Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Algorithms of Bioinformatics/Алгоритмы биоинформатики

Purpose of the course:

Give basic understanding of basic principles of bioinformatics algorithms and practical skills in applying bioinformatics methods for analyzing and interpreting biological data.

Tasks of the course:

• give an idea of the basic principle of bioinformatics algorithms;

• make students familiar with modern understanding of efficient analysis of biological data;

• teach how to use the main software in the field;

• introduce basic algorithms and data formats for genome sequence analysis.

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List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- basic data structures: hash table, suffix tree, suffix array;

- quick search for substrings in the string - naive algorithms, Knut-Maurice-Pratt, Rabin-Karp, kangaroo algorithm;

- the Burrows-Wheeler index and transformation;

- BLAST - indexing, Altschul-Karlin statistics;

- motifs in the genomes, search and identification of motifs, multiple local alignment;

- optimization methods; expectation maximization and Gibbs sampling;

- dynamic programming algorithms for finding the shortest path between two vertices in a directed acyclic graph and calculating the sum of weights over all paths (partition function);

- an algorithm for optimal segmentation of a sequence using dynamic programming;

- concept of a hidden Markov model, transition and emission probabilities, search for an optimal sequence of state transitions for a sequence generated by a hidden Markov model (Viterbi

algorithm), calculation of transition probability at a given point (back-and-forth algorithm), use of a dynamic programming algorithm for analyzing hidden Markov chains;

- Fundamentals of Bayesian statistics, likelihood, maximum likelihood method, marginalization of distributions and marginal likelihood;

- estimation of parameters of the hidden Markov chain, Viterbi training, the Baum-Welch method;

- genome analysis methods based on hidden Markov chains, search for coding sequences, search for homogeneous chromatin domains.

be able to:

- design efficient algorithms for mastering of large amount of information;

- be able to model functional motifs in biological sequences.

master:

- of estimating the required time and space resources for software using basic algorithms;

- of planning and implementation of efficient bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. Basic data structures: hash table, suffix tree, suffix array

Hash table, suffix tree, suffix array, search complexity in each case.

2. Quick search for substrings in a string - naive algorithms, Knut-Maurice-Pratt, Rabin-Karp, kangaroo algorithm

Naïve algorithm, Knut-Maurice-Pratt, Rabin-Karp, kangaroo algorithm. Estimates of time and space efficiency. Selection depending on the length of the motif to search. Wildcards. Implementation.

3. Burrows-Wheeler Index and Transformation

Barrows-Wheeler Index and Transformation. Evaluation of the search complexity. Problem with indels. Use in the BWA and Bowtie programs read mapping.

4. BLAST - Altschul-Karlin indexing

Indexing, dependence of the key length on the alphabet, using the BLAST index in proteomics problems, comparing the BLAST and Smith-Waterman approaches in the search for local alignments. Altschul-Karlin Statistics. Extreme values distribution. Gumbel distribution. High scoring paths. P-value and E-value.

5. Motifs in genomes, search and identification of motifs, multiple local alignment

Motifs in genomes, search and identification of motifs, multiple local alignment. Representations of motives: consensus string, matrix of positional weights, Bayesian network. Tuset-Varre algorithm for calculating the probability of observing the motive in a random sequence. Algorithms for constructing multiple local alignments and identifying motives: the Stormo greedy algorithm, MEME, Gibbs sampler, ChIPmunk.

6. Algorithms of dynamic programming for finding the shortest path between two vertices in a directed acyclic graph and calculating the sum of weights over all paths (partition function)

Dynamic programming algorithms for finding the shortest path between two vertices in a directed acyclic graph (Bellman-Ford) and calculating the sum of weights over all such paths (partition).

7. Applications of dynamic programming algorithms. Algorithm for optimal sequence segmentation using dynamic programming

Applications of dynamic programming algorithms. Smith-Waterman local alignment algorithm. Smith-Waterman matrix and corresponding graph. Examples of paths. The algorithm of optimal segmentation of a sequence into domains that are homogeneous in composition. Graphs representations.

8. Hidden Markov Models.

The concept of a Hidden Markov Model, transition and emission probabilities, the search for the optimal sequence of transitions between states for the sequence generated by a Hidden Markov Model (Viterbi algorithm), the calculation of the transition probability at a given point (back and forth algorithm), the use of a dynamic programming algorithm for analyzing Hidden Markov Model.

9. Fundamentals of Bayesian statistics, likelihood, maximum likelihood method, marginalization of distributions and marginal likelihood

Likelihood, maximum likelihood method, marginalization of distributions and marginal likelihood. Sequential Bayes Estimation. Dirichlet integral. Dirichlet mixture. Conjugate Distributions. The role of prior distributions.

10. Optimization Methods: Expectation Maximization Gibbs Sampling

Expectation maximization. Cluster separation problem. Selection initial values. Convergence assessment. Multiple local alignments via expectation maximization (MEME). Gibbs sampling. Detailed balance. Convergence assessment problem.

11. Estimation of parameters of a Hidden Markov Mode, Viterbi training, Baum-Welch method

Viterbi training, Baum-Welsh approach, the role of dynamic programming and Bayesian estimation

12. Genome functional annotation methods based on Hidden Markov Model, search for coding sequences, search for homogeneous chromatin domains

Functional annotation methods based on Hidden Markov Mhains, search for coding sequences, search for homogeneous chromatin domains.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Analysis of OMICS Data/Анализ омиксных данных

Purpose of the course:

Hands on experience in applying bioinformatics methods for analyzing and interpreting biological data.

Tasks of the course:

• give an idea of the basic mechanisms of gene transcription regulation;

• make students familiar with modern understanding of regulatory transcriptome and epigenomics;

• teach how to use the main bioinformatics tools, programming languages and databases;

• introduce basic algorithms and data formats.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- physical and chemical properties of nucleic acids and chromatin proteins;

- processes involving nucleic acids and chromatin proteins;

- research methods of the genome and evolution of living organisms;

- the main mechanisms of regulatory genomics, transcriptome and epigenetics;

- basic bioinformatics algorithms, databases, file formats used in transcriptome and epigenomics;

- modern molecular biological methods for studying cell processes;

be able to:

- use the main databases of regulatory genomics;

- run bioinformatics tools in UNIX environment and program in python/R;

- analyze large scale datasets.

master:

- of working with large volumes of biological data;

- of planning and implementation of multi-stage bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. Introduction to bioinformatics tools

The main UNIX commands, installation of tools, approaches to genome assembly from NGS data

2. Biopython and R

GenBank file format, Download sequences from NCBI, parse genome annotation in GenBank format

3. Bacterial genome annotation

Predict the protein coding genes with GeneMark, compare the de novo prediction with the GenBank annotation

4. Systems biology

KEGG database. Predict bacterial phenotype from its genes.

5. Molecular evolution

Comparative genomics - Build 16S rRNA gene tree

6. Non-coding genome

RepeatMasker, Composition of the genomes of different organisms (Bacteria, Archaea, Yeast, Drosophila, Arabidopsis, mouse, human)

Regulatory elements in the genomes of higher organisms -- promoter, enhancer, insulator, TADs and Hi-C experiments.

7. RNA-seq

De novo transcript assembly, splicing. Differentially expressed genes, DESeq2 R package.

8. DNA methylation

DNA de-methylation during embryogenesis, differentially methylated regions (DMRs)

9. ChIP-seq

ChIP-seq for histone marks: NGS.plot & ChromHMM, ChIP-seq for transcription factors, sequence logo.

10. DNA accessibility

DNAse-seq and ATAC-seq

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Basic Biostatistics/Базовая биостатистика

Purpose of the course:

Give an idea of the mechanisms of the implementation of genetic information, biostatistics and practical skills in applying bioinformatics and statistical methods for analyzing and interpreting biological data.

Tasks of the course:

• give an idea of the basic methods of statistical analysis of biological data;

• make students familiar with modern understanding of statistical populational studies;

• teach how to use the main databases in the field;

• introduce basic algorithms and data formats for statistical genetics and biostatistics.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- the main methods of assessing statistical significance;

- methods for allowing for the multiplicity of comparisons;

- Meta-analysis methods;

- statistical characteristics of associative tests;

- ROC analysis;

- methods for assessing heritability and genetic risks;

- methods for reducing the number of variables when analyzing large data arrays;

- data classification methods;

- the basics of Bayesian data analysis.

be able to:

- use the Internet and reference books on scientific and applied biostatistics character to quickly find the necessary data and concepts;

- compare statistical processing methods and adequately evaluate them applicability;

- apply basic methods of biostatistics in scientific research;

- apply basic methods of biostatistics when working in the laboratory.

master:

- of conducting large scale data arrays;

- of computer analysis of the statistical significance of the results of genetic and medical/biological experiments.

Content of the course (training module), structured by topics (sections):

1. Biological data structure and descriptive statistics

File organization and data management in EXCEL, SPSS and STATISTICA. Descriptive statistics. Some tricks of fast statistical calculations. Statistical hypothesis testing. Exact and Mediated Criteria. I and II type eroors. Multiple comparison testing. Type I error control. Grouping and Simpson's Paradox. Parametric and non-parametric comparison criteria. Variance analysis.

2. Conjugacy analysis

Regression analysis. Residual analysis. Partial correlations and confounders. Contingency analysis of qualitative features. Odds ratio and relative risk. Biomarker statistics. Estimates of the test sensitivity and specificity. ROC analysis.

3. Multidimensional methods

Multiple regression analysis. Methods to reduce the number of predictors. Friedman paradox. Estimates of heritability and genetic risk. The “missing heritability” problem. Factor analysis. The principal component method. Classification methods. Cluster analysis. Discriminant analysis.

4. Bayesian statistics

Limitation of p-values. Reproducibility of experimental results. Bayesian factor. Priors. Statistics in epidemiology. Analysis of large samples. Bayesian frequency estimates of rare events.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Chinese/Китайский язык

Purpose of the course:

The formation and development of intercultural, professionally-oriented communicative competence of students at the elementary level to solve communicative problems in the professional, business, socio-cultural and academic spheres, as well as for the development of professional and personal qualities of bachelor graduates.

Tasks of the course:

Achieving the elementary level of intercultural professionally-oriented communicative competence in the course of studying the discipline "Chinese language" requires to solve a number of tasks which consist in the consistent mastering a set of sub-competencies. The main of the latter are:

– linguistic competence: the ability to understand other people's speech and express oneself in Chinese;

– sociocultural competence: the ability to take into account in communication speech and non-speech behavior adopted in China;

– social competence: ability to interact with communication partners using the relevant strategies;

– discursive competence: knowledge of the rules for building oral and written discourse messages, the ability to build such messages and understand their meaning in the speech of other people;

– strategic competence: the ability to use the most effective strategies in solving communicative problems;

– subject competence: knowledge of subject information when organizing one’s own utterance or understanding of the utterance of other people;

– compensatory competence: he ability to overcome the communication barrier through the use of well-known speech and meta-language means;

– pragmatic competence: the ability to choose the most effective and expedient way of expressing thoughts, depending on the conditions of the communicative act and the task.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

– Basic facts, realities, names, sights, and traditions of China;

– historical, social, political and cultural events in China;

– phonetic, lexical and grammatical, stylistic features of the Chinese language and its difference from the native language;

– main features of written and oral forms of communication.

be able to:

– Generate adequate oral and written texts in the context of a specific communication situation;

– realize the communicative intention with the aim of influencing the communication partner;

– adequately understand and interpret the meaning and intention of the author in the perception of oral and written authentic texts;

– identify similarities and differences in the systems of native, first foreign (second foreign) and Chinese languages;

– show tolerance, empathy, openness and friendliness when communicating with representatives of another culture.

master:

– Intercultural professionally-oriented communicative competence in different types of speech activity at the elementary level;

– sociocultural competence for successful understanding in the conditions of communication with representatives of another culture;

– various communication strategies;

– learning strategies for organizing their learning activities;

– strategies of reflection and self-esteem to self-improve personal qualities and achievements;

– different methods of memorization and structuring of digestible material;

– Internet technologies to select an optimal mode of obtaining information;

– presentation technologies for providing information.

Content of the course (training module), structured by topics (sections):

1. Introductory-phonetic and introductory-hieroglyphic course. Meeting Chinese colleagues, fellow students, neighbours.

Introduction into the basics of Chinese pronunciation (putonghua) and the basic rules of calligraphy and hieroglyphics.

Communicative tasks: to perceive by ear and reproduce words, word combinations, phrases according to the pronunciation norm of the Chinese language. To read words, word combinations and phrases both written in pinyin and in hieroglyphs, according to the pronunciation norm of the Chinese language. To compose phrases, including everyday life phrases, according to the lexical and grammatical norms of the Chinese language. To use courtesy phrases. Participate in a dialogue-inquiry and dialogue-incitement to action. To take part in the role-playing game “Meet the Chinese colleagues”.

Pronunciation: The sound-letter standard for recording Chinese words is pinyin, following the basic requirements for pronouncing Chinese sounds and distinguishing all Chinese sounds by ear. Following the rules of the tone system of the Chinese language, the main types of intonation of Chinese sentences.

Vocabulary: phrases of greeting and farewell, fixed expressions, courtesy phrases. Names of the countries, cities in China and the world. Common last names, social roles, educational supplies.

Grammar: the main communicative types of sentences - narrative (affirmative/negative), interrogative (general and special question), imperative, exclamatory and their structures (word order, topic and comment (subject and predicate, inverted object etc.). A sentence with a quality predicate, quality adjective in the commentary position. Negative sentence form with quality predicate, quality adjective in the commentary position. Sentences with a linking verb是shì, the position of the negation 不bù in a sentence with a linking verb是shì, interrogative sentences with particles吗 ma, 吧ba, 呢 ne. Attribute in the possessive meaning. Particle的 de. Order of attributes in a Chinese sentence. Personal pronouns in Chinese, their functions and usage. Demonstrative and interrogative pronouns in Chinese. Interrogative sentences with interrogative pronouns. Word order in an interrogative sentence with an interrogative pronoun. A sentence with a verb predicate (action verb in the commentary position). Adverbs也yěand都dōu, their place in a sentence with regard to the predicate. The combination of the adverb都dōu with the negation不bù.

Writing: basic rules of calligraphy. The basics of hieroglyphics, mastering graphemes and hieroglyphs in accordance with the lexical and grammatical material studied. Writing short written statements according to the communicative task.

2. Getting to know the university campus, orientation in the city.

Buildings inside the campus, the insides of the building, different institutions and their location relative to each other, orientation in space and in cardinal directions. Using the acquired knowledge and skills in speech.

Communicative tasks: to perceive by ear and reproduce words, word combinations, phrases according to the pronunciation norm of the Chinese language. To understand the main content of various authentic pragmatic and journalistic audio and video texts on relevant topics. To extract the necessary/requested information from various audio and video texts on the relevant topics. To read words, word combinations, phrases and small texts, written both in pinyin and in hieroglyphs, according to the pronunciation norm of the Chinese language. To read authentic texts of various styles using various reading strategies/types in accordance with the communicative task. To compose phrases and short texts according to the lexical and grammatical norms of the Chinese language. To use courtesy phrases. To participate in a dialogue-inquiry and dialogue-incitement

to action, to make a dialogue-exchange of views and a combined dialogue, including elements of different types of dialogues. To talk, to reason within the studied topics and problems, and give examples and arguments. To describe events, to state facts and what one has read/heard een. To describe the university campus, ways to get to one's destination. To take part in the role-playing tour around the campus. To talk about locations and movement directions.

