纳米生物技术专业入学考试大纲

专业名称：纳米生物技术

Нанобиотехнология

Nanobiotechnology

考试课程名称：

Комплексный экзамен по биологии с основами нанобиотехнологии и английскому языку

An Integrated Entrance Exam in Biology with Basics of Nanobiotechnology and English Language

考试内容：

Типы клеток, строение клеток и функции. Клетки прокариот и эукариот: сходства и различия. Клеточная мембрана: строение, механизмы транспорта и их значение. Клеточные органеллы: строение и функции ядра, митохондрий, рибосом, эндоплазматического ретикулума, аппарата Гольджи, лизосом и пероксисом. Деление клеток: митоз и мейоз. Цитоскелет: строение и функции. Передача сигналов в клетках: типы передачи сигналов, пути передачи сигналов и их значение.

Хромосомы: строение, функции и типы. Сцепление и

кроссинговер: понятие, виды сцепления и значение. Структура и функции ДНК и РНК, генетический код, транскрипция, трансляция и регуляция генов.

Виды микроорганизмов, микробиологические методы и их значение. Бактерии: строение, классификация и значение. Археи: строение, классификация и значение.

Гомеостаз: определение и механизм. Нервная система: типы нейронов, нервные импульсы, синаптическая передача и нейронная интеграция. Органы чувств: типы сенсорных рецепторов, сенсорная адаптация и сенсорное кодирование. Эндокринная система: виды гормонов, механизм их действия и обратная связь. Типы мышц, мышечное сокращение и мышечный метаболизм. Пищеварительная система: виды пищеварения, всасывания и метаболизма питательных веществ. Строение костной ткани.

Инструменты и методы нанотехнологий: микроскопия, спектроскопия. Наноструктуры: типы наноструктур, свойства и применение в нанобиотехнологии. Наноматериалы: типы наноматериалов, свойства и применение в нанобиотехнологии. Биосенсоры. Наномедицина: определение, области применения нанотехнологий в

медицине.

Cell types, cell structure and functions. Cells of prokaryotes and eukaryotes: similarities and differences. Cell membrane: structure, transport mechanisms and their significance. Cellular organelles: the structure and functions of the nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes and peroxisomes. Cell division: mitosis and meiosis. Cytoskeleton: structure and functions. Signal transduction in cells: types of signalling, signalling pathways and their significance. Chromosomes: structure, functions and types. Linkage and crossing-over: concept, types of linkage and meaning. Structure and functions of DNA and RNA, genetic code, transcription, translation and regulation of genes. Types of microorganisms, microbiological methods and their significance. Bacteria: structure, classification and significance. Archaea: structure, classification and significance. Viruses: structure, classification and significance.

Homeostasis: definition and mechanism. Nervous system: types of neurons, nerve impulses, synaptic transmission and neuronal integration. Sense organs: types of sensory receptors, sensory adaptation and sensory coding. Endocrine system: types of hormones, their mechanism of action and feedback. Muscle types, muscle contraction and muscle metabolism. Digestive system: types of digestion, absorption and metabolism of nutrients. The structure

of bone tissue. Instruments and methods of nanotechnology: microscopy, spectroscopy, lithography and synthesis methods. Nanostructures: types of nanostructures, properties and applications in nanobiotechnology. Nanomaterials: types of nanomaterials, properties and applications in nanobiotechnology. Biosensors. Nanomedicine: definition, areas of application of nanotechnologies in medicine.

考试形式及要求：

Формат экзамена – письменный экзамен, состоящий из двух разделов: биология с основами нанобиотехнологии и английский язык. Кандидаты должны иметь степень бакалавра в области естественных наук, прикладных наук или наук о жизни с упором на биологию или химию. Они также должны иметь сильную научную подготовку, включая базовые знания по математике и физике. Программа целиков преподается на английском языке, поэтому необходимо иметь хороший уровень владения этим языком. Требуется уровень владения английским языком не ниже B2 по общеевропейской шкале уровней владения языком или 5.5-6.5 ILETS, или 87-109 TOEFL iBT). Кандидаты должны сдать вступительный экзамен. Результаты Единого национального вступительного экзамена в

магистратуру будут учитываться как индивидуальные достижения.

