

Chapter 6: Molecular Basis of Inheritance

NCERT Exemplar · Class 12 · Biology

Multiple Choice Questions

Question 1

In a DNA strand the nucleotides are linked together by:

A.

glycosidic bonds

B.

phosphodiester bonds

C.

peptide bonds

D.

hydrogen bonds

Answer

Correct option: B

Solution

Ans: (b) phosphodiester bonds

A dinucleotide is made up of two nucleotides joined together by a 3'5' phosphodiester bond. To construct a polynucleotide chain, more nucleotides are connected in a similar way.

Question 2

A nucleoside differs from a nucleotide. It lacks the:

A.

base

B.

sugar

C.

phosphate group

D.

hydroxyl group

Answer

Correct option: C

Solution

Ans: (c) phosphate group

A pento is linked to a purine or pyrimidine base. A nucleoside is a sugar that is either ribose or deoxyribose. A nucleotide is a sugar that has one or more phosphate groups connected to it.

Question 3

Both deoxyribose and ribose belong to a class of sugars called:

A.

trioses

B.

hexoses

C.

pentoses

D.

polysaccharides

Answer

Correct option: C

Solution

Ans: (c) pentoses

Both deoxyribose and ribose belong to the Pentoses sugar family. The sugar molecule pentose has five carbons.

Question 4

The fact that a purine base is always paired through hydrogen bonds with a pyrimidine base leads to, in the DNA double helix:

A.

the antiparallel nature

B.

the semiconservative nature

C.

uniform width throughout DNA

D.

uniform length in all DNA

Answer

Correct option: C

Solution

Ans: (c) uniform width throughout DNA

Purine always couples with pyrimidine to provide stability to the DNA strand. Because the sizes of the two bases differ, the arrangement is such that the bigger base forms a bond with a smaller base, making DNA 2nm thick and providing a uniform width to DNA throughout its length.

Question 5

The net electric charge on DNA and histones is:

A.

both positive

B.

both negative

C.

negative and positive, respectively

D.

zero

Answer

Correct option: C

Solution

Ans: (c) negative and positive, respectively

A nucleosome is formed when negatively charged DNA is wrapped around positively charged histone. This explains the nucleus's ability to pack so much DNA into such a compact region.

Question 6

The promoter site and the terminator site for transcription are located at:

A.

3'

(downstream) end and

5'

(upstream) end, respectively of the transcription unit

B.

5'(\[upstream

)] end and

3'

(downstream) end, respectively of the transcription unit

C.

the

5'

(upstream) end

D.

the

3'

(downstream) end

Answer

Correct option: B

Solution

Ans: (b)

5'

(upstream) end and

$3'$

(downstream) end, respectively of the transcription unit

As transcription continues from

 $5'$

to

 $3'$

, the promoter sequence should be in front of upstream of the start site in the

 $5'$

end, and the terminator sequence should be in the

 $3'$

end downstream.

Question 7

Which of the following statements is the most appropriate for sickle cell anaemia?

A.

It cannot be treated with iron supplements

B.

It is a molecular disease

C.

It confers resistance to acquiring malaria

D.

All of the above

Answer

Correct option: D

Solution

Ans: (d) All of the above

Because sickle cell anemia is an inherited condition, iron supplementation will not help. In persons with sickle cell anemia, the altered structure of RBCs confers malaria resistance.

Question 8

One of the following is true with respect to AUG

A.

It codes for methionine only

B.

It is also an initiation codon

C.

It codes for methionine in both prokaryotes and eukaryotes

D.

All of the above

Answer

Correct option: D

Solution

Ans: (d) All of the above

The initiation code is the first codon of a messenger RNA (mRNA) transcript translated by a ribosome, and it is one of the genetic codes. The start codon is ubiquitous and codes for methionine, an amino acid, in both prokaryotes and eukaryotes.

Question 9

The first genetic material could be:

A.

protein

B.

carbohydrates

C.

DNA

D.

RNA

Answer

Correct option: D

Solution

Ans: (d) RNA

There are numerous convincing pieces of evidence that RNA was the earliest genetic substance. However, as a catalyst, RNA proved reactive and unstable. As a result, DNA became a genetic material in the living world.

Question 10

With regard to mature mRNA in eukaryotes:

A.

exons and introns do not appear in the mature RNA

B.

exons appear but introns do not appear in the mature RNA

C.

introns appear but exons do not appear in the mature RNA

D.

both exons and introns appear in the mature RNA

Answer

Correct option: B

Solution

Ans: (b) exons appear but introns do not appear in the mature RNA

Introns, also known as intervening sequences or noncoding sequences, are additional regions found in eukaryotic transcripts. They aren't found in either mature or processed RNA. Exons are the functional coding sequences. Splicing is the process of removing introns and joining exons to create functional RNAs.

Question 11

The human chromosomes with the highest and least number of genes in them are respectively:

A.

Chromosome 21 and Y

B.

Chromosome 1 and X

C.

Chromosome 1 and Y

D.