Pronunciation: meeting the basic requirements for pronouncing Chinese sounds and differentiating all of Chinese sounds by ear. Following the rules of the Chinese language tone system. The main types of intonation of Chinese sentences, the melody and rhythm of Chinese sentences of different types, phrasal accent.

Vocabulary: fixed expressions, courtesy phrases. Date, time, time of day, days of the week, postpositions (locatives) to specify spatial relationships.

Grammar: the main communicative types of sentences - narrative (affirmative/negative), interrogative (general and special question), imperative, exclamatory, and their structure schemes. Sentences of presence and possession with the verb有yǒu. Location indications with verbs在и 是 Postpositions ("adverbs of place") specifying spatial relationships (前边qiánbiān, 后边hòubiān, 上边shàngbiānetc.), in the function of a subject, an object and an attribute. Sentences of location (verb在zài, verb有yǒu, linker是shì).

Writing: mastering graphemes and hieroglyphs according to the lexical and grammatical material studied. Writing messages or written statements in according to the communicative task.

3. Everyday life at work and at home, telling the exact time, plans for the nearest future.

Discussing the daily timetable, class schedule, plans for the nearest future, appointing a meeting. Using the acquired knowledge and skills in speech.

Communicative tasks: to perceive by ear and reproduce words, word combinations, phrases according to the pronunciation norm of the Chinese language. To understand the main content of various authentic pragmatic and journalistic audio and video texts on relevant topics. To extract the necessary/requested information from various audio and video texts on the relevant topics. To read words, word combinations, phrases and small texts, written both in pinyin and in hieroglyphs, according to the pronunciation norm of the Chinese language. To read authentic texts of various styles using various reading strategies/types in accordance with the communicative task. To compose phrases and short texts according to the lexical and grammatical norms of the Chinese language. To use courtesy phrases. To participate in a dialogue-inquiry and dialogue-incitement to action, to make a dialogue-exchange of views and a combined dialogue, including elements of different types of dialogues. To talk, to reason within the studied topics and problems, and give examples and arguments. To describe events, to state facts and what one has read/heard een. To talk about the past experience in the everyday and professional life. To tell the exact time, the beginning and the ending of events, class schedule, plans for the nearest future.

Pronunciation: meeting the basic requirements for pronouncing Chinese sounds and differentiating all of Chinese sounds by ear. Following the rules of the Chinese language tone system. The main types of intonation of Chinese sentences, the melody and rhythm of Chinese sentences of different types, phrasal accent.

Vocabulary: fixed expressions, telling the exact time, days of the week, part of the day, adverbs of time today, tomorrow, yesterday, counting from 1 to 100, address, phone number.

Grammar: the main communicative types of sentences - narrative (affirmative/negative), interrogative (general and special question), imperative, exclamatory and their structure schemes. Adverbial modifier of time; ways to specify time and date. Ordering adverbial modifiers of time in a sentence. Special question to the adverbial modifier of time. The verb 有 and the negation没有. Interrogative words几и 多少, phrasal particles吧и 呢.

Writing: basic rules of calligraphy. The basics of hieroglyphics, mastering graphemes and hieroglyphs in accordance with the lexical and grammatical material studied. Writing small written statements according to the communicative task.

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4. Talking about address, phone number, travel route. Shopping. Family. The weather.

Talking to the shop assistant, discussing the planned purchase, its price and quantity. Talking about the family members and pets. Discussing seasons and the weather in Russia and China, the air temperature. Discussing preferences.

Communicative tasks: to perceive by ear and reproduce words, word combinations, phrases according to the pronunciation norm of the Chinese language. To understand the main content of various authentic pragmatic and journalistic audio and video texts on relevant topics. To extract the necessary/requested information from various audio and video texts on the relevant topics. To read words, word combinations, phrases and small texts, written both in pinyin and in hieroglyphs, according to the pronunciation norm of the Chinese language. To read authentic texts of various styles using various reading strategies/types in accordance with the communicative task. To compose phrases and short texts according to the lexical and grammatical norms of the Chinese language. To use courtesy phrases. To participate in a dialogue-inquiry and dialogue-incitement to action, to make a dialogue-exchange of views and a combined dialogue, including elements of different types of dialogues. To talk and reason within the topic studied and give examples and arguments. To describe events, to state facts and what one has read/heard een. To construct mini-dialogs with the shop assistant about the planned purchase, its price and quantity. To make dialogs about the family members. To discuss climate peculiarities of Chine and the speaker’s country, the weather in different seasons, temperature conditions.

Pronunciation: meeting the basic requirements for pronouncing Chinese sounds and differentiating all of Chinese sounds by ear. Following the rules of the Chinese language tone system. The main types of intonation of Chinese sentences, the melody and rhythm of Chinese sentences of different types, phrasal accent.

Vocabulary: fixed expressions, courtesy phrases, purchase, goods, shops, money, counting words for different objects, money, family members. Family members and pets. Seasons of the year, the weather, natural phenomena.

Grammar: the main communicative types of sentences - narrative (affirmative/negative), interrogative (general and special question), imperative, exclamatory and their structure schemes. Interrogative words几и 多少. Numerals二and 两. Using counting words depending on the noun.

Quality predicate and special question to a quality predicate with the interrogative word**怎么样**.

Writing: mastering graphemes and hieroglyphs according to the lexical and grammatical material studied. Writing messages or written statements in according to the communicative task.

5. Talking about present moment of action. Daily and weekly class schedule, plans for tomorrow.

Discussing free time, home tasks, present actions. Discussing plans for the nearest future, at first and then. Using the acquired knowledge and skills in speech.

Communicative tasks: to perceive by ear and reproduce words, word combinations, phrases according to the pronunciation norm of the Chinese language. To understand the main content of various authentic pragmatic and journalistic audio and video texts on relevant topics. To extract the necessary/requested information from various audio and video texts on the relevant topics. To read words, word combinations, phrases and small texts, written both in pinyin and in hieroglyphs, according to the pronunciation norm of the Chinese language. To read authentic texts of various styles using various reading strategies/types in accordance with the communicative task. To compose phrases and short texts according to the lexical and grammatical norms of the Chinese language. To use courtesy phrases. To participate in a dialogue-inquiry and dialogue-incitement to action, to make a dialogue-exchange of views and a combined dialogue, including elements of different types of dialogues. To talk, to reason within the studied topics and problems, and give examples and arguments. To describe events, to state facts and what one has read/heard een. To discuss present actions, to talk about the class schedule and about what happens every day, every week etc. To discuss planned actions for the nearest future and their sequence.

Pronunciation: meeting the basic requirements for pronouncing Chinese sounds and differentiating all of Chinese sounds by ear. Following the rules of the Chinese language tone system. The main types of intonation of Chinese sentences, the melody and rhythm of Chinese sentences of different types, phrasal accent.

Vocabulary: fixed expressions, courtesy phrases. Time expressions from … till ..., present moment, every day, days of the week, at first, then, institutions and purposes to visit those.

Grammar: the main communicative types of sentences - narrative (affirmative/negative), interrogative (general and special question), imperative, exclamatory and their structure schemes. Adverbs of present tense现在and**正在**, expressions**每**...**都**, time period expression**从**...**到**, **先**...**然后**… .

Modal verb **打算**, talking about the purpose of a trip using a serial verb construction**去 商店** 买东. Adverb**一起**. General question with an affirmative-negative predicate.

Writing: mastering graphemes and hieroglyphs according to the lexical and grammatical material studied. Writing messages or written statements in according to the communicative task.

6. Discussing the product before purchasing, friend's birthday, choosing a present, talking about preferences.

Talking about choosing the color of the clothes, about preferences. Discussing a purchase, its benefits and drawbacks. Choosing a birthday present for a friend, discussing different options and people's preferences. Using the acquired knowledge and skills in speech.

Communicative tasks: to perceive by ear and reproduce words, word combinations, phrases according to the pronunciation norm of the Chinese language. To understand the main content of various authentic pragmatic and journalistic audio and video texts on relevant topics. To extract the necessary/requested information from various audio and video texts on the relevant topics. To read words, word combinations, phrases and small texts, written both in pinyin and in hieroglyphs, according to the pronunciation norm of the Chinese language. To read authentic texts of various styles using various reading strategies/types in accordance with the communicative task. To compose phrases and short texts according to the lexical and grammatical norms of the Chinese language. To use courtesy phrases. To participate in a dialogue-inquiry and dialogue-incitement to action, to make a dialogue-exchange of views and a combined dialogue, including elements of different types of dialogues. To talk, to reason within the studied topics and problems, and give examples and arguments. To describe events, to state facts and what one has read/heard een. To discuss a product before purchase, its benefits and drawbacks. To discuss a present for a friend and help with the choice. To give advice and arguments.

Pronunciation: meeting the basic requirements for pronouncing Chinese sounds and differentiating all of Chinese sounds by ear. Following the rules of the Chinese language tone system. The main types of intonation of Chinese sentences, the melody and rhythm of Chinese sentences of different types, phrasal accent.

Vocabulary: fixed expressions, courtesy phrases, colors and shades, properties of objects, expression "a little…" (**有一点儿**...), vocabulary related to birthdays.

Grammar: the main communicative types of sentences - narrative (affirmative/negative), interrogative (general and special question), imperative, exclamatory and their structure schemes. Attributive construction with the **的**, adverb **有一点儿**... and adverb **挺**, alternative question with the conjunction 还是, attribute with the "prefix" **可** (**可送的**，**可看的**，**可去的**).

Writing: mastering graphemes and hieroglyphs according to the lexical and grammatical material studied. Writing messages or written statements in according to the communicative task.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Data Structures and Algorithms/Структуры данных и алгоритмы

Purpose of the course:

• form an understanding of the various computational problems in graph theory and the asymptotic complexity of their solutions;

• provide theoretical and practical knowledge about algorithms and data structures of graph theory with proof of the correctness of their work, about methods for assessing the complexity of algorithms.

Tasks of the course:

• teach to formulate tasks in terms of theories studied, choose the appropriate algorithm for the task;

• teach you how to develop combinations of algorithms to solve problems, evaluate the complexity of algorithms, their modifications and combinations, including using depreciation analysis, select the appropriate data structures for the tasks, implement the algorithms in a generalized form in the C ++ programming language.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• Graph algorithms and data structures associated with them,

• Estimates of the complexity of standard algorithms.

• Standard graph algorithms and data structures used, approaches to the modification of classical algorithms.

• A variety of classical problems in graph theory and the asymptotic complexity of their solutions.

be able to:

• formulate tasks in terms of theories studied, choose the appropriate algorithm for the task;

• develop combinations of algorithms to solve the problem,

• evaluate the complexity of algorithms, their modifications and combinations, including using depreciation analysis,

• select the appropriate data structures for a specific task,

• implement the algorithm in a generalized form in the c ++ programming language;

• implement standard graph algorithms and data structures in the C ++ programming language.

master:

• Methods of decomposition of tasks in the field of information technology and the construction of a single solution using the studied algorithms.

• Methods for assessing the complexity of algorithms, their modifications and combinations.

Content of the course (training module), structured by topics (sections):

1. graph traversals

• Oriented graph, pseudograph. Undirected graph, pseudograph.

• Connectivity in neor. graph, connected components.

Weak and strong connectivity in op. column. Components of weak, strong connectivity.

• Walking in depth. The colors of the vertices. Entry and exit times. The white path lemma.

• Check connectivity of an undirected graph.

• Search for a loop in an undirected and oriented graph.

• Topological sorting.

• Finding components of strong connectivity. Kosarayu algorithm. Tarjan's algorithm.

• Components of rib biconnectedness. Bridges. Search for bridges.

• Components of vertex biconnectedness. Articulation points. Search for articulation points.

• Wave algorithm. Traversal in width (application of the queue in the wave algorithm).

• A criterion for the existence of the Euler path and cycle in an oriented and non-oriented graph. Search for the Euler path and cycle.

2. Shortest paths in a weighted graph

• Dijkstra's algorithm.

• The colors of the vertices. The tree of shortest paths.

• Potentials. The applicability condition for the Dijkstra algorithm for modified edge lengths. The potential $\pi(v) = \rho(v, t)$.

• Algorithm A *. Monotonicity condition on heuristics. Examples of heuristics.

• Two-way Dijkstra algorithm.

• Ford-Bellman Algorithm.

• Storage in the matrix: Dvk is equal to the length of the shortest path to the vertex v for exactly k edges (no more than k edges). Proof of correctness. Estimated work time.

• Restore the path.

• Detection of a negative weight cycle. Search for the cycle itself.

• Finding the shortest paths taking into account negative weight cycles.

• Floyd's algorithm. Evidence. Restoring the path.

• Finding a negative weight cycle.

• Johnson's algorithm. Adding a dummy root and dummy edges to run the Ford-Bellman algorithm.

3. Spanning trees

• Spanning tree. Build with a walk in depth and in width.

• Definition of a minimum spanning tree.

• Sectional theorem. Evidence.

• Prim's algorithm. Analogy with Dijkstra's algorithm.

• Proof using the cut theorem. Estimated runtime for various priority queue implementations: binary heap, Fibonacci heap (the latter without proof).

• Kruskal algorithm. Evidence. Estimated work time.

• A system of disjoint sets. Heuristic potentials with proof of an estimate of the run time.

• Heuristic compression paths without proof.

• Boruvka Algorithm. Evidence. Estimated work time.

• Approximation of the solution of the traveling salesman problem using a minimum spanning tree.

4. Network streams

• Network definition. Flow definition.

• Physical meaning. An analogy with the laws of Kirchhoff.

• Definition of section. The concepts of flow through a cut.

• Proof of the fact that the flow through any section is the same.

• The concept of a residual network. The concept of a complementary path.

• The need for a lack of a complementary path for maximum flow.

• Ford-Fulkerson theorem.

• Ford-Fulkerson Algorithm. Search for the minimum cut.

• An example of an integer network in which the algorithm runs for a long time.

• Edmonds-Karp algorithm.

• Proof that the shortest distance in a residual network does not decrease.

• General estimate of the running time of the Edmonds-Karp algorithm.

• Layered network. Algorithm Dinitsa.

• Matching. Maximum matching. The greatest matching. Perfect match.

• The task of finding the greatest matching. Examples of real problems.

• Alternating path. Berg's Lemma.

• The greatest matching in a bipartite graph. Rating.

5. Segment Data Structures

• RSQ and RMQ.

• Rarely-table.

• Segment tree.

• Processing requests from leaves.

• Processing requests from the root.

• Changing the values in the array, updating the tree of segments.

• Multiple operations.

• Fenwick tree.

• LCA. Binary lifting method.

• Reducing LCA to RMQ problem.

• Reducing RMQ to an LCA problem.

• Cartesian tree by implicit key.

• Multiple operations in a Cartesian tree using an implicit key.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Data Visualization/Визуализация данных

Purpose of the course:

Study practical skills in using the R, IDE R-studio language and basic packages for data analysis.