The exam format is a written exam consisting of two sections: Biology with Fundamentals of Nanobiotechnology and English. Candidates should have a Bachelor´s degree in the field of Science, Applied Sciences or Life Sciences that have a strong focus on Biology or Chemistry. They should also have a strong scientific background, including basic knowledge of Mathematics, and Physics. The programe is taught in English, so the candidates must be proficient in this language. Required level: B2 CEFR or 5.5-6.5 ILETS or 87-109 TOEFL iBT. Candidates must pass an entrance exam. The results of the Unified National Graduate Entrance Examination will be taken in account as individual achievement.

相关文献：

Biological Science 1 & 2. D. J. Taylor, N. P. O. Green, G. W. Stout, R. Soper. Cambridge University Press; 3rd edition. 1997

Biology: the essentials, second edition. Mariëlle Hoefnagels. McGraw-Hill Education, 2016

Biology. Robert Brooker, Eric Widmaier, Linda Graham), Peter Stiling. McGraw Hill; 5th edition, 2019

Essentials of Ecology. Begon M., Howarth R.W., Townsend C.R. 4th

edition. Wiley, 2014. 480 pp.

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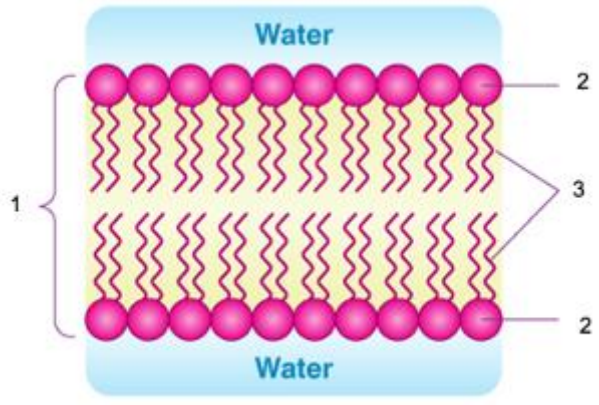
An Integrated Entrance Exam in Biology with Basics of Nanobiotechnology and English Language
Faculty of Biology
Master's programme in Nanobiotechnology
Demo version

I Biology with Basics of Nanobiotechnology (80 min)

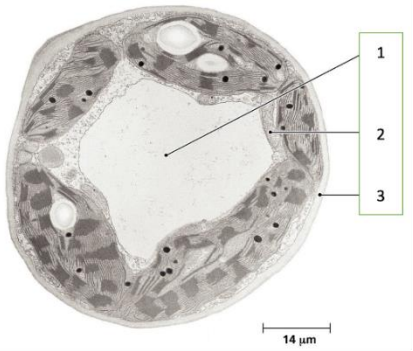
1. Bacteria stain pink in a laboratory test. Name them.
2. Which object we can name a nanoparticle?
3. _____ is a selectively permeable lipid bilayer that encloses the contents of the cell and regulates the transport of materials into and out of it.
4. Which cellular organelle is responsible for producing energy within the cell?
5. Name 4 representatives of different kingdoms /domains that have a cell wall.
6. True or false: Transcription is the process where mRNA's genetic information is decoded by ribosomes, forming a sequence of amino acids. tRNA's anticodons pair with mRNA codons, adding amino acids to the growing protein chain.
7. True or false: Nerve impulses are electrical signals transmitted along neurons.
8. True or False: Homeostasis refers to the body's ability to maintain a stable internal environment despite external changes.
9. Name two types of neurons based on their function.
10. What is the term for the electrical signal transmitted along a nerve fiber?
11. True or False: Synaptic transmission involves the release of neurotransmitters from the presynaptic neuron to the postsynaptic neuron.
12. Draw the structural formula of cysteine.
13. Chemical digestion of protein begins in the: _____
14. What proteins provide muscle contraction?
15. What kind of microscopy makes it possible to distinguish crystalline nanoparticles from amorphous ones?
16. Fill in the missing words from the picture, separate (1), (2), (3) answers with commas.



17. In which cellular structures proteins are embedded to assist transport within the cell?

A. Nucleus
B. Ribosome
C. Mitochondria
D. Golgi apparatus
E. Endoplasmic reticulum
F. Cell membrane

18. Name the organelle 1 in the picture. Which method was used to obtain the picture? Provide the name of organelle and method separated with comma.



19. List the main phases of the cell cycle.

20. In which element cycle bacteria do not use the oxidation of this element (in more complex substances containing it as a source of energy?

