***iGenetics: A Molecular Approach***

**DNA: The Genetic Material**

MATCHING

**Please select the best match for each term.**

A) The basic structural unit of chromatin with "bead-on-a-string" morphology

B) The region of a eukaryotic chromosome found near the attachment point of mitotic or meiotic spindle fibers

C) A DNA molecule and associated proteins

D) The constituent monomer of DNA and RNA

E) The region of a prokaryotic cell where the chromosome is located

1) Centromere

2) Nucleoid

Skill: Factual recall

3) Nucleotide

Skill: Factual recall

4) Chromosome

5) Nucleosome

Answers: 1) B 2) E 3) D 4) C 5) A

MULTIPLE CHOICE

6) Loosely aggregated DNA bound to proteins in a eukaryotic cell is called

A) chromosomes.

B) chromatin.

C) chromatid.

D) centromere.

E) nucleoid.

Answer: B

7) The C-value is the amount of DNA in a

A) haploid genome.

B) diploid genome.

C) bacterial genome.

D) eukaryotic genome.

E) cell's nucleus.

Answer: A

8) The chromosome of most prokaryotes differs from those of eukaryotes in that

A) the prokaryotic chromosome is linear, while the eukaryotic chromosome is circular.

B) the prokaryotic chromosome is circular, while the eukaryotic chromosome is linear.

C) the prokaryotic chromosome does not replicate before mitosis, while the eukaryotic chromosome does.

D) the prokaryotic chromosome does not contain genes, while the eukaryotic chromosome does.

E) the prokaryotic chromosome is not necessary for the organism's survival, while the eukaryotic chromosome is.

Answer: B

9) A Barr body is an example of

A) constitutive euchromatin.

B) facultative euchromatin.

C) facultative heterochromatin.

D) a nucleosome.

E) constitutive heterochromatin.

Answer: C

10) The definition of transformation is

A) the shift of genetic information from DNA to protein.

B) the genetic alteration of an organism.

C) the uptake of genetic information by a cell from the environment.

D) Both B and C

E) None of these

Answer: D

11) In Griffith's experiment involving the transformation of *Streptococcus pneumoniae*,

A) the *R* strain was virulent.

B) the *S* strain was virulent.

C) both the *R* and *S* strains were virulent.

D) the *R* strain had a protein capsule.

E) the *S* strain had a protein capsule.

Answer: B

12) What was the transforming principle isolated in Griffith's experiment?

A) Protein

B) RNA

C) DNA

D) Virus

E) Polysaccharide

Answer: C

13) Who used radioactively labeled T2 bacteriophage to confirm the identity of the transforming principle?

A) Griffith

B) Hershey and Chase

C) Avery

D) Gierer and Schramm

E) Beadle and Tatum

Answer: B

14) Which part of the T2 bacteriophage entered *E. coli* cells in the experiment which confirmed the identity of the transforming principle?

A) The RNA

B) The DNA

C) The whole virus

D) The protein coat

E) No part

Answer: B

15) Certain \_\_\_\_\_\_\_\_ have RNA for their genetic material.

A) bacteria

B) viruses

C) plants

D) eukaryotes

E) prokaryotes

Answer: B

16) What did the X-ray diffraction patterns *initially* reveal about the DNA molecule?

A) It is of uniform diameter and has a helical structure.

B) It is a helical molecule with paired bases in the center.

C) It is double-stranded with antiparallel strands.

D) It is acidic, phosphorus-rich, and large.

E) It contains hereditary information.

Answer: A

17) What did Watson and Crick deduce about the three-dimensional structure of DNA?

A) There is a repeating pattern every 3.4 nm and every 0.34 nm.

B) It is a double-stranded helix.

C) It contains a lot of phosphorus.

D) It is a large molecule.

E) It consists of supercoiled chromatin.

Answer: B

18) Which of the following is a nonhistone protein found in chromatin?

A) H1

B) HMG

C) H2A

D) H5

E) All of these

Answer: B

19) Antiparallel means that

A) the two polynucleotide chains run in opposite directions.

B) each DNA molecule consists of one old and one new strand.

C) opposite strands are held together by base pairing.

D) the helix twists to the right.

E) there is complementary base-pairing.

Answer: A

20) Complementary base-pairing allows for

A) spontaneous mutations to occur.

B) genes to be expressed as a phenotype.

C) DNA to serve as its own template for replication.

D) replication to be semiconservative.

E) covalent bonds to form between the opposite bases.

Answer: C

21) Which of the following are the purine nucleotides in DNA?

A) Adenine and thymine

B) Cytosine and guanine

C) Adenine and cytosine

D) Guanine and adenine

E) Thymine and uracil

Answer: D

22) Topoisomerases function to

A) remove nucleotides from DNA.

B) join DNA pieces together.

C) twist DNA molecules.

D) attach DNA loops to scaffold proteins.

E) move chromosomes along spindle fibers.

Answer: C

23) Which form of DNA is a left-handed double helix?

A) A-DNA

B) B-DNA

C) L-DNA

D) R-DNA

E) Z-DNA

Answer: E

24) The displacement loop (D-loop) may be a characteristic of

A) centromeres.

B) telomeres.

C) A-DNA.

D) B-DNA.

E) Z-DNA.

Answer: B

25) Which nucleotide is absent in RNA?

A) Adenine

B) Guanine

C) Uracil

D) Cytosine

E) Thymine

Answer: E

TRUE/FALSE

26) DNA and RNA both contain phosphate and ribose.

Answer: FALSE

Explanation: They both contain phosphate, but DNA contains the sugar deoxyribose rather than ribose.

27) Hershey and Chase used radioactive sulfur to label the genetic material of bacteriophages.