Tasks of the course:

• Study the basics of the R programming language;

• Learn to use IDE R-studio;

• Introduce basic data analysis packages with R;

• The development of students' basic bioinformatic skills and the acquisition of

practical experience is necessary for conducting independent scientific research in the field of system biology.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- Main packages of the R software environment;

- Basic R syntax;

be able to:

- Obtain an ability of programing in R language

- Implement and debug bioinformatics algorithms;

- Implement statistical analysis in a software environment R.

master:

- skills of working with large volumes of biological data;

- the culture of planning and implementation of multi-stage bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. Introduction to the programming language R and IDE R-studio.

Introductory lesson. The main commands in R. Setting up the R-studio workspace. Install packages and updates.

2. Syntax of R

The implementation of the code on R. Syntax R. The main objects in R, the concept of variables, array, matrix, data.frame, list, array.

3. Operators and functions

Operators in R. Implementation of functions in the language R, functions of the first level. Functions of the nth level. It is assumed that, based on the results of the module, students will be able to implement their own functions in the R language, as well as manipulate variables using the basic operators in R.

4. Basic graphics in R

Fundamentals of graphics in R. Construction of two-dimensional graphs on the plane using the base () package. Boxplot, barplot, pie plot, dot plot, histogram. Adjustable parameters of the plot and par () object. Legend on base () charts. The parameters of the axes of the plot in the base plot.

5. Implementing graphs with ggplot2

Implementing graphs using the ggplot2 package. Layers in ggplot2 objects. Additional features of the ggplot2 package: geom_point, geom_abline, geom_polygon, geom_rect. Facet and grid on ggplot2 charts. Adjustable environment settings graphics. Main (), axis labesl. Legend in ggplot2

6. Correlation and linear regression

The concept of correlation. Pearson and Spiren correlation. Data visualization. Linear regression. Multiple linear regression. R2 and F-statistics. Testing models. Test and training sample. ANOVA. Glm, generalized linear model. Logit regression and AIC. Amendment for multiple comparison. FDR, Bonferroni amendment.

7. PCA and Heatmaps

Analysis of the main components. General principles of PCA implementation. The prcomp functions of the stats package. Pca3d package Heat maps. Packages heatmap and heatmap.2. Data visualization with PCA and heatmap.

8. Clustering in R;

Basic clustering algorithms. Euclidean, manhattan, maximum, canberra. Hierarchical clustering. The distance between the clusters. Comlete, Single, Average linkage. Dendrogram as an object R. K-means, k-medoids. Self-organizing map. Silhouette.

9. NGS and search for differentially expressed genes;

General principles of the next generation sequencing. Trimming and QC Reed. FastQC and trimmomatic. Overview of alignment algorithms. BWA, Bowtie, STAR. Alignment of reads on the genome. Detection of alternative splicing. Cufflinks. Cuffdiff. Normalization of reads.

DEXseq, EdgeR, limma. Log fold-change. Search for differentially expressed genes and identification of reliable DEGs.

10. Packages for working with sequences. The final lesson.

The main functions of the package Seqinr, Ape, annotation of genes using the package GenomicRanges, GenomicAlignments. Go-enrichent. Hypergeometric distribution.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Deep Learning in Biology/Глубокое обучение в биологии

Purpose of the course:

Mastering the methods and theory of deep learning for solving applied problems, including in the field of computer vision and natural language processing.

Tasks of the course:

Mastering by students of knowledge (concepts, concepts, methods and models) in the field of deep learning;

Acquisition of theoretical knowledge and practical skills in the field of deep learning for solving applied problems, including the necessary knowledge of software development;

Providing advice and assistance to students in conducting their own research in the field of deep learning.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

theory of machine and deep learning (concepts, axioms, methods);

modern problems of the relevant sections of deep learning;

basic libraries and software for the implementation of their own or typical projects using deep learning.

be able to:

understand the task and evaluate its correctness;

use your knowledge to solve applied problems;

find algorithms for solving problems and analyze them;

analyze scientific literature on deep learning.

master:

skills of mastering a large amount of information and solving problems (including complex ones);

skills of independent work and mastering new disciplines;

culture of setting, analyzing and solving mathematical and applied problems;

the subject language of deep learning and the skills of competently describing problem solving and presenting the results.

Content of the course (training module), structured by topics (sections):

1. Introduction to deep learning

Neural networks. Backpropagation of the error. Stochastic gradient descent. Weighing initialization. Implementation using the Pytorch library.

2. Fighting overfitting in neural networks

Advanced optimization techniques. Optimization of hyperparameters. Batch normalization. Regularization. Dropout. Fading gradient problem.

3. Convolutional neural networks

Image tasks: classification, localization, detection, segmentation, semantic segmentation. Basic Convolutional Network Architectures. Transfer learning.

4. Recurrent neural networks

GRU and LSTM. Application of recurrent networks for natural language processing problems. Vector representations of words. word2vec: CBOW and skip-gram. Language models. GPT models - (1,2,3).

5. Seq2seq models

Seq2seq models. Translation tasks, text2speech, speech recognition.

6. Attention mechanism

Attention mechanism. Transformers (Transformer). BERT, RoBERTa models.

7. Learning without a teacher

Autoencoders. Variation autoencoder.

8. Generative models

Generative Adversarial Networks (GAN). Generation of images.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

English Language. Intercultural Communication/Английский язык. Межкультурная коммуникация

Purpose of the course:

Formation of cultural and linguistic competence as a basis for a respectful intercultural attitude towards spiritual, national, and other values of other countries and nations; development of graduate students' cultural sensitivity, the ability to correctly interpret specific manifestations of communicative behavior in different situations; intercultural contacts, practical skills and abilities in communicating with representatives of other cultures, the ability to correctly interpret specific manifestations of communicative behavior and tolerant attitude to them; mastering intercultural interaction up to the necessary and sufficient level to solve communicative and social problems in different cultural, everyday, academic and professional tasks, in communication with representatives of other cultures.

Tasks of the course:

To form the learner's ability to solve communicative tasks by language means in various situations of intercultural communication, to interact on the interpersonal and professional level in a foreign language, considering the peculiarities of the culture of the language being studied, as well as the ability to overcome intercultural differences in situations of everyday, social and professional communication; to develop the ability to reflect on one's own and other cultures, which initially prepares one to have a respectful attitude to cultural manifestations of the target language; to expand the knowledge on the corresponding culture for deep understanding of diachronic and synchronic relations between one' own and the culture of the target language; to acquire new insights into the conditions of socialization and enculturation in one's own and other cultures, social stratification, and sociocultural forms of interaction in shared cultures.

To achieve the goals and objectives of mastering the discipline, students must master a foreign language professional communicative competence, including:

Ethnographic competence: the ability to understand the country of the studied language, its history and culture, everyday life, prominent representatives, traditions and manners; the ability to compare the history, culture, customs of their own and other cultures, understanding of cultural specificity and the ability to explain the causes and origins of a particular cultural characteristic.

Linguistic competence: the ability to correctly construct grammatical forms and syntactic constructions in accordance with the norms of the studied language.

Sociolinguistic competence: the ability to use and transform language forms in accordance with the situation of foreign-language communication.

Sociocultural competence: the ability to consider verbal and non-verbal behavior of the studied language country in communication.

Social competence: the ability to interact with communication partners, possession of appropriate strategies.

Discursive competence: the ability to understand and achieve coherence of individual statements in meaningful communicative models.

Strategic competence: the ability to use the most effective strategies in solving communicative tasks.

Object competence: knowledge of meaningful information when organizing one's own statement or understanding other people's statements.

Subject-professional competence: the ability to operate with knowledge in real world communication with representatives of the studied culture, showing empathy as the ability to understand the norms, values and motives of behavior of representatives of another culture.

Communicative competence: the ability to establish and maintain contacts with representatives of different age, social and other groups of both their own and other cultures, the ability to be a mediator between their own and other cultures.

Pragmatic competence: the ability to choose the most effective and expedient way of expressing thoughts, depending on the conditions of the communicative act and the task set.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- interrelation, mutual influence and interaction of language and culture;

- the role of language as an organic part of culture in human life, behavior and communication with speakers of other languages and other cultures, national individuality and identity of peoples;

- the concept of a cultural and anthropological view of a person, his/her way of life, ideas, attitudes, customs, system of values, perception of the world - his/her own and others';

- the influence of culture through language on human behavior, worldview and life in general;

- the history of emergence, development stages and teaching methods of intercultural communication;

- the meaning of the concept of "culture", its role in the communication process, as well as the relationship with such concepts as "socialization", "inculturation", "acculturation", "assimilation", "behavior", "language", "identity", "global citizenship";

- the impact of various social transformations on cultural identity changes;

- the specifics of how other cultures are perceived, the causes of prejudice and stereotypes in intercultural encounters;

- mechanisms of forming intercultural tolerance and dialogue of cultures;

- types, kinds, forms, models, structural components of intercultural communication;

- the norms and styles of intercultural communication;

- features of mentality and national customs of different cultures, cultural standards of ethnic, political and economic plans;

- linguistic worldview of native speakers of foreign languages, their distinctive features of outlook and understanding of the world;

- ethical and moral norms of behavior in a culturally different environment;

- language standards of oral communication culture, ethical and moral norms of behavior adopted in the country of the studied language; stereotypes and ways to overcome them; norms of etiquette in the country of the studied language;

- methods of systematic and critical analysis; methods of developing an action strategy for identifying and solving a conflict situation;

- stages of the project life cycle; stages of project development and implementation; methods of project development and management;

- team building techniques; methods of effective team management; basic leadership theories and leadership styles;

- rules and patterns of personal and business oral and written communication; modern communication technologies in Russian and foreign languages; existing professional communities for professional interaction;

- regularities and peculiarities of social and historical development of different cultures; peculiarities of intercultural society diversity; rules and methods of effective intercultural interaction;

- methods of self-assessment, self-control and self-development

be able to:

- apply the techniques of studying cultural systems and intercultural situations;

- perceive, analyze, interpret and compare cultural facts;

- determine the role of basic cultural concepts in intercultural communication;

- find adequate solutions in various intercultural communicative situations;

- analyze the peculiarities of intercultural communication in a team;

- reflect on the reference system of one's own culture;

- recognize and correctly interpret nonverbal signals in the process of intercultural communication;

- compose a communicative portrait of a representative of another linguistic culture;

- discover the meanings of concepts and actions in an intercultural situation;

- analyze coincidences and differences in communicative behavior from the perspective of the cultures in contact;

- adequately implement one' s communicative intentions when communicating with representatives of other linguistic cultures;

- switch when encountering another culture based not only on linguistic, but also on non-linguistic norms of behavior;

- identify the causes of communicative problems and apply ways to overcome them;

- take the position of a partner in intercultural communication and identify possible conflicts as conditioned by the values and norms of one' s culture;

- successfully overcome barriers and conflicts in communication and achieve mutual understanding;

- reveal the relationship and mutual influence of language and culture;

- be tolerant of other cultures and languages;

- analyze the main stages and regularities of the historical development of society to form their civic position;

- respect and preserve the historical heritage and cultural traditions;

- use models of social situations, typical scenarios of interaction of participants of intercultural communication;

- guide the principles of cultural relativism and ethical norms, which imply rejection of ethnocentrism and respect for the diversity of foreign language culture and value orientations of foreign-language societies;

- overcome the influence of stereotypes and carry out intercultural dialogue in general and professional lines of communication;

- model possible communicative situations between representatives of different cultures and societies;

- apply methods of systematic approach and critical analysis of problem situations; develop action strategies, make concrete decisions to implement them;

- develop a project taking into account the analysis of alternative options for its implementation, determine the target stages, the main directions of work; explain the goals and formulate tasks related to the preparation and implementation of the project; manage the project at all stages of its life cycle;

- develop a plan of collective and organizational communications in preparation and implementation of the project; formulate tasks for team members to achieve the set goal; develop a team strategy); apply effective styles of team leadership to achieve the set goal;

- apply communicative technologies, methods and ways of business communication in practice for academic and professional interaction;

- determine theoretical and practical significance of cultural and linguistic factors in the interaction of different philosophical and academic traditions;

- understand and tolerate intercultural diversity of society; analyze and take into account the diversity of cultures in the process of intercultural interaction;

- solve the problems of personal and professional development, determine and implement the priorities of improvement of own activity; apply the methods of self-assessment and self-control.

master:

- norms of etiquette and behavior when communicating with representatives of other cultures;

- principles of tolerance in resolving intercultural conflicts;

- methods of communicative research, the ability to apply the acquired knowledge in research activities, oral and written communication;

- communicative strategies and tactics characteristic of other cultures;

- skills for proper intercultural communication, independent analysis of intercultural conflicts in the process of communication with representatives of other cultures and ways to resolve them;

- the ability to correctly interpret specific manifestations of verbal and nonverbal communicative behavior across cultures;

- oral and written communication skills in Russian and foreign languages to solve interpersonal and intercultural communication issues;

- skills of operating with a focus on ethical and moral norms of behavior accepted in a foreign cultural society;

- the necessary interactive and contextual knowledge, allowing to overcome the influence of stereotypes and adapt to changing conditions in contact with representatives of different cultures

- methodology of systematic and critical analysis of problematic situations; methods of setting a goal, determining the ways to achieve it, developing action strategies

- methods of project development and management; methods of resource and project efficiency evaluation;

- the ability to analyze, design and organize interpersonal, collaborative and organizational communication in a team to achieve an objective; methods of organization and management of the team;

- methods of interpersonal business communication in Russian and foreign languages, with the use of professional language forms, tools, and modern communication technologies;

- methods and skills of effective intercultural interaction;

- technologies and skills for managing one's own cognitive activity and improving it on the basis of self-assessment, self-control and principles of lifelong learning.

Content of the course (training module), structured by topics (sections):

1. Topic 1. Culture and language

The fundamental principles of intercultural communication and dialogue of cultures. Cultural worldview: an understanding of the values, norms, and morals of one's own culture and those of others. Types of relations between cultures. Linguistic system. The communicative function of language. Various forms of language communication. Human speech as a means of transmitting and receiving the bulk of vital information. The correlation between human speech and the language system as a whole. The meaning of language in peoples' cultures. Language as a unique means of storing and passing information, as well as controlling human behavior. The relationship between language, culture and communication. Language culture, language personality communication, identity, stereotypes of consciousness, world pictures, etc.

Communicative tasks: to carry out communication in oral and written forms: explaining the values and ethical norms of one's own culture and those of other cultures; discussing the characteristics and types of relationships between cultures; discussing the importance of taking into account the differences in the means of communication and the communication styles of other cultures; expressing hypotheses and one's own perspective on the interaction between language and culture.

2. Topic 2. Typology of cultures

The fundamental principles of intercultural communication and dialogue of cultures. Cultural worldview: an understanding of the values, norms, and morals of one's own culture and those of others. Types of relations between cultures. Parametric model of culture by G. Hofstede. Theory of cultural standards by A. Thomas. Differentiation of cultures by R. Lewis and F. Trompenaars. Perceptual stereotypes, prejudices and their functions, importance for intercultural communication. Tolerance in intercultural communication.