A. N
B. P
C. S
D. Fe
E. C

21. _____ in cell signaling regulates protein activity by adding _____ to proteins, which can alter their conformation, activity, or interactions with other molecules. This process regulates various cellular processes, including cell growth, differentiation, and apoptosis.

22. For your experiment, you need to prepare 0.1 liters of a 2.5 M working solution from a 10 M stock solution. Describe, how you will do it.

23. What is the primary function of second messengers in signaling pathways, and give an example of a second messenger involved in cell signaling?

24. Translate the following sequence into a sequence based on the single letter codes.
Ala-Phe-Phe-Lys-Arg-Ser-Ser-Ser-Ala-Thr-Leu-Ile-Val-Thr-Lys-Lys-Gln-Gln-Phe-Asn-Gly-Gly-Pro-Asp-Glu-Val-Leu-Arg-Thr-Ala-Ser-Thr-Lys-Ala-Thr-Asp.

25. Assuming a point accepted DNA mutation rate of 20 (20 PAMs/100 residues/10^8 years) establish the degree of DNA homology for two proteins each of 200 residues that diverged 500 million years ago. What is the maximal level of amino acid residue homology between proteins and what is the lowest level?

26. Please, calculate the volume of the chromatography tube with dimensions: length 10 cm, diameter 1 cm

27. A PCR amplification proceeds for 25 cycles. The initial target sequence was present in the reaction at 3*10^5 copies. At the end of the 25 cycles, 4*10^12 copies have been produced. What is the efficiency of the reaction?

28. Calculate the relative centrifugal force for a rotor spun at 5000 r.p.m at distances of 9, 6 and 3 cm from the center of rotation. Calculate the forces if the rotor is now rotating at 20 000 r.p.m.

29. What is the wavelength range of infrared spectroscopy studies conducted at 300–4000 cm−1.

30. Explain how disulfide bonds affect protein stability. What would you expect to be the effect on protein stability of introducing a disulfide bond using mutagenesis? What would be the effect of removing a disulfide bond on protein stability?

II English Language

Part. 1. Writing

Task 1. Read the text. Summarize the information of the text in 80-100 words. You cannot use more than 5-words-long sequences from the original text (20 min).

Accumulating fewer genetic mutations linked to living a longer life

Genetic mutations passed down through generations may hint at how long a person will live

The number of genetic mutations a person amasses in their reproductive cells could help tell us how long they will live – and having a lower proportion of these germ line mutations may also influence when a woman's fertility starts to decline.

Richard Cawthon at the University of Utah and his colleagues analysed previously collected genetic information from 61 men and 61 women, all of whom were grandparents and most of whom had died by 2018, with the exception of two. These people were part of a project to build a genetic database of families across three generations.

Because mutations in reproductive cells can be passed to the next generation, the researchers were able to calculate how many the grandparents had before they had children, and they did the same for the second and third generations. In an analysis of 41 families in the database, the team found that a slower accumulation of mutations was linked to longer life.

People with mutation numbers in the top 75 per cent were more than twice as likely to die from any cause over the study period than those in the bottom 25 per cent, who had an average survival advantage of almost five years. Men accumulated more of these mutations than women, though it isn't yet known whether this affects their lifespan.

This lends support to the idea that ageing is down to the accumulation of mutations, driving cell damage and death.

"The fairly clear association between mutation rate and mortality is a potentially very important and novel finding", says Scott Kennedy at the University of Washington in Seattle.

"Once we have good, strong associations of biomarkers with how long people live, the idea is that we might be able to figure out what the mechanisms of ageing are and come up with medical and lifestyle interventions that can help people stay healthy as long as possible," says Cawthon. (From *New Scientist* 24 June 2020)

Part 2. Grammar

Task 2. Complete the sentences choosing the correct form of the words in italics (5 min).

'Nanoblade' slips organelle into cells

A laser-based technique permits the **(1)** ***deliver / delivery / delivering*** of energy-generating organelles called mitochondria **(2)** ***in / to / into*** single mammalian cells, where they can **(3)** ***restore / be restored / have restored*** metabolic activities.

