北京大学考场纪律

1、考生要按规定的考试时间提前5分钟进入考场，隔位就座或按照监考人员的安排就座，将学生证放在桌面。无学生证者不能参加考试；迟到超过15分钟不得入场；与考试无关人员不得进入考场。如考试允许提前交卷，考生在考试开始30分钟后可交卷离场；未交卷擅自离开考场，不得重新进入考场继续答卷；交卷后应离开考场，不得在考场内逗留或在考场附近高声交谈。

2、除非主考教师另有规定，学生只能携带必要的文具参加考试，其它所有物品（包括空白纸张、手机等电子设备）不得带入座位；已经带入考场的手机等电子设备必须关机，与其他物品一起集中放在监考人员指定位置，不得随身携带或带入座位及旁边。

3、考试使用的试题、答卷、草稿纸由监考人员统一发放和收回，考生不得带出考场。考生在规定时间前答完试卷，应举手示意请监考人员收卷后方可离开；答题时间结束监考人员宣布收卷时，考生应立即停止答卷，在座位上等待监考人员收卷清点无误后，方可离场。

4、考生要严格遵守考场规则，在规定时间内独立完成答卷。不准旁窥、交头接耳、打暗号或做手势，不准携带与考试内容相关的材料参加考试，不准使用手机、非教师允许的计算器等具有信息发送、接受、存储功能的设备，不准抄袭或协助他人抄袭试题答案或者与考试内容相关的资料，不准窃取、索要、强拿、传、接或者交换试卷、答卷、草稿纸，不准代替他人或让他人代替自己参加考试，等等。凡违反考试纪律或作弊者，按《北京大学本科考试工作与学习纪律管理规定》给予相应处分。

5、考生须确认自己填写的个人信息真实、准确，并承担信息填写错误带来的一切责任与后果。

学校倡议所有考生诚信答卷，共同维护北京大学的学术声誉。

2020 Spring Cell Biology Final Exam (10:10am~12:00pm, June 16th, 2020)

1. Provide your answers on the answer sheet provided. Be sure to fill in your name and student ID number. Send your answer sheet to T.A. via email by 12:00pm, June 16th, 2020.
2. Questions 1~34: Select the best answer unless instructed otherwise. (Questions 1~26 are 1.5 points each; Questions 27~34 are 0.5 points each answer.) Questions 35~39 are short-answer/essay questions. The exam has 106.5 points in total; if you get more than 100 points, your grade will still be 100.

1. The chromatin remodeling complexes play an important role in chromatin regulation in the nucleus. They …
   A. can slide nucleosomes on DNA.
   B. have ATPase activity.
   C. interact with histone chaperones.
   D. can remove or exchange core histone subunits.
   E. All of the above.

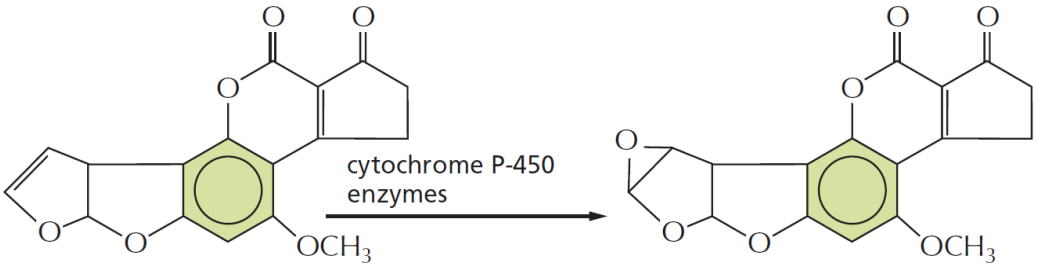
2. The two chromosomes in each of the 22 homologous pairs in our cells ...
   A. have the exact same DNA sequence.
   B. are derived from one of our parents.
   C. show identical banding patterns after Giemsa staining.
   D. usually bear different sets of genes.
   E. All of the above.

3. Which of the following events normally activates a GTP-binding protein?
   A. GTP hydrolysis by the protein
   B. Activation of an upstream GTPase-activating protein
   C. Activation of an upstream guanine nucleotide exchange factor
   D. Phosphorylation of a bound GDP molecule by an upstream phosphorylase
   E. P_i release after GTP hydrolysis

4. Consider a signaling protein that is only made up of one SH2 domain and two SH3 domains. This protein is most likely ...
   A. a monomeric G protein.
   B. a guanine nucleotide exchange factor.
   C. a kinase associated with receptor tyrosine kinase signaling.
   D. an adaptor protein.
   E. a negative regulator of receptor tyrosine kinase signaling.