Communicative tasks: to carry out communication in oral and written forms: explaining the differences in various types of cultures; discussing the specifics of cultural standards, models, concepts; describing the values, norms, and morals of one's own culture and those of other peoples; analyzing coincidences and differences in communicative behavior from the perspective of contacting cultures; taking the partner's position in intercultural communication and identifying possible conflicts as conditioned by values and norms of his/her culture; discussing possible problems in communication with the representative of another culture and ways to resolve them in case analysis.

3. Topic 3. The essence and types of intercultural communication

Existing cultural differences between different people. Overcoming intercultural differences as the main goal of interpersonal communication. Cognitive, social and communication styles of intercultural communication. Verbal and nonverbal communication. Forms and methods of verbal and nonverbal communication. Paraverbal communication. National and cultural characteristics of verbal and nonverbal communicative behavior in different cultures.

Communicative tasks: to carry out communication in oral and written forms: describing events, concepts (space, time, personality, life, etc.) in terms of one' own and other cultures; discussing means of verbal and nonverbal intercultural communication; finding similarities and differences in ways of intercultural communication, typical for foreign and one' own cultures; modeling features of communicative behavior of representatives of one' own and other cultures in a role play.

4. Topic 4. Intercultural scientific communication

Forms of academic and intercultural communication: oral, written, formal, informal. Academic communication: intercultural aspect. Intercultural academic communication and the problems of translation. Academic text as a subject-sign model in a monocultural and intercultural environment. Difficulties and contradictions that occur in the perception and understanding of foreign-language texts.

Communicative tasks: to carry out communication in oral and written forms: describing similarities and differences in foreign-language and native-language academic communication; using cultural standards in situations of oral and written intercultural academic communication; transforming academic texts (from oral to written, from formal to colloquial, etc.); translating academic texts with regard to cultural context and genre tyle affiliation.

5. Topic 5. International academic mobility

Academic mobility as a means of intercultural communication. The importance of intercultural communication for academic mobility. Features of social and academic adaptation in the context of academic mobility. Intercultural communication and communicative competence in the process of academic mobility.

Communicative tasks: to carry out communication in oral and written forms: discussing the benefits of international academic mobility; giving examples of academic mobility in foreign-language and native-language cultures; solving issues related to cultural adaptation in an international academic environment; participating in a role play on typical situations of international academic mobility.

6. Topic 6. Intercultural communication in business

Etiquette and business communication features in different countries. General principles of business etiquette. National principles of business negotiations. Comparing the etiquette of business negotiations. European and Asian communication styles. General features of business etiquette in Asian countries. The influence of different cultural factors on business development of companies planning to enter foreign markets. Communication strategies for achieving mutual understanding in international business. Working with Chinese partners. Knowledge of cultural characteristics as a competitive advantage. Participating in international projects and programs. Working in an international team.

Communicative tasks: to carry out communication in oral and written forms: describing corporate cultures, norms of business etiquette and behavior accepted in the native and foreign countries; solving common problem situations in intercultural business communications; using effective interpersonal communication strategies in intercultural business communications; writing a business e-mail to a foreign partner taking into account his/her cultural affiliation; negotiating with representatives of another linguistic culture.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

English Language. Leadership and Communication in Science, Industry and Academia/Английский язык. Лидерство и коммуникация в науке, индустрии и образо

Purpose of the course:

Formation and development of social, business, cultural and professionally-oriented communicative competencies in accordance with the Common European Framework of Reference for solving communicative tasks in the socio-cultural, academic and professional-business spheres of activity, as well as for the development of professional and personal qualities of master's graduates.

Tasks of the course:

To form the learner's ability to solve communicative tasks by language means in various situations of intercultural communication, to interact on the interpersonal and professional level in a foreign language, considering the peculiarities of the culture of the language being studied, as well as the ability to overcome intercultural differences in situations of social and professional communication. To achieve the goals and objectives of studying the course, students are to master a foreign language general professional communicative competence, including:

Linguistic competence: the ability to correctly construct grammatical forms and syntactic constructions in accordance with the norms of the studied language.

Sociolinguistic competence: the ability to use and transform language forms in accordance with the situation of foreign-language communication.

Sociocultural competence: the ability to consider verbal and non-verbal behavior of the studied language country in communication.

Social competence: the ability to interact with communication partners, possession of appropriate strategies.

Discursive competence: the ability to understand and achieve coherence of individual statements in meaningful communicative models.

Strategic competence: the ability to use the most effective strategies in solving communicative tasks.

Object competence: knowledge of meaningful information when organizing one's own statement or understanding other people's statements.

Pragmatic competence: the ability to choose the most effective and expedient way of expressing thoughts, depending on the conditions of the communicative act and the task set.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- methods of system and critical analysis;

- methods of developing an action strategy to identify and solve a problem situation;

- stages of the project life cycle;

- stages of project development and implementation; methods of project development and management;

- methods of forming teams;

- methods of effective team management, characteristics of communicative behavior in the process of intercultural communication;

- basic leadership theories and leadership styles;

- rules and patterns of personal and business foreign language oral and written communication;

- modern communication technologies in Russian and foreign languages, culturally determined features of communication in the process of intercultural communication;

- existing professional communities for professional interaction;

- patterns and features of socio-historical development of various cultures;

- features of the intercultural diversity of society;

- rules and technologies of effective intercultural interaction; methods of self-assessment, self-control and self-development.

be able to:

apply methods of a system approach and critical analysis of problem situations;

- to search for solutions to the problem situation and develop a strategy of actions to achieve the goal, to make certain decisions for its implementation, using the skills of foreign language oral and written speech;

- to assess the impact of the decisions taken on the external environment of the planned activity and the relationships of the participants in this activity;

- to develop a project considering the analysis of alternative options for its implementation, to determine the target stages, the main directions of work;

- formulate goals and objectives, relevance, significance related to the preparation and implementation of the project, expected outcomes and possible areas of their application, using the skills of foreign language oral and written speech;

- manage the project at all stages of its life cycle;

- organize and coordinate work with due account for the diversity of the project participants' cultures;

- develop a plan of group and organizational communications during the preparation and implementation of the project;

- formulate tasks for team members to achieve the goal; develop a team strategy using the skills of foreign language oral and written speech;

- apply effective team leadership styles to achieve the set goal;

- exchange business information in oral and written forms in the language being studied;

- to present the results of academic, scientific and professional activities at various events, including international;

- to put into practice communication technologies, methods and patterns of business communication for academic and professional interaction;

- to identify the specifics of the philosophical and scientific traditions of the main world cultures, to understand and tolerate the intercultural diversity of the society;

- analyze and consider the diversity of cultures in the process of intercultural interaction;

- to solve the tasks of personal and professional development, to determine and implement priorities for improving the own activities;

- apply methods of self-assessment and self-control; apply methodologies of improving and preserv health in the process of life.

master:

- methodology of system and critical analysis of problem situations;

- methods of setting goals, determining ways to achieve it, developing strategies for actions using foreign language oral and written speech skills;

- methods of project development and management, forecasting the results of activities using the skills of foreign language oral and written speech;

- methods of assessing the need for resources and the effectiveness of the project using the skills of foreign language oral and written speech;

- ability to analyze, design and organize interpersonal, group and organizational communications in a team to achieve a goal;

- methods of organizing and managing a team, applying the skills of intercultural interaction in the language being studied;

- methodology of interpersonal business communication in the language being studied, using professional language forms, means and modern communication technologies for academic, scientific and professional interaction;

- methods and skills of effective intercultural interaction;

- skills necessary for writing translation and editing various academic texts (abstracts, essays, reviews, articles, etc.);

- ability to determine theoretical and practical significance of the cultural and linguistic factor in the interaction of various philosophical and scientific traditions;

- technologies and skills to manage the own cognitive activity and improve it based on self-assessment, self-control and principles of self-education throughout life.

Content of the course (training module), structured by topics (sections):

1. Topic 1. The new reality of the leadership concept

Leadership in modern society, science, industry, education. Modern concepts of leadership. Types of leadership and personal characteristics of a leader. Leadership technologies. A team as a social group. Principles of team building, roles and tasks within the team. The role of a leader in a team, leadership communication. Effective and dysfunctional models of leadership communication. Organization of interpersonal, group and organizational communications in a team. Team and motivation, feedback.

Communicative tasks: to carry out communication in oral and written forms:

to discuss basic principles of teamwork; to discuss effective team interaction; to give arguments for the definition of "team spirit"; to collaborate, cooperate, express the own point of view, constructively overcome differences, use the potential of the group and achieve collective results; to use methods of communicative interaction and significantly increase the effectiveness of a multinational team; to establish the most effective rules of communication when interacting with the team; ask clarifying questions, leading the interlocutor to his opinion; conduct interviews, building a system of effective interaction when discussing a given topic; mediate when disagreements arise and successfully resolve them; create an atmosphere of friendliness and openness; convincingly express judgment and influence the opinion of the interlocutor; recognize the needs and interests of the interlocutor and build on them in the process of dialogue.

2. Topic 2. The phenomenon of scientific leadership in the modern world

Scientific leadership and its historical transformations. Scientific potential and leadership in science. Communicative nature of leadership in science as a specific model. World leaders in science and technology. The Strategic Academic Leadership program "Priority 2030" is leadership in the creation of new scientific knowledge. Goals of the program. Objectives of the program. Priorities of the program.

Communicative tasks: to carry out communication in oral and written forms:

to describe and discuss effective models of leadership communication; to discuss conditions conducive to competitiveness and scientific leadership; to reason the choice of effective methods in scientific communication; to discuss their features; to discuss the main characteristics of the chosen method; to evaluate models of leadership communication and effective methods in scientific communication; to describe and discuss the goals, objectives and priorities of the academic leadership program; to describe stages of the research project.

3. Topic 3. Leadership in academia, science and industry

Successful career at the university. The program "Leaders of Russia". The program "School of Rectors". Development of strategic plans for the development of the university. The connection of science, technology and education in universities. Personnel reserve. Research leadership. Creation of scientific schools. Scientific projects in education. The MIPT project "Talents in the Regions". Institute of mentoring in science, education, entrepreneurship. Practices of scientific, educational and corporate volunteering.

Communicative tasks: to carry out communication in oral and written forms:

discuss the principles of modern scientific leadership, functions and competencies of a leader in education, science, industry; discuss responsibility for the results and consequences of their scientific activities; give arguments for the definition of "scientific ethics"; coordinate the efforts of all project participants (team, working group), delegate authority; predict the possible development of the technological system in terms of influence the impact of technology on society; to reveal the relationship between the leadership style and the effectiveness of innovation; analyze the results of the implementation of large-scale projects in the field of science and education and their impact on the scientific and technological development of the country; determine the conditions for the disclosure of leadership potential; use effective strategies of the communicative behavior of a leader in science, education and industry.

4. Topic 4. Scientific, educational and scientific-technical projects

Features of the team of a scientific, educational, scientific and technical project. Professional communication in the project team. Goals, objectives, content, basic requirements for the implementation of the project, expected results; scientific, scientific-technical and practical value. Opportunities and solutions, necessary resources for the implementation of the project.

Communicative tasks: to carry out communication in oral and written forms:

discuss the implementation stages of a scientific, technological and business project; discuss the principles of the distribution of roles in the project team; form a team united by a common professional trajectory based on the principles of team building; create a group project taking into account the genre features of the research plan, business plan, technological solution, etc.; make arguments in favor of choosing one or another shared workspace, identify adequate interpersonal communication strategies in the team and use them while preparing a group project; to have a convincing influence on team members; to give rational arguments in defense of their position; to conduct a discussion based on the principles of eco-friendly communication: adequately express agreement and disagreement, use effective strategies for interacting with an unfriendly audience, create a productive working atmosphere, avoiding conflicts and disagreements; to choose the appropriate way of presenting a project; to defend the project by providing verbal and non-verbal influence on experts and representatives of a wide audience; substantiate the relevance, theoretical, practical, social significance of the project, its investment attractiveness and competitive advantages.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Genetic and Genomic Engineering/Генная и геномная инженерия

Purpose of the course:

mastering the basic concepts, modern knowledge and principles, as well as research methods, the implementation of hereditary information in living systems, to understand the use of approaches and techniques of genetic and genomic engineering in the context of solving bioinformatics problems.

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts, methods and models) of genetic and genomic engineering used in biology;

• acquisition of theoretical knowledge and practical skills and knowledge in the field of genetic and genomic engineering technologies and their application in biology and medicine;

• providing advice to students in the course of solving model problems on the application of bioinformatics in fundamental biology and medicine.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts and principles of the implementation of hereditary information in living systems;

 modern principles and problems of application of genetic and genomic engineering methods for solving various biological and medical problems;

 legal and ethical aspects of the application of genetic and genomic engineering for solving medical and biotechnological problems. Features of legal regulation in Russia and abroad.

be able to:

 set goals and objectives for research using genetic and genomic engineering technologies in biology and medicine, understand the goals and objectives;

 use their knowledge to solve problems and apply the technology of applying genetic and genomic engineering in biology and medicine;

 evaluate the correctness of the problem formulations and build algorithms for achieving their optimal solution in various living systems;

 set goals and objectives for research using genetic and genomic engineering technologies in biology and medicine, understand the goals and objectives;

 use your knowledge to solve problems and apply the technology of applying genetic and genomic engineering in biology and medicine;

 evaluate the correctness of the problem formulations and build algorithms for achieving their optimal solution in various living systems;

 to apply the obtained fundamental knowledge for applied purposes of applying genetic and genomic engineering technologies for solving fundamental problems and problems of practical medicine.

master:

 skills of mastering a large amount of information and approaches to solving problems in molecular biology and medicine;

 skills of independent work and mastering new knowledge, abilities and skills;

 principles and approaches to solving biological and medical problems related to genomics;

 terminology, including working terms sufficient to understand the scientific literature.

Content of the course (training module), structured by topics (sections):

1. Realization of genomic information in a cell

Analogy: Software and Hardware.

Features of the implementation of hereditary information in living systems. Maintaining the integrity of the genome: replication, recombination and repair of genomic DNA. Central dogma of biology. Gene expression: transcription and translation.

2. Genetic engineering techniques

Major milestones in the creation of recombinant DNA technology. Vectors and enzymes in genetic engineering. Restriction enzymes, DNA manipulation enzymes. Cloning techniques

3. Polymerase chain reaction and its modifications

PCR, gene isolation by PCR, primer design - gene-specific primers, nested primers, degenerate primers, optimization of PCR components and temperature conditions, PCR controls, PCR types

- reverse PCR, nested PCR, TAIL PCR, LAMP, semi-quantitative PCR, RT-PCR in real time with SYBR and Taqman probe, site-directed mutagenesis.

4. Methods for cloning and creating DNA libraries

Sticky end cloning, blunt end cloning, cloning using adapters, linkers and homopolymer tail, GATYWAY cloning, Gibson assembly cloning, cDNA library construction, cDNA subtraction libraries, normalized cDNA libraries, genomic libraries

5. Genomic engineering in eukaryotes

Genomic engineering in yeast. Genomic engineering in mice. Programmable artificial nucleases: Meganucleases, ZFN, TALN, CRISPR system. Use of the CRISPR system in knockouts, gene insertions, genomic editing, transcriptional regulation, and epigenomics. Radix editors CBE and ABE. Genome-wide CRISPR screening. Cellular Engineering. Genomic engineering of animals and plants.