Chromosome X and Y

Answer

Correct option: C

Solution

Ans: (c) Chromosome 1 and Y

There are 2968 genes on chromosome 1 and 231 genes on chromosome Y.

Question 12

Who amongst the following scientists had no contribution in the development of the double-helix model for the structure of DNA?

A.

Rosalind Franklin

B.

Maurice Wilkins

C.

Erwin Chargaff

D.

Meselson and Stahl

Answer

Correct option: D

Solution

Ans: (d) Meselson and Stahl

The X-ray diffraction data of DNA was created by Rosalind Franklin and Maurice Wilkins, and Erwin Chargaff presented two rules based on thorough experimentation that helped lead to the discovery of the double helix structure of DNA, known as the Chargaff rules. Meselson and Stahl were not involved

in the creation of the double helix, but they were involved in the testing of the semi-conservative character of DNA replication.

Question 13

DNA is a polymer of nucleotides that are linked to each other by a



phosphodiester bond. To prevent polymerization of nucleotides, which of the following modifications would you choose?

A.

Replace purine with pyrimidines

B.

Remove/Replace



group in deoxyribose

C.

Remove/Replace



group with some other group in deoxyribose

D.

Both '

B

' and '

C

,

Answer

Correct option: B

Solution

Ans: (b) Remove/Replace



group in deoxyribose

If the



group in deoxyribose is deleted or replaced, no phosphodiester linkages are formed, and so nucleotide polymerization is blocked.

Question 14

Discontinuous synthesis of DNA occurs in one strand, because:

A.

DNA molecule being synthesized is very long

B.

DNA dependent DNA polymerase catalyzes polymerization only in one direction (5'



)

C.

it is a more efficient process

D.

DNA ligase has to have a role

Answer

Correct option: B

Solution

Ans: (b) DNA dependent DNA polymerase catalyzes polymerization only in one direction (5'

→ 3'

)

Polymerization is only catalyzed in one direction by DNA-dependent DNA polymerases, which is 5'3. At the replicating fork, this adds a layer of complexity. As a result, replication is continuous on one strand (the template with polarity 3 5) but discontinuous on the other (the template with polarity 53). The enzyme DNA ligase joins the fragments that are synthesizing intermittently.

Question 15

Which of the following steps in transcription is catalyzed by RNA polymerase?

A.

Initiation

B.

Elongation

C.

Termination

D.

All of the above

Answer

Correct option: D

Solution

Ans: (d) All of the above

In bacteria, a single DNA-dependent RNA polymerase catalyzes the transcription of all kinds of RNA. The promoter is bound by RNA polymerase, which starts transcription (Initiation). It polymerizes in a template-dependent manner using nucleoside triphosphates as a substrate, following the complementarity rule. It also aids in the opening of the helix and promotes elongation. Only a little portion of the RNA is still linked to the enzyme. The nascent RNA and the RNA polymerase both fall off once the polymerases reach the terminator region. Transcription is halted as a result of this. Only the elongation phase can be catalyzed by the RNA polymerase. It forms transitory associations with initiation-factor () and termination-factor () to start and stop transcription, respectively. The RNA polymerase's selectivity to initiate or terminate is altered when it interacts with certain factors.

Question 16

Control of gene expression takes place at the level of:

A.

DNA-replication

B.

Transcription

C.

Translation

D.

None of the above

Answer

Correct option: B

Solution

Ans: (b) Transcription

The initial stage in gene expression is transcription. A specific region of DNA is transcribed into mRNA during this process. As a result, it regulates gene expression.

Question 17

Regulatory proteins are the accessory proteins that interact with RNA polymerase and affect its role in transcription. Which of the following statements is correct about regulatory protein?

A.

They only increase expression

B.

They only decrease expression

C.

They interact with RNA polymerase but do not affect the expression

D.

They can act both as activators and as repressors

Answer

Correct option: D

Solution

Ans: (d) They can act both as activators and as repressors

Regulatory proteins have an impact on RNA's ability to recognize initiation sites. Both negative (repressor) and positive (activator) roles are played by regulatory proteins.

Question 18

Which was the last human chromosome to be completely sequenced:

A.

Chromosome 1

B.

Chromosome 11

C.

Chromosome 21

D.

Chromosome

X

Answer

Correct option: A

Solution

Ans: (a) Chromosome 1

The Human Genome Project was a megaproject that began in 1990 with the goal of sequencing all

$$3 \times 10^9$$

base pairs of the human genome. Because chromosome 1 has the most genes

(2968)

, it was the last human chromosome to be sequenced entirely.

Question 19

Which of the following are the functions of RNA?

A.

It is a carrier of genetic information from DNA to ribosomes synthesizing polypeptides.

B.

It carries amino acids to ribosomes.

C.

It is a constituent component of ribosomes.

D.

All of the above.

Answer

Correct option: D

Solution

Ans: (d) All of the above.

mRNA transports genetic information from DNA to ribosomes for polypeptide chain synthesis. Amino acids are carried by tRNA to mRNA for translation. Ribosomes require rRNA to function properly.