5. Which of the following events occurs in mitotic metaphase?
   A. Nuclear envelope breakdown
   B. Nuclear envelope reassembly
   C. Chromosome attachment to spindle microtubules for the first time
   D. Chromosome alignment at the spindle equator

6. Which of the molecules (A or B) in the following drawing is a more potent mutagen? Write down A or B as your answer.



AFLATOXIN
(A)

AFLATOXIN-2,3-EPOXIDE
(B)

7. Which of the following structures is exclusively found in eukaryotic cells?
   A. Plasma membrane
   B. Cell wall
   C. Chromosome
   D. Ribosome
   E. Lysosome

8. All cells in a multicellular organism have normally developed from a single cell and share the same genome, but can nevertheless be wildly different in their shape and function. What in the eukaryotic genome is responsible for this cell-type diversity?
   A. The genes that encode transcription regulatory proteins
   B. The regulatory sequences that control the expression of genes
   C. The genes that code for molecules involved in receiving cellular signals
   D. The genes that code for molecules involved in sending cellular signals to other cells
   E. All of the above

9. When the gene encoding a certain cytoskeleton protein is deleted, the resulting mutant cells round up and do not form their normal appendages. These mutants can be rescued when a gene encoding an N-terminal green fluorescent protein (GFP) fusion of the protein is expressed, but not when a gene encoding a C-terminal GFP fusion is expressed. Which fusion protein (N or C) is appropriate to use in studying cellular localization and activity? Write down N or C as your answer.

10. What are the advantages of monoclonal antibodies over antisera?
   A. They can be produced in higher quantities.
   B. They can be produced with higher purity.
   C. They have a more uniform specificity.
   D. They can be made against molecules that constitute only a minor component of a complex mixture.
   E. All of the above.

11. An ion channel …
   A. always mediates passive transport.
   B. is ion-selective.
   C. is typically several orders of magnitude faster than a transporter.
   D. is usually gated.

E. All of the above.

12. Which of the following proteins or protein complexes is directly required for the targeting of mitochondrial inner membrane multipass proteins, such as metabolite transporters, whose signal sequence is normally not cleaved after import?

A. TIM22
B. TIM23
C. OXA
D. Mia40
E. SAM

13. The γ-tubulin ring complex is to microtubules what … is to actin filaments.

A. the Arp 2/3 complex
B. the dynactin complex
C. the troponin complex
D. formin
E. contractile ring

14. Imagine a chromosome translocation event that brings a gene encoding a histone acetyl transferase enzyme from its original chromosomal location to a new one near heterochromatin. Which of the following scenarios is definitely NOT going to happen?

A. The gene gets silenced due to heterochromatin expansion, leading to the misregulation of gene expression for a number of critical genes.
B. The translocation event also brings along a chromatin barrier that can prevent heterochromatin expansion into the gene, and there is no phenotypic anomaly.
C. Since the gene encodes a histone acetyl transferase, it resists heterochromatin expansion by acetylating its own histones.
D. The level of the gene product decreases due to a position effect, leading to an imbalance in the chromatin state of the cell that results in the activation of programmed cell death.

15. Polytene chromosomes are useful for studying chromatin because they …

A. are smaller than regular chromosomes and easier to manipulate.
B. lack heterochromatin.
C. have distinct visible banding patterns.
D. can make polyploid cells.
E. All of the above.

16. A gene that had been turned off in a liver cell has just been induced to be highly expressed as the cell responds to a new metabolic load. What observations do you expect to accompany this change?

A. More than 100 proteins would become associated with the gene for its transcription.
B. The nuclear position of the gene would change to place it in a “transcription factory.”
C. Chromatin modifications associated with the gene would change in favor of higher expression.
D. All of the above.

17. Which of the following is NOT a common second messenger in cell signaling?

A. Ca^{2+}
B. Cyclic adenosine monophosphate
C. Diacylglycerol
D. Tyrosine
E. Inositol trisphosphate

18. What is the major way by which the monomeric G protein Ras is activated in receptor tyrosine kinase signaling?
A. Activation of Ras-GAP
B. Activation of Ras-GEF
C. Inactivation of Ras-GAP
D. Inactivation of Ras-GEF
E. Inactivation of Ras-GDI

19. How does the expression of Delta on the surface of a cell activate the expression of certain genes in the nucleus of its neighboring cell?
A. Delta binding activates Notch, which activates a transcriptional activator through the JAK–STAT pathway.
B. Delta binding leads to the stabilization of a cytoskeleton-associated transcriptional activator.
C. Delta binding releases the intracellular tail of Notch, which enters the nucleus and converts a transcriptional repressor into a transcriptional activator.
D. Delta binding leads to Notch-mediated recruitment of protein complexes to the plasma membrane, resulting in the degradation of a transcriptional repressor.
E. Delta binding leads to the proteolytic cleavage of Notch and inhibition of its activity as a transcriptional repressor, leading to the activation of target genes.