6. Application of the CRISPR system in cell biology

Varieties of CRISPR nucleases. Cas nickases and Cas inactivated proteins. Application of the CRISPR system in cell biology. RNA editing. Radix editors CBE and ABE. CRISPR detection of specific DNA and RNA. The problem of the specificity of the CRISPR system. Delivery of nucleases into cells and tissues. Gene therapy. Social and ethical problems of genome editing in higher organisms.

7. DNA structure

DNA structure. DNA analysis. Assembly. Genetic mutations in DNA. Double helix formation.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

German for Scientific Purposes/Немецкий язык для научных целей

Purpose of the course:

Formation and development of social, business, intercultural and professionally-oriented communicative competencies for solving communicative tasks in the socio-cultural, academic and professional-business spheres of activity, as well as for the development of professional and personal qualities of a graduate.

Tasks of the course:

To form the learner's ability to solve communicative tasks by language means in various situations in the academic and professional sphere, to acquire knowledge in a wide range of fields of science, to make an in-depth analysis of information and to form his opinion both orally and in writing.

To achieve the goals and objectives of mastering the discipline, students must master a foreign language professional communicative competence, including:

Linguistic competence: the ability to correctly construct grammatical forms and syntactic constructions in accordance with the norms of the studied language.

Sociolinguistic competence: the ability to use and transform language forms in accordance with the situation of foreign-language communication.

Sociocultural competence: the ability to consider verbal and non-verbal behavior of the studied language country in communication.

Social competence: the ability to interact with communication partners, possession of appropriate strategies.

Discursive competence: the ability to understand and achieve coherence of individual statements in meaningful communicative models.

Strategic competence: the ability to use the most effective strategies in solving communicative tasks.

Object competence: knowledge of meaningful information when organizing one's own statement or understanding other people’s statements.

Domain expertise: the ability to operate with knowledge in conditions of real communication with the studied culture representatives, manifestation of empathy as the ability to understand the norms, values and motives of behavior of another culture representatives.

Communicative competence: the ability to establish and forge contacts with representatives of various age, social and other groups of native and other linguistic cultures, the ability to be a mediator between the own and foreign-language cultures.

Pragmatic competence: the ability to choose the most effective and expedient way of expressing thoughts, depending on the conditions of the communicative act and the task set.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- features of speech activities in German;

- the main phonetic, lexical and grammatical phenomena and structures used in oral and written speech when communicating in German, their difference from the native language for the reasoned and logical construction of statements that allow the application of the studied language in everyday, academic, scientific, business and professional communication;

- features of foreign-language academic communication, techniques for extracting and delivering foreign-language information for academic purposes;

- fundamentals of organizing written communication, types of written communicative tasks and functions of written communication tools;

- specifics of using verbal and non-verbal means in situations of foreign-language communication;

- types and features of written texts and oral presentations, general content of complex texts on abstract and specific topics, features of foreign-language texts, universal patterns of structural organization of the text, including highly specialized texts;

- rules of using various technical means for the purpose of searching and extracting foreign-language information, basic rules of determining the relevance and reliability of foreign-language sources, analysis and synthesis of information;

- world achievements, discoveries, events from the field of history, culture, politics, social life;

- general forms of teamwork organization; special aspects of behavior and interests of other participants; fundamentals of strategic planning of the team to achieve the goal;

- standard types of communicative tasks, goals and objectives of business negotiations, socio-cultural features of business negotiations, their communicative-pragmatic and genre features;

- vocabulary and terminology for academic, scientific and professional communication.

be able to:

- understand and use language tools in all types of speech activities in German;

- conduct discussions in German in various spheres of communication: everyday life, socio-cultural, socio-political, professional;

- verbally implement a communicative intention in order to influence a communication partner to start, conduct/maintain and finish a dialogue-asking about what he saw, read, dialogue-exchanging opinions and observing the norms of speech etiquette, if necessary using strategies to restore a failure in the communication process (re-questioning, paraphrasing, etc.);

- extract general and detailed information when reading authentic scientific and scientific-journalistic German-language texts;

- provide information based on the read text in the form of a prepared monologue (presentation on the proposed topic);

- understand monologue and dialogue statements in direct communication and in audio/video recordings;

- understand communicative intentions of the received written and oral messages;

- expand the proposed argument in the form of illustrations, details, explanations;

- use modern information technologies for professional activity, business communication and self-development;

- convey in Russian the content of German-language scientific and scientific-journalistic texts in the field of professional activity;

- select literature on the topic, compile a bilingual glossary, translate and review special literature, prepare scientific reports and presentations based on the read special literature, explain the own point of view and tell about plans;

- carry out oral and written foreign language communication in accordance with the student's field of professional activity;

- use the techniques and principles of building public speech for the report;

- recognize and differentiate linguistic and speech phenomena, distinguish basic and secondary information when reading texts and listening to speech, use standard means of oral and written communication in interpersonal communication; apply adequate communicative means in standard interaction situations on professionally oriented topics;

- use graphic editors, create easily perceived visual materials;

- describe graphical information (circular histogram, table, column and line graphs); write a short article on a given topic;

- write a summary, a review, a short article-advice on the proposed topic;

- abstract and annotate foreign-language professional texts;

- present research results in a written and oral form;

- apply information and communication technologies in communication and speech activity in a foreign language;

- identify and formulate problems that arise in the process of learning a foreign language; evaluate the student's capabilities, the realism and adequacy of the planned ways and ways to achieve the planned goals.

master:

- intercultural professionally oriented communicative competence in different types of speech activity;

- various communication strategies: educational strategies for organizing educational activities; strategies of reflection and self-assessment in order to improve personal qualities and achievements; strategies for perception, analysis, creation of oral and written texts of various types; Internet technologies for choosing the optimal mode of obtaining information; different methods of memorizing and structuring the acquired material;

- presentation technologies for information communication;

- method of searching and analyzing information from various sources in the professional field;

- skills of annotating and abstracting original scientific and scientific-journalistic articles;

- methods of assessing and self-assessing the results of foreign language learning activities;

- methods of identifying and realizing individual language capabilities, personal and professionally significant qualities in order to improve them;

- the ability to understand the speech of native speakers at a fast rate and respond adequately considering cultural norms of international communication;

- the ability to create clear, logical monologue and dialogue statements in various situations of everyday and professional communication, using the necessary set of communication tools;

- techniques of public speech and business and professional discourse in German.

Content of the course (training module), structured by topics (sections):

1. Topic 1. Flexible skills

Social and emotional intelligence. Personal and social skills. A relationship with the self. Skills and abilities to recognize emotions, understand the intentions, motivation and desires of other people and their own, managing emotions in order to solve practical problems. Inner harmony. Self-understanding. Self-regulation. Motivation. Empathy. Creativity. Sociability. Corporationism. Criticism. Key characteristics of a successful person. Success of the individual. Overcoming difficulties.

Communicative tasks: to carry out communication in oral and written forms: to build logical statements about personal and social skills, to describe various situations using illustrations; to use aphorisms in communication and be able to interpret them; to discourse upon ways of achieving success, possibilities of developing internal potential, life prospects, life meaningfulness, formation of responsibility assumed voluntarily; to talk about ways of self-improvement.

2. Topic 2. Communication in the modern world

Communication in society. Culture of communication based on common values: honesty, respect, mutual trust. Types and forms of communication. Means of communication. Social network.

Communicative tasks: to carry out communication in oral and written forms: to search, receive, transmit and exchange information, to apply in practice various types of information messages: statements, texts, images, sound messages, signals, signs, forum messages, conducting discussions, expressing one's own opinion, reviewing texts, description of illustrations; reasoned essay.

3. Topic 3. Ecology, nature, society

Modern environmental problems. Interaction of nature and society. Environmental protection. Biosphere and humans. Ecological consciousness.

Communicative tasks: to carry out communication in oral and written forms: to exchange opinions on the role of ecology and modern humans' attitude to nature; to discourse upon the dependence of public health on environmental factors; to discuss the impact of environmental factors on the generation of the future; to make descriptive essays on the subject; to draw conclusions, formulate an opinion on the role of society in the preservation of natural habitats on the planet.

4. Topic 4. Social and ethical issues in science, industry, and consumption

Globalization of consumption and social consequences. Science for sustainable development. Production and consumption. Conscious consumption. Principles and strategies of minimalism. Consumer culture. Consumption as a new form of control in society.

Communicative tasks: to carry out communication in oral and written forms: to discuss the problems of consumption globalization to meet the needs of the individual, society, the state; to express a reasoned opinion about the role of science and the impact of economic development on consumer attitudes to the world; to discuss socio-ethical issues and social consequences of consumerism.

5. Topic 5. The New Digital World

Global technological processes related to digitalization. Digital technologies – the Internet of Things. The digital world of science and business. Immersion in the digital world. Safe gadgets. Young hackers. The influence of the digital world on the perception of modern life.

Communicative tasks: to carry out communication in oral and written forms: to be able to search for the necessary information on the topic; to prepare reports on the topic; to express their own judgments about the advantages, limitations and prospects of using digital technologies, and their capabilities; to participate in a group discussion; to exchange opinions on technological innovations for solving various problems using technical means of the digital world; to compose essay-reasoning on the proposed topic.

6. Topic 6. Industry 4.0: on the way to "digital" production

Integration and cooperation with the use of digital technologies and increased flexibility in the organization of work. Transformation of economic sectors and types of activities and its impact on employment. Creating new markets and new forms of work through digital platforms. Problems

related to big information data. Relation between the use of human and machine labor (devaluation of experience, individual support). Possibility of flexible working conditions in terms of time and location. Profound changes in the structures of organizations.

Communicative tasks: to carry out communication in oral and written forms: to discuss flexibility in the organization of work in the context of the Work 4.0 concept; to talk about transformation of economic sectors and its impact on employment and activities in the world of labor; to recognize needs and interests of the interlocutor and base on them in the process of dialogue; to make messages about the creation of new markets and new forms of work through digital platforms; to express the own point of view, to speak constructively about the relationship between the use of human and machine labor; to make messages about the choice of a strategy for flexible working conditions; to be able to justify the chosen strategy; to prepare a report on the proposed topic.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

History, Philosophy and Methodology of Natural Science/История, философия и методология естествознания

Purpose of the course:

To familiarize students with the historical experience of world philosophical thought, give a clear idea of the main stages, directions and problems of the history and philosophy of science, contribute to the formation of skills to work with extreme issues related to the boundaries and foundations of various sciences and scientific rationality, and mastery of the principles of a rational philosophical approach to processes and trends in the development of modern science.

Tasks of the course:

- systematic study of the philosophical and methodological problems of natural science, taking into account the historical and philosophical context and the current state of science;

- the acquisition by students of theoretical ideas about the diversity of forms of human experience and knowledge, the nature of thinking, the ratio of truth and error;

- understanding the role of science in the development of civilization, the relationship between science and technology and related modern social and ethical problems, the ability to distinguish between historical types of scientific rationality, to know the structure, forms and methods of scientific knowledge in their historical genesis, modern philosophical models of scientific knowledge;

- acquaintance with the main scientific schools, directions, concepts, with the role of the latest information technologies in the world of modern culture and in the field of humanities and natural sciences;

- understanding the meaning of the correlation of biological and social in man, man's attitude to nature, discussions about the nature of changes taking place with man and humanity at the turn of the third millennium;

- knowledge and understanding of the dialectic of personality formation, its freedom and responsibility, the uniqueness of the intellectual, moral and aesthetic experience of different historical eras.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 - the structure of the natural and socio-humanitarian sciences, the specifics of their methodological appa-ratus;

 - the ratio of principles and hypotheses in the construc-tion of scientific systems and theories;

 - the foundations of a modern scientific picture of the world, the basic principles of scientific knowledge and key areas of interdisciplinary research;

 - concepts of the development of science and different approaches to the problem of the cognitive status of scientific knowledge;

 - the problem of matter and motion;

 - concepts of energy and entropy;

 - problems of space-time;

 - modern problems of physics, chemistry, mathematics, biology, ecology;

 - great scientific discoveries of the XX and XXI centu-ries;

 - key events in the history of the development of science from ancient times to the present day;

 - the relationship of worldview and science;

 - the problem of forming a worldview;

 - a system of interdisciplinary relations in science, the problem of reductionism in science;

 - theoretical models of fundamental processes and phenomena in physics and its applications to the natural sciences;

- about the Universe as a whole as a physical object and its evolution;

- about the relationship between order and disorder in nature, about the problems of non-linear processes and self-organizing systems;

- dynamic and statistical patterns in nature;

- of the role of probabilistic descriptions in the scientific picture of the world;

- principles of symmetry and conservation laws;

- The latest discoveries of natural science for the creation of technical devices;

- Features of the biological form of organization of mat-ter, principles of reproduction and development of living systems;

- About the biosphere and the direction of its evolution.

be able to:

 - effectively use in practice the theoretical components of science: concepts, judgments, conclusions, hypotheses, evidence, laws;

 - apply the methodology of science in the organization of specific research;

- - give a panorama of the most universal methods and laws of modern science.

master:

- - scientific methodology as the initial principle of cognition of the objective world;
- - the principles of choosing an adequate methodology for the study of specific scientific problems;
- - system analysis;
- - knowledge of the scientific picture of the world;
- - the conceptual and methodological apparatus of interdisciplinary approaches in science.

Content of the course (training module), structured by topics (sections):

1. The formation of science and philosophy in the West and in the East.

The problem of the emergence of science in antiquity. Prescription and applied nature of knowledge in the Ancient East. The birth of philosophy. Scientific programs of Plato, Aristotle and Democritus. The origin of ancient science: mathematics, physics, astronomy and biology. The problem of the social organization of ancient science. "Musical" cult and scientific and philosophical schools. The Alexandrian Museyon and the further development of Hellenistic science. The science of ancient Rome. Arab medieval science.

Science in Europe in the Middle Ages. Christianity and science The dispute of faith and reason. Rethinking Antique Heritage. Medieval empiricism. Nikolay Kuzansky and the concept of infinity. The ideological turn of the Renaissance.

2. The main periods and basic forms of the development of science

The emergence of modern science: basic concepts and key personalities. Key research programs in modern European science. The triumph of Newtonian physics and the formation of mathematical science. Central theoretical postulates and methods of classical science.

3. Rationalistic and empiricist traditions in the philosophy of the Modern Times

The dispute of rationalism and empiricism Rationalistic direction: the method of deduction and the concept of intellectual intuition in the philosophy of Descartes and Spinoza. Cartesian probabilism. The theory of innate ideas. Leibniz’s teaching on the “truths of fact” and “truths of the mind”, on the types of knowledge, on analysis and synthesis. Rationalist interpretation of the thesis of the correspondence of being and thinking.

The tradition of English empiricism: Bacon's doctrine of experience, the role of induction, the “idols” of knowledge. Locke's model of scientific knowledge. Berkeley thesis: to be means to be perceived. Humeian skepticism and psychologism, criticism of the concept of causality.