Answer: FALSE

Explanation: The radioactive sulfur labeled the protein coat.

28) In a strand of DNA, a hydrogen bond connects the phosphate group of one nucleotide to the sugar of the adjacent nucleotide.

Answer: FALSE

Explanation: A covalent phosphodiester bond connects the two adjacent nucleotides.

29) The genome of the T-even family of bacteriophage consists of single-stranded RNA.

Answer: FALSE

Explanation: It consists of double-stranded DNA.

30) *Borrelia burgdorferi* is a bacterium whose genome consists of one large and several small linear chromosomes.

Answer: TRUE

31) By weight, the amount of DNA in chromatin is less than that of histone.

Answer: FALSE

Explanation: The weights of DNA and histone in chromatin are equal.

32) The virus first shown to have RNA as its genetic material was tobacco mosaic virus (TMV).

Answer: TRUE

33) The more condensed a part of a chromosome is, the more likely it is that the genes in that region will be active.

Answer: FALSE

Explanation: The genes in a region are less likely to be active the more condensed a part of a chromosome is.

34) The genome of most prokaryotes consists of moderately repetitive DNA.

Answer: FALSE

Explanation: The genome of most prokaryotes consists of unique-sequence DNA.

35) In eukaryotes, the greatest relative amount of tandemly repeated DNA is associated with centromeres and telomeres.

Answer: TRUE

SHORT ANSWER

36) In Griffiths' transformation experiments, under what conditions did the injected mice die?

Answer: The mice died when they were injected with living, virulent bacteria, and when they were injected with living, nonvirulent bacteria mixed with heat-killed, virulent bacteria.

37) How could you test whether the transforming ability of a cell extract was due to DNA or RNA?

Answer: You could treat the extract with a DNase or RNase enzyme and test whether its transforming ability was intact.

38) One of the strands in a DNA double helix has the nucleotide sequence 5'-ACCTGCTACGG-3'. What is the sequence of the complementary DNA strand?

Answer: 3'-TGGACGATGCC-5'

39) What is the function of dispersed repeated sequences such as SINEs and LINEs in eukaryotes?

Answer: Little is known about the function of such sequences, but one hypothesis is that they have no function at all. Another is that they are involved in regulating gene expression.

40) What is the C-value paradox, and what is its cause?

Answer: There is also no direct relationship between the C-value (the total amount of DNA in the haploid genome) and the structural or organizational complexity of the organism. This is due in part to the amount of repetitive-sequence DNA found in the genome of some organisms.

41) Define Chargaff's rules of the base composition of DNA.

Answer: Chargaff's rules include the following: (1) the amount of adenine = the amount of thymine, (2) the amount of guanine = the amount of cytosine, and (3) the amount of purines = the amount of pyrimidines.

42) Describe the differences between heterochromatin and euchromatin in chromosomes. Are there any situations in which one can be changed into the other?

Answer: Euchromatin contains actively transcribed genes and undergoes normal cycles of condensation and decondensation in the cell cycle. Heterochromatin remains condensed and contains genes that are usually transcriptionally inactive. Euchromatin can be inactivated, as in the case of Barr bodies. It is then known as facultative heterochromatin.

43) What are the three necessary characteristics of the hereditary molecule in cells?

Answer: (1) It must be able to carry information, (2) it must be able to accurately pass on the information to progeny cells (replicate), and (3) it must be capable of change (evolution).

44) Name the constituent parts of a nucleoside and a nucleotide.

Answer: A nucleoside consists of a pentose sugar covalently bonded to a nitrogenous base; a nucleotide is a nucleoside with the addition of a phosphate group.

45) The DNA phage ΦΧ174 was found to have a ratio of bases of 25A:33T:24G:18C. This departs from the usual A/T = 1 and G/C = 1 ratios. How can you explain this?

Answer: The genome of the phage consists of single-stranded, rather than double-stranded, DNA.

46) If the human egg has 3 billion base pairs, how many nucleosomes will be present in the nucleus of a human somatic cell?

Answer: In humans, the DNA wrapped around each nucleosome is approximately 200 bp (147 bp + 53 bp linker). As such, there will be approximately 3 × 109/2 × 102 = 1.5 × 107 nucleosomes in a human egg nucleus. However, the egg is haploid, whereas the somatic cells are diploid. Therefore, there will be approximately 1.5 × 107 × 2 = 3 × 107 nucleosomes in the nucleus of a human somatic cell.

47) Why are the amino acid sequences of eukaryotic histones so similar to one another, even among distantly related species?

Answer: Evolutionary conservation of these sequences is a strong indicator that histones perform the same basic role in organizing the DNA in the chromosomes of all eukaryotes.

48) Describe the packing of chromatin from the 10-nm to the 30-nm fiber stage. What is the role of histones?

Answer: 10-nm chromatin fiber consists of nucleosomes–"beads" of DNA wound around eight core histone proteins–connected by strands of linker DNA. The 30-nm chromatin fiber is created by the binding of histone H1, which brings the linker DNA and the nucleosomes closer together. In the solenoid model of the 30-nm fiber, the nucleosomes are brought together into a spiraling helical structure, with about six nucleosomes per complete turn.

49) What is the role of centromeres and telomeres?

Answer: Centromeres are the chromosomal regions where mitotic or meiotic spindle fibers attach. They are therefore responsible for the accurate segregation of chromosomes to daughter cells during replication. Telomeres are heterochromatic regions of chromosomes that are also required for replication and stability. They are usually found at the ends of the chromosome and are associated with the nuclear envelope.

50) If the base pairs in a DNA helix are 0.34 nm apart, and a complete (360°) turn of the helix takes 3.4 nm, how many base pairs per turn are there in a DNA molecule?

Answer: There are 10 base pairs per turn.