20. All nuclear receptors ...
A. are cytosolic proteins that enter the nucleus upon ligand binding.
B. have ligand-binding and DNA-binding domains, and can directly bind to DNA.
C. are transcriptional activators when bound to their ligand.
D. bind to steroid hormones.
E. are transcriptional repressors in the absence of their ligand.

21. In most mammalian cells, low M-cyclin protein levels are maintained during G_1 phase. What is mainly responsible for maintaining these low levels?
A. Cdc20–APC/C
B. Cdh1–APC/C
C. Skp2–SCF
D. β-trCP–SCF
E. p27

22. Mutation in which of the following genes is most prevalent in human colorectal cancer cells?
A. *K-Ras*
B. *β-Catenin*
C. *Apc*
D. *p53*
E. *MLH*

23. In some adenomas of the colon, intestinal crypt cells appear to have proliferated abnormally to form small tumors known as polyps. Studies on the familial type of such a disease led to the identification of a major signaling pathway (which was aberrant in the polyp cells) as being involved in the maintenance of the gut stem-cell compartment. What signaling pathway is this? Is it upregulated or downregulated in colon cancers?

A. MAPK pathway; up-regulated
B. MAPK pathway; down-regulated
C. Wnt pathway; up-regulated
D. Wnt pathway; down-regulated
E. Hedgehog pathway; down-regulated

24. All blood cells in our body …

A. have exceptionally short life-spans—at most a month or so.
B. are produced only before adulthood.
C. are ultimately generated from multipotent hematopoietic stem cells.
D. are made from progenitors that themselves circulate in the blood.
E. All of the above.

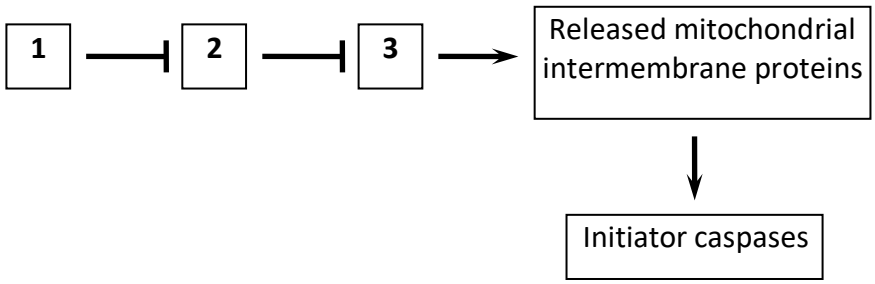
25. Cells of the inner cell mass in an early mammalian embryo can be isolated and grown in culture. Which of the following is NOT true regarding these cells?

A. They are totipotent.
B. They can be introduced into another developing embryo where their progeny become incorporated into the resulting adult animal, even into its germ line.
C. They are stem cells.
D. They can be manipulated in culture to give rise to almost any type of differentiated cell.

26. Which of the following morphological changes is NOT typically seen in a cell that is undergoing apoptosis?

A. The cell rounds up.
B. The nuclear envelope disassembles.
C. The cell swells.
D. Large cells break up into membrane-enclosed fragments.
E. The nuclear chromatin breaks into fragments.

27. The Bcl2 family is comprised of anti-apoptotic (A), BH3-only (B), and effector (E) proteins. In the following diagram representing the regulation of the intrinsic pathway of apoptosis, what class of activated Bcl2 family proteins (A, B, or E) corresponds to boxes 1 to 3, respectively? Your answer would be a three-letter string composed of letters A, B, and E only, e.g. ABE.



28. For each of the following classifications, indicate whether you would expect to find an actively transcribed gene in the first category (1) or the second (2). Your answer would be a six-digit number composed of digits 1 and 2 only, e.g. 222121.

( ) 1: Heterochromatin, or 2: euchromatin
( ) 1: Chromosome puffs, or 2: condensed chromosome bands
( ) 1: Nuclear periphery, or 2: the center of the nucleus
( ) 1: Within the chromosome territory, or 2: extended out of the territory
( ) 1: Apart from, or 2: close to actively transcribed genes within the nucleus
( ) 1: 11-nm "beads-on-a-string" fibers, or 2: 30-nm fibers

29. Indicate true (T) and false (F) statements below regarding G-protein-coupled receptors (GPCRs). Your answer would be a five-letter string composed of letters T and F only, e.g. TTFFF.