4. Kant’s solution of the problem of knowledge

Kant's solution to the problem of knowledge. The question of the possibility of knowledge. Space and time as forms of sensuality. The construction of objectivity in the process of cognition. Reason as a legislator. The specifics of Kant's understanding of thinking. Critique of the possibility of supersensory knowledge The concept of "things in themselves." Antinomies of the mind.

5. The approach to knowledge in neokantian philosophy

Interpretation of knowledge in neo-Kantianism. Marburg and Baden schools of neo-Kantianism. Neo-Kantian development of the theory of knowledge. Division of sciences into nomothetic and idiographic. The problem of values in the Baden school.

6. Positivism

Positivism and postpositivism. The first and second positivism of the XIX century. Analytical philosophy of B. Russell and L. Wittgenstein. Logical positivism and the “linguistic turn”. Postpositivism of K. Popper, T. Kuhn and I. Lakatos.

7. Critique of positivism from the point of view of logic. Critical rationalism of Karl Popper

Logical criticism of positivism by K. Popper: problems of induction and demarcation; falsification principle; attitude to the truth. K. Popper's concept of science growth: fallibilism and likelihood theory. The development of modern cosmology and elementary particle physics.

8. Historical criticism of positivism. Historical approach in the philosophy of science.

Historical criticism of positivism. Are there “crucial experiments”? The thesis of the "incommensurability of theories." The Kuhn’s model of the development of science: the scientific community and the scientific paradigm, “normal” and “abnormal” phases in the history of science. The model of research programs by I. Lakatos: “hard core” and “protective belt of hypotheses”; “Progressive problem shift” as a criterion for rejecting research programs. Historical Relativism of P. Feyerabend.

The dispute between realism and antirealism in modern philosophy of science. Sociologization of modern philosophy of science. The debate about the model of the "external" and "internal" history of Lakatos. Laboratory place in science. The relationship of science and technology in the second half of the XX - beginning of the XXI century.

9. The structure of scientific knowledge

The structure of science. Place of mathematics and measurements. Place of foundations and theories of phenomena. Place of methodological principles.

10. Philosophical problems of natural sciences

The concept of dynamic and statistical laws and probability as an objective characteristic of natural objects. Place of principles of symmetry and conservation laws.

Synergetics, selforganization and the ratio of order and disorder. Model of global evolutionism.

Specific features of life sciences. Question of the reduction of biology and chemistry to physics. Contradictions between nature and man today. Global problems of modern civilization, the

possibility of environmental disaster. Biosphere, noosphere, ecology and the problem of sustainable development.

Interdisciplinary approaches in modern science.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Introduction to Cancer Biology/Основы биологии рака

Purpose of the course:

understanding the biological aspects of the emergence and development of cancer.

Tasks of the course:

mastering by students of basic knowledge about oncological diseases, their causes and molecular mechanisms of development.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• fundamental concepts and aspects related to the emergence of cancer, its development, as well as physiological and molecular biological characteristics of cancerous tumors;

• modern problems associated with the treatment of cancerous tumors.

be able to:

• navigate the molecular mechanisms of tumor formation;

• to operate with the acquired knowledge and concepts in future research work;

• adequately assess the potential prospects for new cancer therapy;

• to establish causal relationships between the biological aspects of cancer development and modern methods of therapy and diagnostics, which are increasingly being improved.

master:

• molecular biological and biomedical terminology related to aspects of cancer biology;

• skills in mastering a large amount of information and understanding the biological processes associated with cancer;

• skills of independent work and mastering new knowledge.

Content of the course (training module), structured by topics (sections):

1. Introduction to Cancer Biology

Cancer concept. Features of benign and malignant tumors. Classification of cancerous tumors. Properties of cancerous tumors.

2. DNA damage and repair. Mutations, Oncogenes and Tumor Suppressors

Types of DNA damage and damaging factors (exogenous and endogenous). Direct reverse repair. Single- (base repair, nucleotide repair, mismatch repair) and double-stranded breaks (homologous recombination, non-homologous end-joining, microhomologous end-joining and single-stranded annealing) repair systems. Cell cycle and checkpoints (G1 and G2). DDR kinases that regulate the global cellular response to DNA damage. The role of p53 in the regulation of the cellular response to DNA damage. Classification of mutations (by scale and source). "Driver" and "passenger" mutations. The concept of oncogenes and tumor suppressors. Inheritance of mutations, the "double blow" hypothesis, the phenomenon of haploinsufficiency.

3. The role of oncoviruses and epigenetic changes in cancer development

Types of oncoviruses. Influence of oncoviruses on the stability of the cellular genome. Epigenetic changes, their role in cancer mutagenesis. Epicarcinogens. Influence of epigenetic changes on the expression of microRNA and the activity of mobile elements.

4. Oncoevolution and genetic heterogeneity of tumors. Cancer stem cells

The concept of "oncoevolution". Cancer stem cells. Cellular (replicative) aging. Telomeric crisis. Overcoming the telomeric crisis by cancer cells. Chromotripsis.

5. Receptors and signaling pathways in tumors

G-protein coupled receptors (GPCRs) and their regulation. Signaling pathways triggered by GPCRs. Wnt and sonic hedgehog (SHH) signaling pathways. Receptors for chemokines and prostaglandins. Tyrosine kinase receptors, their signaling pathways and regulation. GTPases, guanine nucleotide exchange factors (GEF) and guanine nucleotide hydrolysis activators (GAP) from the G-protein family, their role in signaling and regulation of signaling pathways. Participants in the transmission of intracellular signals: receptors, adapter proteins, G-proteins, secondary messengers, GTPases, kinases, activators and co-activators of transcription. TGFβ receptors. Cytokine receptors (JAK / STAT receptors). Integrin receptors and their ligands and signaling pathways. TNF receptors superfamily, their intracellular domains (TRAF, FADD, TRADD) and signaling. Notch receptors, their role in angiogenesis. Nuclear (intracellular) receptors.

6. Molecular mechanisms of invasion and metastasis

Warburg effect. Key differences in cancer cell metabolism. Mutations and signaling pathways that affect the metabolism of cancer cells. The role of hypoxia. Adaptation of cancer cells to acidosis and hypoxia.

7. Cancer cell metabolism

The concepts of invasion and metastasis. Types of cell contacts. Epithelial-mesenchymal transition. Signaling pathways involved in cancer cell migration. Tumor-associated fibroblasts. Extracellular matrix, its components and role in cancer progression. Formation of pre-metastatic

niches and the role of exosomes in this process. Contribution of platelets to the process of metastasis.

8. Tumor angiogenesis. Physiological features of solid tumors

The structure of capillaries and the main stages of angiogenesis: activation, elongation, maturation of blood vessels. Differences between normal and pathological angiogenesis. The role of hypoxia in stimulating vascular growth. Receptors and signaling pathways involved in angiogenesis. Pathophysiological features of solid tumors.

9. Inflammatory processes in the tumor. "Immune surveillance"

How does the immune system recognize tumor cells? Presentation of neoantigens as part of MHC classes I and II. The cells of innate and adaptive immunity that carry out "immune surveillance".

10. Mechanisms for avoiding immune surveillance

Dialogue of cancer cells with stromal components and immune cells. Mechanisms for avoiding immune surveillance. The role of inflammation in cancer promotion.

11. Pathogenesis and key molecular events in the development of various tumors

Consideration of key mutations, signaling cascades, and the role of inflammation in the development of breast cancer, prostate cancer, non-small cell lung carcinoma, ductal adenocarcinoma of the pancreas, and cutaneous melanoma.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Introduction to Molecular Biology and Genetics/Введение в молекулярную биологию и генетику

Purpose of the course:

Give an idea of the main mechanisms of storage, flow and implementation of genetic information, genome organisation. Give an overview of the diversity of tools for molecular biology.

Tasks of the course:

• Give knowledge of molecular biology of prokaryotic and eukaryotic cell;

• Give an overview of genetics and applied biotechnology;

• Train skills of information retrieval for research in the field of molecular biology, genetics, bioinformatics.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- physical and chemical properties of nucleic acids and chromatin proteins;

- processes involving nucleic acids and proteins;

- the main mechanisms of DNA replication, transcription;

- modern molecular biological methods for studying cell processes;

be able to:

- understand the mechanisms underlying the research methods in genetics, genomics, molecular biology;

- understand the methods of modern molecular biology and the main features of experimental setup

master:

- categories and concepts used in cell biology;

- ideas about modern methods used in the study of cells.

Content of the course (training module), structured by topics (sections):

1. Biology of the cell and modern taxonomy

Structure of prokaryotic and eukaryotic cell. Structure of viral particles. Modern data on taxonomy and phylogenetic linkage of living organisms.

2. The basics of prokaryotic and eukaryotic genome organization

Chromosomes and extrachromosomal elements in prokaryotes. Chromosomes of eukaryotes.

3. Transcription, reverse transcription, translation. DNA replication and reparation

Transcription in prokaryotes and eukaryotes. Retroviruses and mobile genetic elements. RNA processing. Ribosome. Protein folding. DNA replication and reparation. SOS response.

4. Genetics. Mendel's laws. Chromosome mapping

Genes as elementary units of heredity. Mutations as the source of raw matter for evolution process. Chromosomal theory of inheritance. Mendel's laws. Genetic linkage and crossing-over. Chromosome mapping.

5. Non-Mendelian inheritance

The extrachromosomal inheritance: plastids, mitochondria. The cytoduction. The inheritance of episomes, prions, endosymbiotic organisms. Linkage disequilibrium.

6. Immunity. Innate immunity, acquired immunity. Mechanisms of antigen recognition. Inflammation.

Cellular and humoral components of innate immunity. Mechanisms of antigen recognition in innate immune response. Inflammation. The acquired immunity. The active and passive immunity.

7. Antibodies. Immune response, immune memory. Immune system and cancer.

Antigen presentation. Main histocompatibility complex. Immune response and immune memory. Immune system and cancer. Antiviral immune response. The ways by which pathogens override immune response or gain control over it.

8. Applications of antibodies and enzymes in biotechnology and research.

The applied use of organisms in biotechnology and research. Biomass production. Fabrication and conversion of organic compounds. The use of antibodies from different sources in therapy, diagnostics and research. Enzymes for use in research.

9. Genetic therapy

Genetic therapy of inherited diseases. Therapeutic approaches, delivery systems. Delivery to different organs and tissues.

10. Biology of aging

Free radical theory of aging. Mitochondrial theory of aging. DNA reparation efficiency and average lifespan. The role of chaperones and proteasomes in recycling and refolding of damaged proteins. The telomeres and their length

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Introduction to Quantitative Genetics/ Введение в количественную генетику

Purpose of the course:

Give an idea of the mechanisms of the implementation of genetic information, mastering the basic concepts of population genetics and modern methods of population genome-wide data analysis, the development of logical thinking abilities, understanding the possibilities and problems of interdisciplinary research of human genetics.

Tasks of the course:

• mastering the basic concepts of population genetics;

• studying of the gene pool structure analysis methods, including those based on genome-wide data;

• introduction to the nature of interdisciplinary research at the intersection of population genomics and human Sciences;

• acquisition of the fundamental knowledge of the laws of biological inheritance and variability at the population level of the organization of living matter.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- theoretical foundations of the dynamics of gene pools;

- their practical appearance on the examples of real gene pools;

- methods of analysis of the gene pool structure;

- basic regularities in the structure of the world gene pool;

- achievements and prospects of ancient DNA research;

- the relationship of genetic, linguistic and anthropological variability.

be able to:

- use databases and reference resources available on the Internet to quickly find the necessary data;

- interpret standard graph types in terms of similarity and affinity of populations;

- to identify signs that increase and decrease the reliability of the findings in population genetic studies.

master:

- of working with large volumes of biological data;

- of planning and implementation of multi-stage bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. Statistical methods of genomic geography

Genetic distance. Methods of dimensionality reduction (principal components, multidimensional scaling). Cluster analysis. Approaches to the results interpretation.

2. Ancient DNA

Opportunities and precautions. Example of use

3. Structure of the world gene pool (linguistics, anthropology)

The concept of language classification. Basic linguistic families. The problem of race. Big and small races.

4. Structure of the world gene pool (genetics)

Regularities of distribution of inter- and intra-population diversity. Continental and sub-continental clusters of populations. The invariance of the results.

5. A databases of gene pools

Principles of the population genetic databases construction. Review of existing resources. Examples of their use.

6. The history of the European gene pool formation

The main historical stages and the most important migrations. The role of neolitization and dissemination of Indo-European languages. The gene pool of the Slavic peoples.

7. Patterns of variability in different parts of the genome. Quasi-genetic markers

Features of interpopulation variability of mitochondrial DNA and Y-chromosome. The possibility of using quasi-genetic markers. Principles of combining results by different types of markers.

8. Forensic aspects of population genomics

Probabilistic character of personal identification and reference databases. Phenotypic identification based on DNA data. Population identification based on DNA data.

9. Medical aspects of population genomics

Genetic load and methods of its prognosis. Genomic geographic zoning and pharmacogenetics. Examples of genomic geographic analysis.

10. Logic of population genomics

Review of passed material. Logical connections between basic concepts.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Machine Learning in Biology/Машинное обучение в биологии

Purpose of the course:

give theoretical and practical skills in the application of methods of machine analysis and interpretation of biological data.

Tasks of the course:

• give basic knowledge of Python programming language;;

• make students familiar with modern understanding of machine learning algorithms;

• teach how to use the main databases in the field;

• form students' understanding of the applicability of various machine learning algorithms to biological problems

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- Main tasks and methods of machine learning

- Theory of the main methods of machine learning;

- Ways of validating a model built to solve a problem;

- Examples of the use of machine learning methods in biological tasks

be able to:

- Use Python packages for machine learning (sklearn, xgboost, lightgbm, catboost, pytorch);

- Train and validate machine learning models;

- Determine the applicability of a particular machine learning method to this task;

- Use ready-made models to solve the proposed problem;

- Implement custom algorithms for machine learning;

- Use models to analyze data and patterns in them.;

master:

- work with large volumes of biological data;

- plan and implementation of multi-stage bioinformatic analysis;

- work with various machine learning algorithms.

Content of the course (training module), structured by topics (sections):

1. Introduction to machine learning. Examples of real biological problems and their solutions.

Introduction to machine learning. Examples of real biological problems and their solutions. The focus of this module is to introduce the concepts of machine learning with as little mathematics as possible. We will introduce basic concepts in machine learning, including logistic regression, a simple but widely employed machine learning (ML) method. Also covered is multilayered perceptron (MLP), a fundamental neural network. The concept of deep learning is discussed, and also related to simpler models.

2. Supervised learning. Regression, classification. Quality metrics. Bias-variance tradeoff. ROC curve and PR curve.

Supervised learning. Regression, classification. Quality metrics. Bias-variance tradeoff. ROC curve and PR curve. In this module we will be discussing the mathematical basis of learning deep networks. We'll first work through how we define the issue of learning deep networks as a minimization problem of a mathematical function. After defining our mathematical goal, we will introduce validation methods to estimate real-world performance of the learned deep networks. We will then discuss how gradient descent, a classical technique in optimization, can be used to achieve this mathematical goal. Finally, we will discuss both why and how stochastic gradient descent is used in practice to learn deep networks.