Question 20

While analyzing the DNA of an organism a total number of 5386 nucleotides were found out of which the proportion of different bases were: Adenine = 29%, Guanine = 17%, Cytosine = 32%, Thymine = 17%. Considering Chargaff's rule, it can be concluded that:

A.

it is a double-stranded circular DNA

B.

It is single-stranded DNA

C.

It is a double-stranded linear DNA

D.

No conclusion can be drawn

Answer

Correct option: B

Solution

Ans: (b) It is single-stranded DNA

According to Chargaff's guidelines, DNA from any cell of any organism should have a 1:1 ratio of pyrimidine and purine bases (base Pair Rule). This means that the amounts of guanine and cytosine are equal, and the amounts of adenine and thymine are equal. This pattern can be found on both DNA strands. The percentages of adenine and guanine are not equal in this example, and the same is true for cytosine and thymine. As a result, it's single-stranded DNA.

Question 21

In some viruses, DNA is synthesized by using RNA as a template. Such a DNA is called:

A.

A-DNA

B.

B-DNA

C.

C DNA

D.

r DNA

Answer

Correct option: C

Solution

Ans: (c) C DNA

In a synthesis catalyzed by the enzyme reverse transcriptase, complementary DNA (cDNA) is double-stranded DNA generated from a messenger RNA (mRNA) template.

Question 22

If Meselson and Stahl's experiment is continued for four generations in bacteria, the ratio of

$$^{15}\text{N}/^{15}\text{N} : ^{15}\text{N}^{14}\text{N} : ^{14}\text{N}^{14}\text{N}$$

containing DNA in the fourth generation would be:

A.

$$1:1:0$$

B.

$$1 : 4 : 0$$

C.

$$0 : 1 : 3$$

D.

$$0:1:7$$

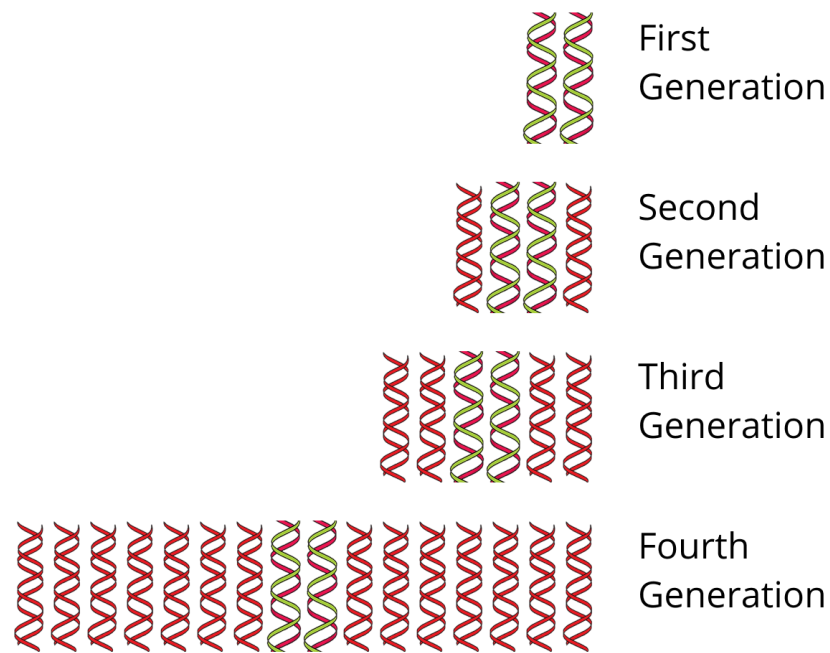
Answer

Correct option: D

Solution

Ans: (d) 0:1:7

In the following generation, the $^{15}\text{N}/^{15}\text{N}$ ratio remains zero. The $^{15}\text{N}/^{14}\text{N}$ ratio remains constant (one), whereas the $^{14}\text{N}/^{14}\text{N}$ ratio rises. This is depicted in the diagram below.



Question 23

If the sequence of nitrogen bases of the coding strand of DNA in a transcription unit is:



the sequence of bases in its RNA transcript would be;

A.



B.



C.



D.



Answer

Correct option: A

Solution

Ans: (a)



The process of converting DNA to RNA is known as translation. It consists of coding and template strands of DNA, with the template strand becoming RNA and following the base-pairing rule except in the RNA strand, where uracil replaces thymine. We have coding strand-ATGAATG in the question.

So, the template strand is TACTTAC

As a result, the RNA strand-AUGAAUG

Question 24

The RNA polymerase holoenzyme transcribes:

A.

the promoter, structural gene, and the terminator region

B.

the promoter, and the terminator region

C.

the structural gene and the terminator regions

D.

the structural gene only.

Answer

Correct option: D

Solution

Ans:

(d)

the structural gene only

Transcription is divided into three stages: start, elongation, and termination. When the RNA polymerase binds to the promoter, which is solely used as a binding site for the RNA polymerase and is not transcribed, initiation begins. Each gene has its own promoter region that directs the start of transcription. This is followed by a transcribed gene section (structural gene) and finally a terminator that stops transcription.