( ) All GPCRs share a similar structure composed of seven transmembrane helices.
( ) All GPCR ligands (signal molecules) have a similar structure.
( ) GPCRs have only been found in multicellular organisms, consistent with their role in intercellular signaling.
( ) The hormone insulin is recognized by a GPCR on the surface of its target cells.
( ) Once activated, a GPCR molecule can activate multiple molecules of G protein to amplify the incoming signal.

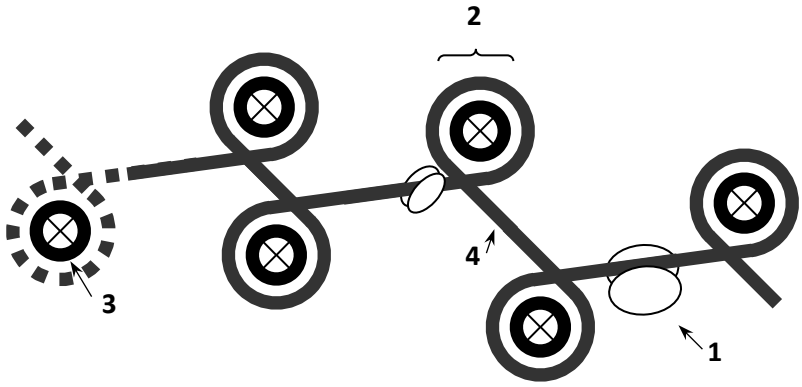
30. Indicate whether each of the following transport processes occurs via the mechanisms described as gated transport (G), transmembrane transport (T), or vesicular transport (V). Your answer would be a five-letter string composed of letters G, T, and V only, e.g. VTTTG.

( ) Import into nucleus
( ) Export from nucleus
( ) Import into mitochondria
( ) Return from Golgi to ER
( ) Return from ER to cytosol

31. Indicate if each of the following descriptions matches actin filaments (A), microtubules (M), or intermediate filaments (I). Your answer would be a four-letter string composed of letters A, M, and I only; e.g. AAMM.

( ) They form hollow structures with multiple lateral interactions.
( ) They form strong structures that are more resilient than the other two cytoskeletal filaments.
( ) Their subunits bind GTP and hydrolyze it.
( ) They form coiled-coil interactions between the subunits.

32. Indicate which feature (1 to 4) in the schematic drawing below of a chromatin fiber corresponds to each of the following. Your answer would be a four-digit number composed of digits 1 to 4 only, e.g. 2431.



( ) Nucleosome core particle
( ) Linker DNA
( ) Histone octamer
( ) Non-histone protein

33. In the fission yeast *Schizosaccharomyces pombe*, the proteins Cut1 and Cut2 form a complex that is catalytically inactive. At the onset of anaphase, Cut2 is polyubiquitylated by a large E3 complex containing Cut4, Cut9, Cut23, and other proteins, and is subsequently destroyed. Cut1 then cleaves Rad21, a non-SMC component of a complex that also contains two SMC proteins, thus allowing sister-chromatid separation. Mutations in the *cut* genes lead to the *cut* phenotype, in which the cell attempts cytokinesis without chromosome segregation. Indicate which of the following proteins or protein complexes corresponds to or contains the product of the genes *cut1* (A), *cut2* (B), *cut4* (C), and *rad21* (D). Your answer would be a four-letter string composed of letters A to D only, e.g. DCAB.

( ) Securin
( ) Cohesin
( ) Anaphase-promoting complex
( ) Separase

34. Indicate true (T) and false (F) statements below regarding cancer. Your answer would be a four-letter string composed of letters T and F only, e.g. TFFF.

( ) Cancer can be induced by infectious agents such as viruses.
( ) The earlier a cancer is diagnosed, the better the chances are for a cure.
( ) Most cancers originate from a single aberrant cell.
( ) A single mutation is NOT enough to turn a normal cell into a cancer cell.

Questions 35~39 are short-answer/essay questions.

35. (a) Please describe the activation of JAK-STAT pathway by cytokines. (8 %)

(b) Please name an example of the cytokines that can activate JAK-STAT signaling. (2%)

36. (a) Please describe the 4 phases of which the eukaryotic cell cycle is composed. (Name the phases in sequential order, and briefly describe the key process taking place in each phase.) (8%)

(b) How are cyclin-dependent protein kinases (CDKs) activities being controlled? (6%)

(c) How does the anaphase-promoting complex/cyclosome (APC/C) regulate cell cycle? (6%)

37. *Rb* is a tumor suppressor gene. (a) In contrast to oncogenes whose mutations are normally not inherited, why can *Rb* mutation be inherited in a heterozygous manner? (5%) (b) What is “Loss of Heterozygosity”? (5%)

38. What is the function of a kinetochore? (5%)

39. What is the difference between “totipotent” and “multipotent”? (5%)

40. Anything you want to say after taking this course?