

Molecular Biology Midterm Exam 1

1. In an attempt to explain the laws of human heredity the Greek physician Alcmaeon suggested that genetic material was transmitted from different parts of the human body to the sperm and eggs which would then join to make an embryo. Which of the following theories most accurately describes Alcmaeon's views of heredity?

- A. Theory of Pangenesis
- B. Chromosomal Theory of Inheritance
- C. Germ Cell Theory
- D. The Blending Theory

2. Nearly 23 centuries after Alcmaeon's attempts to explain human heredity, August Weismann surgically removed the tails of mice (which were then mated) for 23 generations. Despite removing the tails prior to mating the progeny all had tails. Which of the following theories was put forth by Weismann to explain his findings and replace Alcmaeon's ideas?

- A. Theory of Pangenesis
- B. Germ Plasm Theory
- C. Chromosomal Theory of Inheritance
- D. Law of Independent Segregation

3. Gregor Mendel crossed pure breeding pea plants and analyzed the inheritance patterns of several different traits such as plant height, seed color and pod texture. His Law of Independent Segregation applies to which of the following?

- A. The inheritance pattern of two genes that lie close together on a single chromosome.
- B. The inheritance pattern of two alleles of the same gene.
- C. The inheritance pattern of two genes that reside on different chromosomes.
- D. The inheritance pattern of genes that lie on the X chromosome.

4. Mendel's Law of Independent Assortment applies to which of the following?

- A. The inheritance pattern of two genes that lie at opposite ends of a chromosome.
- B. The inheritance pattern of two alleles of the same gene.
- C. The inheritance pattern of two genes that reside on different autosomal chromosomes.
- D. The inheritance pattern of genes that lie on the X and Y chromosomes.

5. In flies eye development is governed by the eyeless gene. Flies that are either homozygous or heterozygous for the Ey allele have normal eyes while flies that are homozygous for the ey allele lack eyes. If Ey/ey males are mated to ey/ey females what percentage of the progeny will lack compound eyes?

- A. 0%
- B. 25%
- C. 50%
- D. 75%

6. The Notch gene controls the shape of the fly wing. The N allele is dominant and gives normal wings while the n allele is recessive and gives a small notch in the wing blade. Imagine that you are mating males that are homozygous for the n allele with females that are heterozygous for both alleles. While screening the progeny for wing shape you notice that 50% of the males and 50% of the females have notched wings. Where is the gene for wing shape located.

- A. On one of the three autosomes
- B. X chromosome
- C. Y chromosome
- D. cannot be determined with this level of information

7. In class we talked about a variety of peppers called stoplight peppers. They are named this way since they come in red, yellow and green varieties (brown peppers exist as well). Based on our class discussion which of the following best describes the inheritance of coat color?

- A. The multiple colors are the result of incomplete or co-dominance
- B. The gene for pepper color is located on the X chromosome so males and females produce different pepper colors.
- C. Multiple genes located on the autosomes regulate the color of peppers.
- D. The color of the pepper is not genetically regulated – the colors are determined by the environmental temperature.

8. A chromosome contains hundreds if not thousands of genes. Alfred Sturtevant used the process of recombination to determine the relative position of genes along the length of each Drosophila chromosome. Which of the following best describes the relationship between genes that are located on the same chromosome?

- A. Genes that reside close together on a chromosome recombine at a lower frequency than genes that are situated far apart from each other.
- B. Genes on the same chromosome follow Mendel's Law of Independent Assortment so the recombination rate is 100%.
- C. The distance between two genes is inversely proportional to the recombination/linkage rate.
- D. Recombination does not occur between genes on the same chromosome – only between genes on non-homologous chromosomes.

9. Seymour Benzer used bacteriophage to study the process of recombination. One of his major accomplishments was to determine that recombination occurs at the level of the nucleotide. Based on this information and your knowledge of the structure of DNA which of the following is a true statement?

- A. Recombination occurs only at nucleotides that lie between genes so as to prevent the induction of mutations.
- B. The process of recombination occurs only at nucleotides that line the major groove
- C. Recombination occurs only in DNA that is found in the Z conformation.
- D. Recombination can happen anywhere along the chromosome including within genes themselves.

10. When does recombination take place?

- A. Prophase of mitosis
- B. Prophase of Meiosis I
- C. Metaphase of Meiosis II
- D. G1 of both Meiosis I and Meiosis II

11. During class we introduced ourselves to a number of model systems. In these discussions we talked about a few of their properties and the types of processes that each model system is used to study. Based on these discussions which of the following would be the most appropriate for studying metastatic tumors?

- A. Drosophila
- B. C. elegans
- C. Mouse
- D. Arabidopsis

12. Which of the following model systems would be best suited for studying pain perception?

- A. C. elegans
- B. Drosophila
- C. Arabidopsis
- D. A and B

13. Which of the following would be the most appropriate model system for studying early developmental processes such as blastula formation in a vertebrate?