Question 25

If the base sequence of a codon in mRNA is

$5' - AUG - 3'$

, the sequence of tRNA pairing with it must be:

A.

$5' - UAC - 3'$

B.

$5' - CAU - 3'$

C.

$5' - AUG - 3'$

D.

$5' - GUA - 3'$

Answer

Correct option: B

Solution

Ans: (b)

 $5' -$

CAU

 $-3'$

In the

 $5' - 3'$

direction, the first base of the anticodon binds to the third base of the codon (reading in the

 $5' - 3'$

direction). The complementary anticodon will be

 $3' - UAC - 5'$

or

 $5' - CAU - 3'$

if the nucleotide sequence in the mRNA codon is

 $5' - AUG - 3'$

.

Question 26

The amino acid attaches to the tRNA at its:

A. $5'$

-end

B.

3^1

- end

C.

Anti-codon site

D.

DHU loop

Answer

Correct option: B

Solution

Ans:

 $(b)3'$

- end

The anticodon loop on tRNA has bases that are complementary to the coding, and the amino acid acceptor end binds to amino acids. In tRNAs, the site is located at the

 $3'$

end opposite the anticodon and is unique to each amino acid.

Question 27

To initiate translation, the mRNA first binds to:

A.

The smaller ribosomal subunit,

B.

The larger ribosomal sub-unit

C.

The whole ribosome

D.

No such specificity exists.

Answer

Correct option: A

Solution

Ans: (a) The smaller ribosomal sub-unit

The ribosome is the cellular factory in charge of protein synthesis. The ribosome is made up of around 80 distinct proteins and structural RNAs. It has two subunits in its inactive state: a large subunit and a small subunit. When the small subunit comes into contact with an mRNA, the mRNA to protein translation process begins.

Question 28

In E. coli, the lac operon gets switched on when:

A.

lactose is present and it binds to the repressor

B.

repressor binds to the operator

C.

RNA polymerase binds to the operator

D.

lactose is present and it binds to RNA polymerase

Answer

Correct option: A

Solution

Ans: (a) lactose is present and it binds to the repressor

Lactose is a stimulant. It attaches to the repressor protein and activates the operon.

Very Short Answer Questions

Question 1

What is the function of histones in DNA packaging?

Solution

Ans: Histones are a type of protein that is extremely alkaline. The nucleus of eukaryotic cells contains them. Histones wrap and organize DNA into nucleosomes, which are structural units. They function as spools around which DNA is wound, allowing a lengthy strand of DNA to fit into a much smaller space. As a result, a 1.8m strand of DNA is spooled to form a structure that is only 90 microns in size.

Question 2

Distinguish between heterochromatin and euchromatin. Which of the two is transcriptionally active?

Solution

Ans: Differences between heterochromatin and euchromatin are:

Heterochromatin	Euchromatin
They are darkly staining and are dispersed or gathered near the nuclear envelope.	Euchromatin is not willingly stainable and is dispersed.
These are transcriptionally less active or sedentary.	These are transcriptionally energetic.

Question 3

The enzyme DNA polymerase in *E. coli* is a DNA-dependent polymerase and also has the ability to proofread the DNA strand being synthesized. Explain. Discuss the dual polymerase.

Solution

Ans: DNA polymerase is dubbed DNA – dependent because it catalyzes the polymerization of deoxynucleotides using a DNA template. When a fresh strand of DNA is digested, this enzyme advances forward to speed up the polymerization process. It also "proofreads" the strand as it is being created. It helps to speed up the process by doing so. As a result, it has a dual nature, in that it reads the template before proofreading the new strand.

Question 4

What is the cause of the discontinuous synthesis of DNA on one of the parental strands of DNA? What happens to these short stretches of synthesized DNA?

Solution

Ans: Only one mode of polymerization is catalyzed by DNA polymerase, namely 5' – 3'. As a result, replication occurs continuously on one strand (3'-5'), but not on the other (5'– 3'). DNA ligase is used to unite the fragments that are not connected.

Question 5

Given below is the sequence of the coding strand of DNA in a transcription unit 3'-AATGCACTATTAGG-5'

Write the sequence of:

(a) its complementary strand

Solution

Ans: 5'-TTACGTCGATAACC-3'

(b) the mRNA

Ans: 5'-UUACGUCGAUAACC-3'

Question 6

What is DNA polymorphism? Why is it important to study it?

Solution

Ans: DNA polymorphism occurs when an inheritable mutation emerges in a population at a high frequency. Because inheritable mutations eventually contribute to evolution, studying DNA polymorphism is crucial from an evolutionary standpoint.

Question 7

Based on your understanding of genetic code, explain the formation of any abnormal hemoglobin molecule. What are the known consequences of such a change?

Solution

Ans: HbA, HbA₂, and HbF are the three kinds of hemoglobin found in humans. The HbS type of hemoglobin is formed when the genes for the beta chain on hemoglobin are altered. Sickle cell anemia is caused by this kind of hemoglobin molecule.

