmanbayeva M.S.**

**Chair of the Academic Committee on the Quality of Teaching and Learning** _____ **Baktybayeva L.K.**

**Head of Department** _____ **Kistaubayeva A.S.**

**Lecturer** _____ **Sandybayeva S.K.**

## RUBRICATOR OF THE SUMMATIVE ASSESSMENT

## CRITERIA EVALUATION OF LEARNING OUTCOMES

**Issued at the request of the teacher for each planned summative assessment (IWST)**

**Oral presentation assignment "Regression Models in Bioengineering: Simple and multiple linear regression models in biomechanical studies" (25% of 100% MC)**

| Criterion | "Excellent" 20-25% | "Good" 15-20% | "Satisfactory" 10-15% | "Unsatisfactory" 0-10% |
|---|---|---|---|---|
| **Understanding Theories and concepts Regression Models in Bioengineering** | Deep understanding of theories, concepts of Regression Models in Bioengineering. Demonstrates a strong understanding of regression models and effectively links these to teaching professionalism. | Understanding theories, concepts of Regression Models in Bioengineering. Shows understanding but with limited connection to professional identity. | Limited understanding of theories, concepts of Regression Models in Bioengineering. Limited references (citations) to key sources are provided. | Superficial understanding / lack of understanding of theories, concepts of Regression Models in Bioengineering. Relevant references (citations) to key sources are not provided. |
| **Awareness of key issues of simple and multiple linear regression models in biomechanical studies** | Links well the key concepts of Simple and multiple linear regression models in biomechanical studies. Excellent substantiation of arguments with evidence from empirical research (for example, based on interviews or statistical analysis). | Links the concepts Simple and multiple linear regression models in biomechanical studies. Supports arguments with evidence from empirical research. | Limited connection of the Simple and multiple linear regression models in biomechanical studies. Limited use of evidence from empirical research. | There is little or no connection between the concepts of Simple and multiple linear regression models in biomechanical studies. Little or no use of empirical research. |
| **Policy proposal or practical recommendations/suggestions** | Well-thought-out recommendations that show depth and applicability. | Good recommendations but lack in-depth analysis. | Basic suggestions that may need further refinement. | Few or impractical recommendations. |
| **Letter, APAstyle** | The writing demonstrates clarity, conciseness and correctness. Strictly follows the APA style. | The letter demonstrates clarity, conciseness and correctness. Basically follows the APA style. | The letter has some key errors and clarity needs to be improved. There are mistakes in following the APA style. | The writing is unclear, it is difficult to follow the content. Lots of mistakes in following the APA style. |

**Oral presentation assignment "Experimental Design in Bioengineering Research: Factorial design analysis for optimizing biological processes" (25% of 100% MC)**

| Criterion | "Excellent" 20-25% | "Good" 15-20% | "Satisfactory" 10-15% | "Unsatisfactory" 0-10% |
|---|---|---|---|---|
| **Understanding Theories and concepts of Experimental Design in Bioengineering Research** | Demonstrates a strong understanding of factorial design and its application in optimizing biological processes, with clear explanations of key concepts. | Demonstrates a good understanding, though with some minor gaps or lack of depth. | Limited understanding of theories, concepts of Experimental Design in Bioengineering Research. Limited references (citations) to key sources are provided. | Superficial understanding / lack of understanding of theories, concepts of Experimental Design in Bioengineering Research. Relevant references (citations) to key sources are not provided. |
| **Awareness of key issues of Factorial design analysis for optimizing biological processes** | Links well the key concepts of Factorial design analysis for optimizing biological processes. Excellent substantiation of arguments with evidence from empirical research (for example, based on interviews or statistical analysis). | Links the concepts Factorial design analysis for optimizing biological processes. Supports arguments with evidence from empirical research. | Limited connection of the Factorial design analysis for optimizing biological processes. Limited use of evidence from empirical research. | There is little or no connection between the concepts of Factorial design analysis for optimizing biological processes. Little or no use of empirical research. |
| **Policy proposal or practical recommendations/suggestions** | Well-thought-out recommendations that show depth and applicability. | Good recommendations but lack in-depth analysis. | Basic suggestions that may need further refinement. | Few or impractical recommendations. |
| **Letter, APAstyle** | The writing demonstrates clarity, conciseness and correctness. Strictly follows the APA style. | The letter demonstrates clarity, conciseness and correctness. Basically follows the APA style. | The letter has some key errors and clarity needs to be improved. There are mistakes in following the APA style. | The writing is unclear, it is difficult to follow the content. Lots of mistakes in following the APA style. |

**Oral presentation assignment "Statistical Quality Control in Biomedical Manufacturing: Reliability testing and life data analysis for biotechnological products" (25% of 100% MC)**

| Criterion | "Excellent" 20-25% | "Good" 15-20% | "Satisfactory" 10-15% | "Unsatisfactory" 0-10% |
|---|---|---|---|---|
| **Understanding Theories and concepts of Experimental Statistical Quality Control in Biomedical Manufacturing** | Demonstrates a strong understanding of Statistical Quality Control in Biomedical Manufacturing, with clear explanations of key concepts. | Demonstrates a good understanding of Statistical Quality Control in Biomedical Manufacturing, though with some minor gaps or lack of depth. | Limited understanding of theories, concepts of Statistical Quality Control in Biomedical Manufacturing. Limited references (citations) to key sources are provided. | Superficial understanding / lack of understanding of theories, concepts of Statistical Quality Control in Biomedical Manufacturing. Relevant references (citations) to key sources are not provided. |
| **Awareness of key issues of Reliability testing and life data analysis for biotechnological products** | Links well the key concepts of Reliability testing and life data analysis for biotechnological products. Excellent substantiation of arguments with evidence from empirical research (for example, based on interviews or statistical analysis). | Links the concepts Reliability testing and life data analysis for biotechnological products. Supports arguments with evidence from empirical research. | Limited connection of the Reliability testing and life data analysis for biotechnological products. Limited use of evidence from empirical research. | There is little or no connection between the concepts of Reliability testing and life data analysis for biotechnological products. Little or no use of empirical research. |
| **Policy proposal or practical recommendations/suggestions** | Well-thought-out recommendations that show depth and applicability. | Good recommendations but lack in-depth analysis. | Basic suggestions that may need further refinement. | Few or impractical recommendations. |
| **Letter, APAstyle** | The writing demonstrates clarity, conciseness and correctness. Strictly follows the APA style. | The letter demonstrates clarity, conciseness and correctness. Basically follows the APA style. | The letter has some key errors and clarity needs to be improved. There are mistakes in following the APA style. | The writing is unclear, it is difficult to follow the content. Lots of mistakes in following the APA style. |