Mitochondria have their own DNA, which can cause disease if **(4)** ***mutate / mutating / mutated / mutation***, and researchers **(5)** ***looked / were looking / have looked / have been looking*** for ways **(6)** ***to isolate / isolating / isolated / isolation*** the organelles, correct genetic defects and return the mitochondria to cells. Pei-Yu Chiou and Michael Teitell at the University of California, Los Angeles, and their colleagues coated a micropipette tip **(7)** ***with / in / for / by*** a 100-nanometre-thick film of light-**(8)** ***absorption / absorbing / absorbed*** titanium and lightly touched it to a cell membrane. A laser pulse heated the tip, **(9)** ***to cause / causing / caused*** a bubble to quickly form and collapse in the cell's **(10)** ***education / culture / civilization*** medium. The bubble's **(11)** ***expand / expanding / expansion*** punctured the membrane, **(12)** ***to create / creating / created / creation*** an opening large enough for the delivery of mitochondria.

The technique's 2% **(13)** ***effect / effective / efficiency*** rate is higher than that of other methods, and the team now **(14)** ***works / is working / have worked*** **(15)** ***to increase / increase / increasing / increased*** throughput. (From *Nature* 18 May 2016)

Task 3. Put the verbs in brackets in the correct form. There is an example at the beginning (7 min).

Weekend lie-ins don't compensate for week-long exhaustion

Catching up on sleep over the weekend doesn't undo the negative metabolic effects of sleep deprivation.

(0) Getting **(to get)** extra sleep at weekends probably isn't enough (1) _____ **(to reduce)** health risks (2) _____ **(to relate)** to insufficient sleep during exhausting working weeks, according to a short-term study of young adults.

Lack of sleep (3) _____ **(to link)** to a range of disorders, including diabetes and heart disease. Kenneth Wright at the University of Colorado Boulder and his colleagues (4) _____ **(to study)** what (5) _____ **(to happen)** when people try (6) _____ **(to compensate)** for insufficient sleep during the week by (7) _____ **(to sleep)** late at weekends.

The team (8) _____ **(to find)** that a group of 14 young adults who (9) _____ **(to sleep)** for only 5 hours each night for 9 consecutive nights (10) _____ **(to snack)** more after dinner, (11) _____ **(to gain)** more weight and (12) _____ **(to exhibit)** reduced insulin sensitivity (13) _____ **(to compare)** with a control group of adults who (14) _____ **(to sleep)** up to 9 hours each night. In a third group, an additional 14 participants (15) _____ **(to sleep)** only 5 hours per night during the working week, but then (16) _____ **(to allow)** (17) _____ **(to sleep)** as much as they (18) _____ **(to want)** over the weekend. Even so, during the subsequent week, the negative metabolic effects of sleeplessness (19) _____ **(to persist)**. (From *Nature* 28 February 2019)

Part 3. Vocabulary

Task 4. Complete the text putting the words in brackets in the correct word form (8 min).

A reindeer's yearning to travel can be read in its genes

The fingerprint of the last ice age can still be seen in the genomes of reindeer that make long migrations.

Some reindeer make epic (0) ____migrations_____ **(migrate)** of more than 1,000 kilometres a year, whereas others stick (1) _____ **(close)** to home. (2) _____ **(science)** have now linked a reindeer's (3) _____ **(tend)** to (4) _____ **(migrate)** and its (5) _____ **(gene)** (6) _____ **(inherit)**.

Maria Cavedon and Marco Musiani at the University of Calgary in Canada and their colleagues tracked 139 reindeer (*Rangifer tarandus*), also known as caribou, moving throughout western North America. The team then looked for (7) _____ **(gene)** that could explain the (8) _____ **(differ)** in individuals' (9) _____ **(move)** patterns.

The (10) _____ **(research)** found (11) _____ **(gene)** vestiges of the last ice age, when an ice sheet that covered part of North America divided reindeer into northern and southern (12) _____ **(populate)**. The authors show that modern individuals that bear (13) _____ **(great)** genetic (14) _____ **(similar)** to the northern population are more (15) _____ **(migrate)** than those more (16) _____ **(close)** (17) _____ **(relate)** to the southern population.

Fifty-seven genetic (18) _____ **(mutate)** seemed to have especially strong (19) _____ **(associate)** with migration. Many are in (20) _____ **(gene)** that, in other animals, affect brain (21) _____ **(act)** and fat (22) _____ **(store)** — logical (23) _____ **(connect)**, given that metabolism and a sense of time could influence migration.

However, because humans have fragmented reindeer habitats, the populations most prone to (24) _____ **(migrate)** could die out. (From *Nature* 10 February 2022)