Question 8

Sometimes cattle or even human beings give birth to their young ones that are having extremely different sets of organs like limbs/position of the eye(s) etc. Comment.

Solution

Ans: The presence of several organs in an animal is caused by a disruption in the coordinated regulation of gene expression.

Question 9

In a nucleus, the number of ribonucleotide triphosphates is 10 times the number of deoxyribonucleotide triphosphates, but only deoxyribonucleotides are added during the DNA replication. Suggest a mechanism.

Solution

Ans: Only deoxyribonucleoside triphosphates are recognized by DNA polymerase, which is highly specific. As a result, it is unable to retain RNA nucleotides.

Question 10

Name a few enzymes involved in DNA replication other than DNA polymerase and ligase. Name the key functions for each of them.

Solution

Ans: Other enzymes and their primary roles are listed below:

- (a) Primase is a protein that attaches RNA primers to template strands. The RNA primer is removed by RNase.
- (b) Exonuclease: Starts nucleotide cleavage one at a time.

Question 11

Name any three viruses which have RNA as the genetic material.

Solution

Ans: Following viruses have RNA as genetic material: Ebola

- (a) virus
- (b) Tobacco Mosaic Virus
- (c) SARS

Short Answer Questions

Question 1

Define transformations in Griffith's experiment. Discuss how it helps in the identification of DNA as the genetic material.

Solution

Ans: Bacteria changed their physical form throughout Griffith's experiment. The phrase for this was "transformation." The DNA of the *S* strain bacteria survived the heating of bacteria in this experiment. The mice died of pneumonia after being injected with a mixture of deceased *S* and *R* strains. This demonstrated that DNA has the ability to survive harsh conditions and manifest itself when favorable conditions returned. For a material to be regarded as genetic material, it must be stable and long-lived. Thus, in Griffith's experiment, transformation aided in the identification of DNA as genetic material.

Question 2

Who revealed the biochemical nature of the transforming principle? How was it done?

Solution

Ans: Experiments by Oswald Avery, Colin Macleod, and Maclyn McCarty (1933-44) revealed the biochemical nature of the transformative principle. The heat-killed *S* cells were purified for biochemicals (proteins, DNA, and RNA). They were testing to determine which of them could change the *R* strain. As a result, they discovered that whereas protein-digesting enzymes (proteases) and RNA-digesting enzymes (RNases) had no effect on transformation, DNase did. As a result, they came to the conclusion that it was the DNA that had the ability to change the R strain.

Question 3

Discuss the significance of heavy isotope of nitrogen in the Meselson and Stahl's experiment.

Solution

Ans: Meselson and Stahl used the heavy isotope of nitrogen in their experiment for a variety of reasons. Centrifugation in a Cesium chloride (CsCl) density gradient allowed the heavy DNA molecule (carrying ^{15}N) to be easily separated from regular DNA. On the basis of density, it could be easily distinguished from lighter nitrogen (^{14}N). The use of lighter and heavier nitrogen simplified the challenge of determining DNA transfer via successive generations.

Question 4

Define a cistron. Giving examples differentiate between monocistronic and polycistronic transcription units.

Solution

Ans: A cistron is a piece of DNA that codes for a polypeptide. A cistron is a type of gene. Monocistronic refers to a stretch of replicating DNA that contains only one cistron (or gene), as seen in eukaryotes. Polycistronic refers to a stretch of replicating DNA that contains more than one cistron, as seen in bacteria and prokaryotes.

Question 5

Give any six features of the human genome.

Solution

Ans: The human genome has six distinct characteristics:

- There are 3164.7 million nucleotides in the human genome.
- In the human genome, the typical gene has 3000 bases. It is estimated that there are 30,000 genes in all.
- Nucleotides are nearly identical in all humans (approximately 99.9%).
- Protein is coded for in less than 2% of the genome.

- Most genes (2968) are found on chromosome 1, whereas the fewest are found on chromosome Y. (231).

Question 6

During DNA replication, why is it that the entire molecule does not open in one go?

Explain replication fork. What are the two functions that the monomers (dNTPs) play?

Solution

Ans: DNA replication is a tremendously energy-intensive process that necessitates a lot of it. As a result, the most practicable method is to copy DNA segments one by one. As a result, the full DNA molecule does not open at the same time.

The replication fork is a tiny opening in the DNA helix where DNA replication takes place. A replication fork is a name for this opening.

NTPs (nucleotide triphosphates) are monomers that contain a nucleotide bonded to three phosphates. The NTPs found in DNA are referred to as dNTPs. They are the fundamental components of life. They play a crucial part in a variety of metabolic processes.

Question 7

Retroviruses do not follow central Dogma. Comment.

Solution

Ans: The core dogma in molecular biology was proposed by Francis and Crick. Genetic information goes from DNA through RNA to Protein, according to this theory. Genetic information travels in the reverse direction in retroviruses, i.e., Protein RNA DNA. As a result, retroviruses are considered to defy fundamental dogma. Retroviruses use a technique known as reverse transcription since the steps are performed in the opposite order.