3. Train and test sample. Crossvalidation and its variants. Biological data train-test split examples.

Train and test sample. Crossvalidation and its variants. Biological data train-test split examples. will cover model training, as well as transfer learning and fine-tuning. In addition to learning the fundamentals of a CNN and how it is applied, careful discussion is provided on the intuition of the CNN, with the goal of providing a conceptual understanding.

4. Linear regression. Logistic regression. L1 and L2 regularisations. Elastic Net.

Linear regression. Logistic regression. L1 and L2 regularisations. Elastic Net. Logistic regression is a method for classifying data into discrete outcomes. For example, we might use logistic regression to classify an email as spam or not spam. In this module, we introduce the notion of classification, the cost function for logistic regression, and the application of logistic regression to multi-class classification.

5. Linear regression in data analysis.

Linear regression in data analysis. What if your input has more than one value? In this module, we show how linear regression can be extended to accommodate multiple input features. We also discuss best practices for implementing linear regression.

6. Decision tree. Oblivious decision tree. Tree with models in the leaves.

Decision tree. Oblivious decision tree. Tree with models in the leaves.

7. Bootstrap and its applications. Confidence intervals using bootstrap. Bagging. Random forest. Bias-variance trade-off for bagging.

Bootstrap and its applications. Confidence intervals using bootstrap. Bagging. Random forest. Bias-variance trade-off for bagging.

8. Boosting, key ideas. AdaBoost. Gradient boosting. XGBoost. LightGBM. CatBoost. DART. BooBag and BagBoo.

Boosting, key ideas. AdaBoost. Gradient boosting. XGBoost. LightGBM. CatBoost. DART. BooBag and BagBoo.

9. Categorial features. One-hot encoding. Lookup tables. Mean encoding.

Categorial features. One-hot encoding. Lookup tables. Mean encoding.

10. KNN. SVM. Kernel trick. K-mers. deltaSVM.

KNN. SVM. Kernel trick. K-mers. deltaSVM. Support vector machines, or SVMs, is a machine learning algorithm for classification. We introduce the idea and intuitions behind SVMs and discuss how to use it in practice.

11. Unsupervised learning. Clustering. Gaussian mixture models. Expectation maximization. KMeans. DBScan. HDBScan. Dimension reduction problem. PCA. TSNE. UMAP.

Unsupervised learning. Clustering. Gaussian mixture models. Expectation maximization. KMeans. DBScan. HDBScan. Dimension reduction problem. PCA. TSNE. UMAP. We use unsupervised learning to build models that help us understand our data better. We discuss the k-Means algorithm for clustering that enable us to learn groupings of unlabeled data points.

12. Semisupervised learning. Key ideas. Semisupervised decision trees. SemiBoost.

Semisupervised learning. Key ideas. Semisupervised decision trees. SemiBoost.

13. Neural networks. Perceptron. DNN. Chain rule. Activation. Vanishing gradient problem. Dropout. Batch normalisation.

Neural networks. Perceptron. DNN. Chain rule. Activation. Vanishing gradient problem. Dropout. Batch normalisation. will cover the application of neural networks to natural language processing (NLP), from simple neural models to the more complex. The fundamental concept of word embeddings is discussed, as well as how such methods are employed within model learning and usage for several NLP applications. A wide range of neural NLP models are also discussed, including recurrent neural networks, and specifically long short-term memory (LSTM) models.

14. Convolutional neural networks. Pooling. Sequence problems. Modified convolutions.

Convolutional neural networks. Pooling. Sequence problems. Modified convolutions. A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the

image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.

15. Recurrent neural networks. LSTM. GRU. Attention.

(RNN) is a class of artificial neural networks where connections between nodes form a directed graph along a temporal sequence. This allows it to exhibit temporal dynamic behavior. Unlike feedforward neural networks, RNNs can use their internal state (memory) to process sequences of inputs.

16. Autoencoders. Sparse autoencoders. Generative neural network. VAE. CVAE. GAN. DCGAN.

Autoencoders. Sparse autoencoders. Generative neural network. VAE. CVAE. GAN. DCGAN. The aim of an autoencoder is to learn a representation (encoding) for a set of data, typically for dimensionality reduction, by training the network to ignore signal “noise”.

17. Ensembles. Stacking. Blending.

Ensembles. Stacking. Blending. Ensemble learning technique that uses predictions from multiple models (for example decision tree, knn or svm) to build a new model.

18. Transfer learning. One-shot learning.

Transfer learning. One-shot learning. knowledge gained while learning to recognize cars could apply when trying to recognize trucks. This area of research bears some relation to the long history of psychological literature on transfer of learning, although formal ties between the two fields are limited.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Microbiology and Metagenomics/Микробиология и метагенетика

Purpose of the course:

Give the essential mechanisms on human microbiome in health and disease, modern methods for analyzing the microbial diversity.

Tasks of the course:

• establish basic knowledge about the interactions between structure and functions of microbiome, their interactions with the host and effect on immune, nervous and other organ systems;

• hands-on development of skills to analyze human microbiome data;

• establishing basic experimental skills and getting experience required for independent research in the field of microbial diversity.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- general concepts, current views and perspectives related to the diversity of human microbiome;

- role of microbiome in health and disease;

- potential microbial biomarkers;

- methods for profiling microbiome composition;

- formats and specifications of metagenomic data;

- bioinformatic algorithms for analyzing metagenomic data;

- experimental methods of work with microorganisms.

be able to:

- quickly find required data and concepts using Internet and scientific/applied literature on biology;

- compare structure, properties and functions of biological objects;

- apply basic bioinformatic methods for human microbiome data analysis in scientific research;

- apply basic experimental methods for work with microbes in laboratory.

master:

- skills of efficiently processing large volumes of information;

- standards of designing and modeling biological tasks for exploring human microbial diversity.

Content of the course (training module), structured by topics (sections):

1. Human microbiome: discoveries and perspectives

Diversity of microbes in human gut and other sites. Structure and functions of human gut microbiome. Microbiome as a cornerstone of precision medicine. Recent discoveries obtained using metagenomics.

2. Microbiome as a new “organ”; its functions in health and disease

Links between human microbiome and clinical status: from associations to mechanisms. Major phyla relevant for human health. Dynamics of human microbiome during lifetime.

3. Modulation of microbiome. Clinical trials and microbiome

Metabolic interdependence of host and microbiome. Diet, probiotics, prebiotics and microbiome transplantation as key ways to manipulate human microbiome. Scientific-based evaluation of intervention efficacy.

4. Applications of omics-technologies for human microbiome research

Metagenomics. Comparative functional genomics. Metatranscriptomics. Metaproteomics. Metabolomics. Culturomics.

5. Algorithms in metagenomics-I: taxonomic composition analysis

Approaches for metagenomic reads classification. Composition, phylogeny and similarity-based methods. Processing of amplicon and shotgun sequencing data. Reference databases related to microbiome. Analytical metagenomic pipelines and online platforms.

6. Algorithms in metagenomics-II: functional composition analysis

Metagenomic assembly de novo. Metabolic potential profiling. Reconstruction of strain gene content and analysis of polymorphisms from shotgun metagenomic data. Correlation-based methods for reconstructing genomes from metagenomes. Prediction of functional potential from 16S rRNA sequencing data.

7. Comparative genomics of human gut microbes. Biotargets and mechanisms of toxin-antitoxin type II systems action

Comparative genomics of bifidobacteria, lactobacilli and other major gut phylotypes. Classification of toxin-antitoxin bacterial systems. Toxin-antitoxin type II systems in human gut microbes. MazE-MazF and RelB-RelE toxin-antitoxin systems.

8. Statistical analysis of metagenomic data

Statistical specifics of microbial composition features derived from metagenomic data. Concepts of significance and statistical power in metagenomics. Parametric and non-parametric statistical tests for metagenomic data. Integrated pipelines for meta-analysis of microbiome data.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Models and Methods of Quantitative Genetics/Модели и методы количественной генетики

Purpose of the course:

Give an idea of the mechanisms of the implementation of genetic information, mastering the basic concepts of population genetics and modern methods of population genome-wide data analysis, the development of logical thinking abilities, understanding the possibilities and problems of interdisciplinary research of human genetics.

Tasks of the course:

• mastering the basic concepts of population genetics;

• studying of the gene pool structure analysis methods, including those based on genome-wide data;

• introduction to the nature of interdisciplinary research at the intersection of population genomics and human Sciences;

• acquisition of the fundamental knowledge of the laws of biological inheritance and variability at the population level of the organization of living matter.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- theoretical foundations of the dynamics of gene pools;

- their practical appearance on the examples of real gene pools;

- methods of analysis of the gene pool structure;

- basic regularities in the structure of the world gene pool;

- achievements and prospects of ancient DNA research;

- the relationship of genetic, linguistic and anthropological variability.

be able to:

- use databases and reference resources available on the Internet to quickly find the necessary data;

- interpret standard graph types in terms of similarity and affinity of populations;

- to identify signs that increase and decrease the reliability of the findings in population genetic studies.

master:

- of working with large volumes of biological data;

- of planning and implementation of multi-stage bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. Factors of microevolution

The idea of the four factors of microevolution. Overview of their features. The special role of natural selection and the complexity of its study.

2. Drift and migration

The opposite direction of action of migration and gene drift. Effective population size, dependence on sex ratio, number of descendants, population fluctuations. The concept of effective migration. Examples of the calculation of the dynamics of allele frequency.

3. Subdivision of a population

Wahlund Effect. Subdivision and inbreeding. Models of subdivision and migration.

4. Phylogenetic and phylogeographic methods

Construction of phylogenetic trees. Molecular and genetic dating. The problem of calibration. Phylogeographic approach.

5. Methods of population analysis of full-genome data

Peculiarities of using the method of principal components for the genome-wide data. ADMIXTURE. Methods based on haplotypes. Examples of sequencing results using.

6. Cartographic methods of genomic geography

The capabilities of the cartographic approach. Maps of major components, genetic distances, heterozygosity, inter-population diversity. Combination of statistical and cartographic methods.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

NGS Data Analysis/Анализ данных NGS

Purpose of the course:

The discipline "NGS data analysis" is an opportunity for students to learn the basic methods used in the processing of high-throughput sequencing data. Students will get a broad overview of the main types of data generated by high-throughput sequencing platforms, focusing on full-genome and full-transcriptome sequencing data. The purpose of the discipline: familiarity of students with the currently known methods of processing data obtained as a result of high-throughput sequencing.

Tasks of the course:

• formation of basic knowledge about the features of data obtained through high-throughput sequencing platforms;

• practical development of methods for the analysis of biological data obtained by high-throughput sequencing;

• formation of students ' basic skills in the development of methods for data analysis and the acquisition of practical experience necessary for independent research in the field of computational processing of biological data obtained using high-throughput sequencing technologies .

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- basic physical principles underlying high-throughput sequencing technologies;

- basic algorithms and data structures used in de novo assembly of genomes and transcriptomes, structural annotation of genomic sequences, mapping of reads;

- statistical methods used in the analysis of data obtained by high-throughput sequencing;

- computational problems arising in the processing of data obtained using high-throughput sequencing;

be able to:

- use basic software tools designed for processing data obtained using high-throughput sequencing;

- apply basic algorithmic ideas to develop new methods and algorithms for processing data obtained using high-throughput sequencing;

master:

- of working with large volumes of biological data;

- of planning and implementation of multi-stage bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. High-throughput sequencing technologies

Physical principles and technological solutions used in high-throughput sequencing technologies. Characteristics of the main high- throughput sequencing platforms.

2. Linux command line basics

Bash command shell. The file system in the Linux family of operating systems. CD, ls, pwd, cp, mv, rm, more, head, tail, grep commands. The vi editor.

3. Train and test sample. Crossvalidation and its variants. Biological data train-test split examples

Training dataset, Validation dataset, Test dataset, spliting data into sets: test, validation and test, Cross-validation, Holdout dataset, hierarchical classification

4. NGS data preprocessing

The main types of errors inherent in high- throughput sequencing technologies. Basic data formats. Quality check of reads. Trimming.

5. De novo genome and transcriptome assembly

Algorithms for de novo Assembly based on de Bruijn graphs and overlap graphs. Features of genomic sequences that make assembly difficult. Assessment of the quality of the assembly. Practical aspects of large genomic projects. Features of de novo transcriptome assembly

6. Genome annotation

The basic principles of construction of annotation algorithms. Assessment of the annotation quality. Practical aspects of application of algorithms for the eukaryotic genomes annotation.

7. Resequencing

Reads mapping. The Burrows-Wheeler transformation. Assessment of mapping quality. SNP calling. Features arising in the detection of somatic mutations.

8. RNA-seq

Mapping RNA-seq reads. Methods of normalization and analysis of gene expression.

9. Metagenomics

Targeted sequencing of 16S rRNA. Taxonomic analysis and biodiversity analysis. Metagenome shotgun sequencing. De novo assembly and gene annotation.

10. ChIP-seq

DNA-protein interaction. Methods for studying DNA-protein interaction, used before the advent of high-throughput sequencing. ChIP – seq Protocol. Main methods of ChIP-seq data analysis.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Populism, Fakes, and Post-Truth: Algorithm-Driven Media Consumption and New Social Phenome/Популизм, фейки и постправда: алгоритмизированное медиапотр

Purpose of the course:

To familiarize students with new media and communication environment and its impact on society, especially in field of public sphere (including political public sphere), provide them tools to analyze media and communication field and its role within the society.

Tasks of the course:

- To introduce students into core concepts of media and their connections with social realm
- To give an overview of the contemporary social media driven media consumption
- To make students able to use social theories in field of media in order to analyze society and role of new technologies within it
- To provide both social-deterministic and techno-deterministic vision of the role of media and make students able to apply them
- To introduce students into the core elements of theory of media effects and make them able to take into consideration the 'effect-driven' approach

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- Core theories and approaches to the role of media and communication within the society
- Core theories of media effects
- Approaches to new social phenomena
- Criteria for analysis of media complexity
- Role of media in politics

be able to:

- Distinguish between socially-oriented and techno-deterministic theories;

- Criticize contemporary communicative capitalism driven by technological algorithms
- Separate well news sources from bad ones, be able to find a bias in media messages
- Write essays on social topic in English language

master:

- Tools for news analysis
- Tools for analysis of political speech and declarations
- Tools of critical information thinking

Content of the course (training module), structured by topics (sections):

1. Media, communication and social institutions

Notion of communication and social communication. Differences in communication between animals and humans. 3 types of interactions in societies and their interconnection. Evolution of interactions and evolution of societies. Role of major media innovations in previous communicative revolutions. Role of printing press and printed book. Media and economic institutions. Media and political institutions. Media and cultural institutions. Soft power and hard power.

2. Media and technological determinism in approaching changes in society and its critic

Media and technological determinist vision vs society-centric vision of changes. Linear and non-linear technological development. Everett Rogers and simplistic vision of innovations. Works about technological impact of media: Lerner and MIT school. Latour and Flichy: toward socio-technical complexity. Overview of techno-determinist theories:

- McLuhan and technical thinking on media
- Information society theories
- Castells and network society theory
- Web 2.0 and prosumerist culture
- Works on new media activism

Critic of technological determinism.