- A. Drosophila
- B. Mouse
- C. Xenopus
- D. C. elegans

14. Fredrick Griffith used two bacterial strains (one pathogenic and one non-pathogenic) and a mouse to discover the "Transforming Principle". Based on your knowledge of his experiments which of the following was the key experimental step in determining that the non-pathogenic (R) strain was transformed by hereditary material from the pathogenic (S) strain?

- A. Live non-pathogenic (R) and pathogenic (S) bacterial strains were mixed at a ratio of 1:5 prior to injection into the mouse.
- B. The pathogenic S strain was heat killed prior to mixing with the non-pathogenic R strain.
- C. A mouse that was resistant to the pathogenic S strain was selected for use in the experiment.
- D. The non-pathogenic (R) and pathogenic (S) strains were both heat killed prior to injection into the mouse.

15. Oswald Avery repeated Griffith's experiments but modified them to show that the transforming agent was actually nucleic acid. Based on your knowledge of his experiments what was the key step in determining that the hereditary material was nucleic acid?

- A. Nucleic acid was isolated from pathogenic (S) bacteria and mixed with the non-pathogenic (R) bacteria prior to injection into the mouse.
- B. Nucleic acid from live non-pathogenic (R) strains were removed and replaced with nucleic acid from pathogenic (S) strain. The genetically modified strain was then injected into the mouse.
- C. The genome of the non-pathogenic (R) strain was genetically modified to be nearly identical to that of the pathogenic (S) strain.
- D. Nucleic acid from pathogenic (S) bacteria was directly injected into the mouse.

16. Martha Chase and Alfred Hershey used bacteriophage and bacterial cells to independently determine that nucleic acids were the transforming agent. Based on your knowledge of their experiments what was the key step in determining that the nucleic acid is the hereditary material?

- A. DNA was marked with radio-labeled ribose and the protein coats were marked with radio-labeled amino acids
- B. The bacteriophages were heat killed prior to being mixed with the live bacterial cells.
- C. Nucleic acid from heat killed bacteriophages were injected into mice.
- D. The empty protein coats were removed from the bacterial cells after the nucleic acid genome was injected into the bacterial cells.

17. Several researchers have discovered that DNA is made up of four nucleotides: adenine, guanine, cytosine and thymine. Edwin Chargaff measured the amount of these four nucleotides from a variety of different cell types from several distinct model systems. Which of the following is a true statement?

- A. The ratio of purines to pyrimidines is 1:1
- B. The amount of each nucleotide is the same in all somatic and germ cells within an organism.
- C. Each cell type contains an equal amount of the four nucleotides.
- D. The amount of each nucleotide is the same in all cells within all model systems.

18. Watson and Crick solved the structure of DNA (with the help of Rosalind Franklin). From Edwin Chargaff's experiments and the solution of the DNA structure it was clear that the nucleotides base pair in very specific patterns. Which of the following base-pairing scenarios would violate the rules that govern the proper structure of the double helix?

- A. purine : pyrimidine
- B. A : T
- C. G : C
- D. purine : purine

19. Nucleotides along a single polynucleotide chain are bound by which of the following type of bond?

- A. Hydrogen bonds
- B. Phosphodiester bonds
- C. Covalent bonds
- D. Aldehyde linkages

20. Transcription factors bind to DNA and can either activate or repress transcription. Which part of the DNA double helix is contacted by the alpha helical segments of DNA binding proteins?

- A. The minor groove
- B. The deoxyribose sugar backbone
- C. The phosphodiester linkages
- D. The major groove

21. The structure of DNA differs slightly from that of RNA. Which of the following is a true statement regarding these structures?

- A. DNA uses a deoxyribose sugar while RNA uses a ribose sugar.
- B. DNA contains a thymine base while RNA contains a uracil base
- C. RNA is mainly single stranded while DNA is always found in a double helix
- D. all of the above

22. There are several species of RNA within a cell. Which of the following codes for protein?

- A. messenger RNA (mRNA)
- B. transfer RNA (tRNA)
- C. ribosomal RNA (rRNA)
- D. ribozymes

23. Which of the following blocks translation by binding to mRNA and forming local areas of double stranded RNA?

- A. ribozymes
- B. transfer RNA (tRNA)
- C. ribosomal RNA (rRNA)
- D. microRNAs

24. Which of the following RNAs are the predecessors to protein enzymes and can function as enzymes to cleave both RNA and protein?