Question 8

In an experiment, DNA is treated with a compound that tends to place itself amongst the stacks of nitrogenous base pairs. As a result of this, the distance between two consecutive bases increases. from

$$0.34 \text{ nm}$$

to

$$0.44 \text{ nm}$$

. Calculate the length of DNA double helix (which has

$$2 \times 10^9 \text{ bp}$$

) in the presence of saturating amount of this compound.

Solution

Ans: By calculating the distance between two successive base pairs by the total number of base pairs, the length of the DNA double helix may be computed.

$$\begin{aligned} 0.44 \times 10^{-9} \text{ m} \times 2 \times 10^9 \text{ bp} \\ = 0.88 \text{ m} \end{aligned}$$

Question 9

What would happen if histones were to be mutated and made rich in acidic amino acids such as aspartic acid and glutamic acid in place of basic amino acids such as lysine and arginine?

Solution

Ans: Acidic amino acids include aspartic and glutamic acid, while basic amino acids include lysine and arginine. Aspartic acid and glutamic acid have negative charges on their side chains, whereas lysine and arginine have positive charges on their side chains. The negative charge of DNA wraps around the positive charge of the histone octamer. DNA will not be able to wrap around itself if acidic amino acids are present in histone due to mutation. As a result, a long strand of DNA will be unable to fit into the

nucleus's limited space. This will signal the end of nuclear power, which is made possible by effective packing.

Question 10

Recall the experiments done by Frederick Griffith, Avery, MacLeod, and McCarty, where DNA was speculated to be the genetic material. If RNA, instead of DNA was the genetic material, would the heat-killed strain of *Pneumococcus* have transformed the R- strain into a virulent strain? Explain.

Solution

Ans: Because RNA is less durable than DNA, DNA has supplanted RNA as the genetic material in living organisms. Heat would have destroyed RNA if it had been the genetic material in Griffith's experiment. As a result, the heat-killed *Pneumococcus* strain could not have turned the R-strain into a virulent strain.

Question 11

You are repeating the Hershey-Chase experiment and are provided with two isotopes:



and



(in place of



in the original experiment). How do you expect your results to be different?

Solution

Ans: The choice of phosphorus and Sulphur was based on the fact that phosphorous is found in DNA and Sulphur is found in proteins. Phosphorus was utilized as a DNA marker in this experiment. Sulfur was utilized as a protein marker in the same way. It was easier to trace the flow of Sulphur and Phosphorus across succeeding generations by following the movement of Sulphur and Phosphorus.

However, nitrogen is found in both DNA and protein. As a result, using

15 N

to determine whether the genetic material is DNA or protein will be ineffective.

Question 12

There is only one possible sequence of amino acids when deduced from given nucleotides. But multiple nucleotides sequences can be deduced from a single amino acid sequence. Explain this phenomenon.

Solution

Ans: There are 61 codons and 20 amino acids in the human genome. This theory was developed by Har Gobind Khorana and Marshall Nierenberg. A codon for an amino acid is thought to be made up of three nucleotides. It was also discovered that each codon only codes for one amino acid (unambiguous and specific). More than one codon codes for several amino acids (degeneracy of codon). In simple terms, when deducing amino acid sequences from a given set of nucleotides, there is only one viable sequence. However, a single amino acid sequence can be used to deduce several nucleotide sequences.

Question 13

A single base mutation in a gene may not 'always' result in loss or gain of function.

Do you think the statement is correct? Defend your answer.

Solution

Ans: A single base mutation in a gene does not always lead to function loss or increase. A codon is made up of three nucleotides, as we know. A codon can be thought of as a three-letter word in its simplest form. A whole word is required to construct any meaningful statement. A meaningful term may not result from the addition or deletion of a single letter. As a result, in most cases, three bases must be mutated to effect function loss or gain. This can be seen in the following example of a statement that has been changed:

RAM HAS RED CAP RAM

HAS BRE DCA P RAM HAS

BIR EDC AP RAM HAS BIG

RED CAP

It is self-evident that only when at least three letters are added in this sequence can a meaningful statement emerge.

Question 14

A low level of expression of lac operon occurs all the time. Can you explain the logic behind this phenomenon?

Solution

Ans: Lactose cannot enter cells unless a very low level of lac operon expression is present in the cell at all times.

Question 15

How has the sequencing of the human genome opened new windows for the treatment of various genetic disorders? Discuss amongst your classmates.

Solution

Ans: The human genome sequencing has opened up new avenues for the treatment of a variety of hereditary illnesses. Genetic illnesses are known to be caused by changes in genes. We don't know the exact base pair sequence where this change occurs right now. As a result, we haven't been able to come up with any tools to prevent genetic illnesses. Scientists may be able to create some strategies to avoid genetic disorders if they have a thorough grasp of the specific sequence responsible for a particular genetic disorder. There may come a time when no one will be affected by genetic illnesses, particularly those that cause severe handicap.

Question 16

The total number of genes in humans is far less

$$(< 25,000)$$

than the previous estimate (up to 1,40,000 genes). Comment.