3. Contemporary algorithmic media reality: social media, prosumerism, sharing economy.

Core technological changes in recent decades driving media development: raise of media channels, digitalization, device individualization. Rising speed and storage capacity for content. Video as a core content. Social media as new media reality. Alone together philosophy.

Convergence culture and prosumer (playbour) vision. Sharing economy ideology. Political economy of sharing and prosumerism (as critique):

- General models of accumulation of capital

- Idea of digital exploitation
- Network and convergence-based society as still capitalist

4. Some basic concepts about news and truth.

The concept of truth in the society and its ambivalence. Truth and opinion dialectical relationship. News and views separation in journalism. Ideology of news in journalism. Principles of news. Dependent journalism as political activism and propaganda but one of the core function of journalism – core normative visions of journalism. Normativistic and non-normativistic view.

5. Fake news as a parallel communicative flow

Historical origins of the term "fake news". How multi-channel media undermines the principles of news. News and views separation in digital reality of prosumerist media. Lowering bargains for creating content.. Fake news, disinformation and misinformation. Fake news as propaganda. Types of fake news. Fake news and strategic disinformation. Regulation of fake news: fake news laws, strategic disinformation dispositive, algorithmic solutions, media literacy as magic pill.

6. Media bias in new communicative environment: why fake news works?

Notion of media bias. 5 filters of Herman and Chomsky. Core approaches to media effects. Cognitive dissonance effect. Confirmation bias and selective exposure. Agenda setting in new media. Two steps flow model and how it combines personal trust with mass information in new media world. Media and viral content distribution in new environment.

7. Political public sphere and new media reality: populism and radicalization

Approaches to media and politics. Different visions of power. Public sphere as core concept about communication and politics. Crisis of rational debate in contemporary media. Rise of alternative media. Core concepts of alternative media. Rise of informational and public in politics. Populism as informational phenomenon. Radicalization of political media outlets. Echo-chambers and echo-bubbles and fragmentation of the debate.

8. Activism and new media

Political activism as a concept. Political participation and how new media are challenging it. Ideology if participatory media. Arab spring and "Twitter revolutions": concept of participatory digital media for changing political regimes. Role of digital media in Trump elections. Critique of digital revolutions. Concept of connective and collective actions and their differences.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Russian as a Foreign Language/Русский язык как иностранный

Purpose of the course:

The Russian as a foreign language (A2) course is aimed at the formation of intercultural professionally oriented communicative competence from the zero level to the elementary level (according to the European scale of foreign language proficiency levels) for solving social and communicative tasks in various areas of everyday, cultural, professional and scientific activities in the Russian language, as well as for further self-education.

Tasks of the course:

The tasks of the formation of intercultural, professionally oriented communicative competence consist of the gradual mastery by students of a set of competences, the main of which are:

– linguistic competence, i.e. the ability to adequately perceive and correctly use language units based on knowledge of phonological, grammatical, lexical, stylistic features of the studied language;

– sociolinguistic competence, i.e. the ability to adequately use realities, background knowledge, situationally conditioned forms of communication;

– sociocultural competence, i.e. the ability to consider during the communication speech and behavioral models adopted in the relevant culture;

– social competence, i.e. the ability to interact with communication partners, to make contact and maintain it, owning the necessary strategies;

– strategic competence, i.e. the ability to apply different strategies to maintain successful interaction in oral/written communication;

– discursive competence, i.e. the ability to understand and generate foreign language discourse considering cultural differences;

– general competence, including, along with knowledge about the country and the world, about the features of the language system, also the ability to expand and improve their own picture of the world, to be guided by the media sources of information;

– intercultural competence, i.e. the ability to achieve mutual understanding in intercultural contacts, using the entire set of skills to realize the communicative intention;

– compensatory competence, i.e. the ability to avoid misunderstandings, to overcome the communication barrier through the use of well-known speech and metalanguage means.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

– The main facts, realities, names, attractions, traditions of Russia;

– some achievements, discoveries, events in the field of Russian science, culture, politics, social life;

– basic phonetic, lexical-grammatical, stylistic features of the Russian language and its difference from the native language;

– the main differences in writing and speaking.

be able to:

– Generate adequate oral and written texts in a specific communication situation;

– to realize the communicative intention with the purpose of influencing the communication partner;

– adequately understand and interpret the meaning and intention of the author in the perception of oral and written authentic texts;

– identify similarities and differences in the systems of native and foreign languages;

– show tolerance, empathy, openness and friendliness when communicating with representatives of another culture.

master:

– Intercultural professionally oriented communicative competence in different types of speech activity at the level of A2;

– social and cultural competences for successful mutual understanding in terms of communication with representatives of another culture;

– various communication strategies;

– learning strategies for organizing the learning activities;

– strategies of reflection and self-evaluation for self-improvement of personal qualities and achievements;

– different methods of memorization and structuring digestible material;

– Internet technologies to select the optimal mode of obtaining information.

Content of the course (training module), structured by topics (sections):

1. My World

Communicative tasks. To talk about your everyday activity. To tell the time. To make an appointment. To talk about your family. To fill the registration form.

Vocabulary. Verbs describing everyday activity. Time. Parts of the day. Numbers 10-100. Events. Family. Registration form.

Grammar. 1st conjugation of verbs. 1 час, 2-4 часа, 5-20 часов. Consolidate conjugation of verbs. Possessive adjectives: мой/моя, твой/твоя.

Phonetics. Pronunciation of sounds: т, ть. Pronunciation of [ц], unstressed «я», «е». Pronunciation of [ж], [ш]. Devocalization of sound «ж» at the end of words.

2. Our Lesson

Communicative tasks. To understand your teacher's instructions in Russian. To ask people if they have something. To indicate something. To set a meeting. To talk about your plans for a week.

Vocabulary. Verbs describing activities at the lesson. Personal things. Numbers 100-1000. Days of week. Events.

Grammar. Imperative form of verbs - читайте, слушайте etc. Construction "у меня есть". Gender of nouns. Construction "У меня + событие". Nouns in plural. Days of week.

Phonetics. Pronunciation of "o" in unstressed position. [ж], [ш]. Devocalization of sound «ж» at the end of words. Pronunciation of у, г.

3. In the City

Communicative tasks. To talk about your city. To ask where to go. To understand signs of a city. To buy a ticket for metro. To order in a restaurant. To refuse an offer. To say where you were yesterday.

Vocabulary. Places in town (parks, restaurants, museums etc.). Words for ordering in a café or buying a ticket for metro. Russian way to say "last/next week".

Grammar. Endings of adjectives. Possessive pronouns. The prepositional case for locations. The past tense of the verb "to be".

Phonetics. Devocalization "д" at the end of words and in front of voiced consonants. Practicing the phrase "к сожалению". Words where "ч" is pronounced as [ш].

4. My Home

Communicative tasks. To describe your house. To call for a master to fix broken things at home. To explain location of things in the house. To talk about your free time and ways to rest at home.

Vocabulary. Furniture. Rooms. Verbs (to sleep, to want, to see, to watch, to hate). Parts of a house (wall, floor etc.). Outside the house (garden, forest). Verbs describing activities at home.

Grammar. Neuter gender nouns in plural. Masculine gender nouns in plural. Exceptions. The prepositional case, exceptions. The past tense. The accusative case for objects.

Phonetics. Pronunciation of the names of the rooms. Pronunciation of words with a change of stress in the prepositional case (в лесу, на полу, etc.). Pronunciation of [х]. Being surprised by the word "ух ты!"

5. Tasty Food

Communicative tasks. To explain what you need to buy. To talk about food preferences. To order and pay in a restaurant. To talk about recipes. To invite friends for dinner. To express admiration or criticism.

Vocabulary. Phrases for shopping. Phrases for restaurants. Phrases for inviting and accepting invitations.

Grammar. Personal pronouns with “нужно”, “надо”, “нравится”. The instrumental case after the preposition “с”. The future tense.

Phonetics. Pronunciation [ы], [и]. Devocalization of the voiced consonants at the end of words (б, д, в, з, ж, г). Intonation of admiration: “Как хорошо!”

6. Health

Communicative tasks. To talk to a doctor. To talk about health. To give recommendations. To talk about mood (I am sad, happy etc.). To agree/disagree.

Vocabulary. Parts of body. Health. Можно/нельзя. Emotions. Mood.

Grammar. Construction “у меня был”. Personal pronouns of with age, “можно”, “нельзя”. Short forms of adjectives.

Phonetics. Intonation of the interjection "ай!" when expressing pain. Pronunciation of ь, ъ.

7. People

Communicative tasks. To talk about people’s character. To describe appearance. To compare things. To buy clothes. To agree to do something.

Vocabulary. Adjectives. Describing a person. Adjectives. Appearance. Clothes. Colors. Size.

Grammar. Endings of adjectives. The comparative and superlative degree. The genitive case in possessive constructions. Endings of adjectives.

Phonetics. Pronunciation of [ш], [щ]. Combination «дж». Intonation of admiration urprise using the word “так”. Pronunciation of “ё” after the hushing sounds.

8. Transport

Communicative tasks. To talk with a taxi driver (price, address, etc.). To order a taxi. To cancel, reschedule or confirm a meeting. To talk about your trip. To describe cities.

Vocabulary. Transport. Dates. Verbs: перенести, отменить, подтвердить, прийти/приехать, уйти/уехать. The compass. Words for travelling.

Grammar. The prepositional case for transport. Ordinal numbers. The accusative case for directions with prepositions “в”, “на”.

Phonetics. Practicing the difference of pronunciation between "е" and "ё" in the conjugation of the verbs "идти", "ехать". Words where the letter "г" is pronounced as "в" (его, сегодня). Devocalization "з" in the preposition "из".

9. My Family

Communicative tasks. To talk about family. To accept the invitation. To talk about hobbies. To refuse the invitation. To ask and tell about biography.

Vocabulary. Family. Relatives. Activities during the holidays. Verb “уметь”. Verbs: пожениться, родиться, случиться, познакомиться.

Grammar. The genitive case. Possession. Reflexive verbs (the present tense). Заниматься + the instrumental case. Reflexive verbs (the past tense).

Phonetics. Devocalization of sound “ж” at the end of words. Pronunciation of тс, тьс = [ц]. Pronunciation of и = [ы] after ш, ж, ц.

10. Holidays

Communicative tasks. To congratulate with holidays. To tell about traditions. To sign postcards. To say wishes. To suggest the idea of gifts. To express surprise.

Vocabulary. Name of the holidays. Verbs: праздновать, поздравлять, прощаться, гулять. Wishes (happiness, love, luck, etc.). Gifts.

Grammar. Поздравлять + the instrumental case. The genitive case with the verb желать. The genitive case after prepositions.

Phonetics. Words with an unpronounceable "д". Words where г = [в]. Intonation of the phrase "Да ладно?!"

11. Shopping

Communicative tasks. To understand the information on the labels of cosmetic products. To buy groceries. To communicate in the store. To buy clothes.

Vocabulary. Body parts. Cosmetic. Stores. Numbers and time. Fruits and vegetables. Clothes, shoes, accessories. In the store.

Grammar. The genitive case. Plural. The genitive case with numbers. The genitive case.

Phonetics. Devocalization of "в" at the end of words. Devocalization of paired voiced consonants before voiceless consonants. The difference in pronunciation between "большой" and "больше".

12. Countries and Nationalities

Communicative tasks. To ask a person where he he is from. To talk about countries. To talk about the weather. To talk about the season. To talk about traditions and nationalities.

Vocabulary. Countries. Months. Weather. Season. Verbs (to love, to call, to speak). Traditions and nationalities.

Grammar. Months in the prepositional case (when?). 2nd conjugation of verbs. Nationalities.

Phonetics. Pronunciation of р, рь, ю. Pronunciation of the names of nationalities.

Annotation

Major: 03.04.01 Прикладные математика и физика

specialization: Applied Bioinformatics/Прикладная биоинформатика

Transcriptomics, Epigenomics and OMICS Data Analysis/Транскриптомика, эпигеномика и анализ ОМИКСных данных

Purpose of the course:

Give an idea of the mechanisms of the implementation of genetic information, transcription regulation and practical skills in applying bioinformatics methods for analyzing and interpreting biological data.

Tasks of the course:

• give an idea of the basic mechanisms of gene transcription regulation;

• make students familiar with modern understanding of regulatory transcriptome and epigenomics;

• teach how to use the main databases in the field;

• introduce basic algorithms and data formats for epigenomics and transcriptomics.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- physical and chemical properties of nucleic acids and chromatin proteins;

- processes involving nucleic acids and chromatin proteins;

- research methods of the genome and evolution of living organisms;

- the main mechanisms of regulatory genomics, transcriptome and epigenetics;

- basic bioinformatics algorithms, databases, file formats used in transcriptome and epigenomics;

- modern molecular biological methods for studying cell processes;

be able to:

- use the main databases of regulatory genomics;

- reproduce the algorithms for analyzing transcriptome and epigenomics data

master:

- of working with large volumes of biological data;

- of planning and implementation of multi-stage bioinformatic analysis.

Content of the course (training module), structured by topics (sections):

1. Introduction to regulatory genomics

The central dogma of molecular biology. Differences in phenotypes of cells of a multicellular organism. Stages of transcription.

2. Basic consepts of transcription and epigenetic regulation

Elements of the regulatory structure of a gene: promoters, enhancers, insulators.

3. Transcriptomics: basic steps of the NGS protocols (RNA-seq)

RNA sequencing protocol. Stages, modifications. RNA-seq and CAGE-seq. Quality control, primary data analysis

4. Algorithms for analyzing RNA sequencing data

Alignment of sequencing reads to intron-containing eukaryotic genes, HiSAT / STAR alignment algorithms, search for exon-intron boundaries, determination of gene expression levels, normalization. Differential expression (edgeR, DESeq, etc).

5. Epigenetics: basic molecular mechanisms of epigenetic regulation

Methylation of cytosisines in DNA, other modifications of DNA and RNA Modifications of histone proteins: methylation, acetylation. Combinations of histone marks. Histone code. Database epigenetic regulators.

6. Important examples of biological prosesses based on epigenetic regulation

Genomic imprinting, X chromosome inactivation, cancer and other diseases, environmental effects, transgenerational inheritance.

7. Epigenetics: detection of DNA methylaiton

Bisulfite sequencing, protocol modifications (WGBS, RRBS), algorithm for determining the methylation degree of individual Bismark cytosines, differential methylation analysis (Methpipe), search for variable methylation regions

8. Epigenetics: detection of histon modifications

Protocol for determining modifications of histone proteins (ChIP-seq), analysis of open chromatin areas (ATAC-seq), “good practices” of building an experiment, searching for peaks (MACS, etc.), visualizing the distribution of readings by metagen, genome segmentation (chromHMM).

9. Epigenetics: determination of the chromatic structure via DNA:DNA interactions and DNA:RNA interactions. LncRNA in epiganetic regulation

Protocols for determining chromatin structure through DNA-DNA interaction (Hi-C), analysis of Hi-C data, determination of DNA-RNA interactions, long ncRNAs in epigenetic regulation, targeting mechanisms of epigenetic regulators using ncRNA

10. Epigenetics: single cell NGS data analysis. Multiomics data analysis.

ATAC-seq for single cells, NOM-seq, protocols for simultaneous analysis of RNA and chromatin structure. Computational data integration