- A. microRNAs
- B. ribozymes
- C. messenger RNAs (mRNA)
- D. transfer RNA (tRNA)

25. During what phase of the cell cycle does DNA replication occur?

- A. Interphase
- B. Prophase
- C. Metaphase
- D. Anaphase

26. During what phase of the cell cycle do chromosomes condense?

- A. Interphase
- B. Prophase
- C. Metaphase
- D. Telophase

27. Which of the following is key to physically separating chromosomes into daughter cells?

- A. Actin filaments
- B. Microtubule filaments
- C. The nucleus
- D. Mitochondria

28. At what point do cells exit from the cell cycle and go on to differentiate?

- A. G1
- B. S
- C. G2
- D. M

29. Down's Syndrome, Klinefelter's Syndrome and Turner's Syndrome are all chromosomal abnormalities. When do these mistakes in chromosomal segregation arise?

- A. Mitosis
- B. Meiosis I
- C. Meiosis II
- D. Meiosis I or II

30. What is the genetic make-up of an individual with Klinefelter's?

- A. XO
- B. XYY
- C. XXY
- D. OY

31. What would be the result if meiosis 2 were eliminated?

- A. The process of recombination or crossing-over will be eliminated
- B. The progeny will be haploid (1N)
- C. The progeny will be tetraploid or 4N
- D. There will be no change to the genetic make-up of the progeny (2N)

32. The DNA double helix is wound around histones. This allows for DNA to be condensed during cell division and for the inhibition of gene transcription. Which of the following is a true statement about histone - DNA interactions?

- A. Histones interact with DNA at the minor groove.
- B. Histone - DNA binding is based on charge interactions and not on recognition of specific DNA sequences.
- C. Modification of the histone N-terminal tail can alter histone - DNA binding.
- D. All of the above

33. What is the effect on the overall rate of transcription within a cell if the level of Histone Acetyl Transferase (HAT) proteins is reduced by mutations?

- A. Increase
- B. Decrease
- C. No change in transcription will be observed
- D. There will be localized increases at some genes and localized decreases at other genes.

34. What would be the effect on the overall rate of transcription within a cell if the levels of Histone DeAcetylase (HDAC) proteins were increased?

- A. Increase
- B. Decrease
- C. No change in transcription will be observed
- D. There will be localized increases at some genes and localized decreases at other genes.

35. In the article “In the beginning....” Stanley Miller is described as testing the hypothesis that life began in the atmosphere. He passed an electric current through a flask containing boiling water and several gases that were thought to exist during the earliest times on Earth. Which of the following molecules were created in this experiment?

- A. nucleic acids
- B. amino acids
- C. lipids
- D. primitive organelles

36. In the article entitled “Nearly there...” Craig Venter is credited with creating the first artificial organism. Which of the following are true statements from the article?

- A. Venter inserted a recreated version of the *M. genitalium* genome into a bacterial cell that had its own DNA removed.
- B. Venter wants to determine the “minimal genome” – a bacterial cell with only the genes absolutely necessary for survival and reproduction.
- C. Synthetic bacteria can be used to produce molecular products such as fuels for cars and jets.
- D. All of the above

37. Based on your understanding of the article entitled “Cavemen, Chimps and Us” which of the following statements is true?

- A. Neanderthals and modern humans share a common ancestor that lived about 400,000 years ago while humans and chimpanzees have been evolving apart for nearly 5-7 million years.
- B. The recent divergence of Neanderthals and modern humans means that there are very few differences between the two genomes.
- C. The few differences between the Neanderthal and human genomes should be responsible for traits such as language, brain size and higher order thinking.
- D. All of the above

38. In the article entitled “Close cousins” it is argued that humans could have interbred with chimpanzees at some point in the distant past. Which of the following is used to support this conclusion?

- A. The X chromosomes of humans and chimpanzees are more similar than the non-sex chromosomes which suggests that viable human-chimp hybrids existed.
- B. The fossil record indicates that a skull dated to be between 6m and 7.4m years old has human-like features.
- C. An analysis of the human and chimp genome indicates there are regions of very high sequence similarity.
- D. All of the above

39. In the article entitled “The origin of speakies” it is suggested that Neanderthals can speak. Which of the following is evidence that is may in fact be true?

- A. Neanderthals had a hyoid bone which is important in tongue and larynx movement.
- B. Neanderthals had a large hypoglossal canal which is used by nerves to enervate the tongue.
- C. Neanderthals had a copy of the FOXP2 gene which is thought to be important for speech and language in modern humans.
- D. All of the above

40. Which team do you want to win the Super Bowl? In Las Vegas the Packers are favored over the Steelers by 2.5 points. I am curious to see what the spread is here in Bloomington. (you will get credit for either answer).

- A. Pittsburgh Steelers
- B. Green Bay Packers

EXAM 1 ANSWER KEY

1. A
2. B
3. B
4. C
5. C
6. D
7. C
8. A
9. D
10. B
11. C
12. D
13. C
14. B
15. A
16. D
17. A
18. D
19. B
20. D
21. D
22. A
23. D
24. B
25. A
26. B
27. B
28. A
29. D
30. C
31. C
32. D
33. B
34. B
35. B
36. D
37. D
38. D
39. D
40. A and B