Solution

Ans: When scientists first started estimating the number of human genes, they used a relatively high number, more than 100,000. The technology for examining human genes was not advanced enough at the time, and the estimate was more qualitative in character because it was based primarily on assumptions. With the advancement of technology and knowledge of human genes, the estimated number has decreased. The total number of genes in humans is estimated to be between 20,000 and 25,000, according to current knowledge.

Question 17

Now, sequencing of total genomes getting is getting less expensive day by the day. Soon it may be affordable for a common man to get his genome sequenced. What is your opinion could be the advantage and disadvantages of this development?

Solution

Ans: Advantages of Affordably Priced Genome Sequencing: It can assist in resolving disputes about a child's parentage. This can also assist in resolving property inheritance issues by identifying the true beneficiary. The human genome can potentially aid in the creation of a criminal records database. It can aid in the detection of the likelihood of genetic illnesses in a family.

Disadvantages: Genome sequencing can raise severe privacy concerns. Some bosses might exploit the information to blackmail their workers. Many private problems may become public, causing embarrassment to the person involved.

Question 18

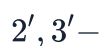
Would it be appropriate to use DNA probes such as VNTR in the DNA fingerprinting of a bacteriophage?

Solution

Ans: A VNTR (Variable Number Tandem Repeat) is a genomic region in which a short nucleoside is organized as a tandem repeat. VNTR analysis is used for a variety of purposes, including DNA finger printing. However, bacteriophage does not contain a large number of DNAs; rather, it only has a few strands of DNA. This eliminates the possibility of a repeating sequence in DNA. As a result, VNTR cannot be used in bacteriophage DNA finger printing.

Question 19

During in vitro synthesis of DNA, a researcher used



dideoxy cytidine triphosphate as raw nucleotide in place of



-deoxycytidine. What would be the consequence?

Solution

Ans: A reverse transcriptase inhibitor is



dideoxy cytidine triphosphate. In HIV and other retroviruses, reverse transcriptase is a viral DNA polymerase that aids DNA replication. Zalcitabine is the commercial name for ddC, which is a medicinal medication used to treat HIV. When



-dideoxy cytidine triphosphate is substituted for



- deoxycytidine as a raw nucleotide, DNA replication is halted. The researcher will be unable to continue with his experiment due to the reagent's opposite effect.

Question 20

What background information did Watson and Crick have made available for developing a model of DNA? What was their contribution?

Solution

Ans: For the development of a DNA model, Watson and Crick made the following background material available.

- Pairing between polynucleotide chains' two strands.
- In nature, the base pairing of polynucleotide chains is complimentary.
- If one strand's base sequence is known, the base sequence of the other strand can be predicted. Both daughter DNAs would be comparable to the mother DNA if each strand of DNA acts as a template.

Watson and Crick's contributions include:

- Because of these, a simplified model of DNA was available.
- The genetic ramifications of DNA replication are simple to comprehend.
- At the molecular level, the model ushered in a revolution in biology.

Question 21

What are the functions of (i) methylated guanosine cap, (ii) poly-A “tail” in a mature on RNA?

Solution

Ans: Methylated Guanosine Cap is a protein that regulates the nuclear export of mRNA. It encourages people to translate. (hnRNA that has been fully processed is referred to as mRNA.)

Poly-A Tail's role is to protect RNA from exonuclease degradation. Plays a key function in the conclusion of transcription.

Question 22

Do you think that the alternative splicing of exons may enable a structural gene to code for several iso proteins from one and the same gene? If yes, how? If not, why so?

Solution

Ans: Approximately 95% of multi-exonic genes in humans are alternatively spliced. Alternative splicing aids in the production of many proteins from a single gene. A certain exon may be excluded from or included in a specific RNA during this procedure. Alternative splicing is a type of splicing those results in a single gene coding for numerous proteins.

Question 23

Comment on the utility of variability in a number of tandem repeats during DNA fingerprinting.

Solution

Ans: In DNA fingerprinting, variability in the number of tandem repeats (VNTR) is quite valuable. Gel electrophoresis or Southern blotting are used to examine the DNA sample. VNTR then appears as a pattern of lines of varying lengths. The lengths of lines and the order in which they are arranged differ from one person to the next. This is similar to how a person's fingerprint is unique. As a result, VNTR aids in determining an individual's specific identify through DNA finger printing.

Long Answer Questions

Question 1

Give an account of the Hershey and Chase experiment. What did it conclusively prove? If both DNA and proteins contained phosphorus and sulfur, do you think the result would have been the same?

Solution

Ans: Hershey and Chase Experiment:

- Viruses were produced on two different types of medium. Radioactive phosphorus was present in one medium, while radioactive Sulphur was present in another.

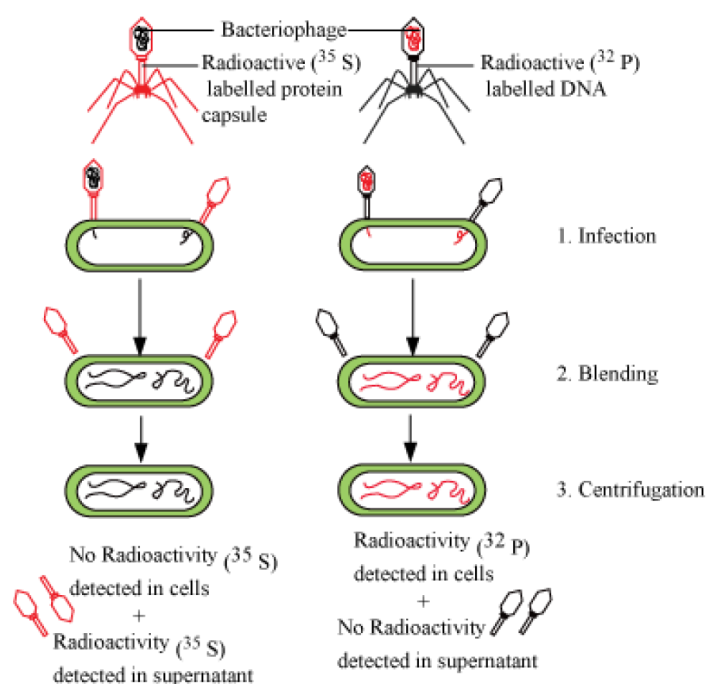
- Because protein does not contain phosphorus, viruses cultured on radioactive phosphorus contained radioactive DNA but no such protein.
- Because DNA does not contain Sulphur, viruses cultured on radioactive Sulphur contained radioactive protein but no such DNA.
- E. coli bacteria were permitted to bind to radioactive phages. Following the infection, the viral coat was removed from the bacterium, and viral particles were isolated from the bacteria for further examination.

Observation:

- Only those bacteria infected with phages growing on radioactive phosphorus showed radioactive DNA.
- In bacteria infected with phages cultured on radioactive Sulphur, no radioactive DNA was found.

Conclusion: DNA was discovered to be a genetic substance.

It would have been impossible to pinpoint the exact genetic material, i.e., DNA or proteins, if both DNA and proteins contained Sulphur and Phosphorus.



Question 2

During the course of evolution why DNA was chosen over RNA as genetic material? Give reasons by first discussing the desired criteria in a molecule that can act as genetic material and in the light of biochemical differences between DNA and RNA.

Solution

Ans: The parameters for a molecule that can operate as genetic material are as follows:

It needs to be able to replicate itself. Chemically and structurally, it should be stable.

Slow changes (mutation) are essential for evolution; hence it should be able to accommodate - them.

It must be capable of expressing itself in Mendelian characteristics.

DNA and RNA Biochemistry:

- DNA and RNA are both capable of replication because their base pairs are complementary.
- Griffith's experiment demonstrated that DNA is more stable than RNA since it could withstand heat-killing during the experiment.
- In RNA, there is a 2'-OH group. Because of this, RNA is labile and degradable, whereas DNA is not
- Mutations can be passed on through both RNA and DNA. However, because DNA is more stable, it is better suited for long-term mutation storage.
- As a result, during evolution, DNA was favored as the genetic material.

Question 3

Give an account of post-transcriptional modifications of a eukaryotic mRNA.

Solution

Ans: Following events happen during the transformation of hnRNA (precursor of mature mRNA):

Polymerase II assists in the conversion of hnRNA to mature mRNA. Introns and exons are both present in primary transcripts, however, they are non-functional. Splicing occurs, resulting in the elimination of introns and the linking of exons in a predetermined order. In hnRNA, capping and tailing occur. It gets a methyl guanosine cap and a poly adenylate tail. At the 5' end of hnRNA, a cap is added, and at the 3' end, a Poly-A tail is added. The hnRNA is now transformed into mature mRNA.

Question 4

Discuss the process of translation in detail.

Solution

Ans: Translation is the process of polymerizing amino acids to produce polypeptides. As a result, translation refers to the biological process of protein synthesis. The following are the main steps in the translation process:

Initiation: The ribosome forms a ring around the target mRNA, and we know that the ribosome is where protein is made. At the start codon, the first tRNA is connected. A codon is a three-amino-acid sequence. **Elongation:** occurs when the tRNA adds an amino acid to the tRNA that corresponds to the following codon. In this phase, more amino acids are added to build a lengthy chain. This is the most important step in the protein production process.

Translocation: The ribosome subsequently translocate to the next mRNA codon and repeats the process. This results in the formation of an amino acid chain.

Termination: When a stop codon is reached, the polypeptide is released by the ribosome.

Question 5

Define an operon. Giving an example, explain an Inducible operon.

Solution

Ans: An operon is a functional unit of genomic DNA that contains a cluster of genes controlled by a single promoter. In most cases, an operon is transcribed into polycistronic mRNA. Polycistronic mRNA is a type of mRNA that codes for several proteins. An operon consists of three basic DNA components:

(a) Promoter: A nucleotide sequence that empowers a gene to be transcribed is termed a promoter. It is known by RNA polymerase, which then pledges transcription.

(b) Operator: A section of DNA to which a repressor binds is titled, operator.

(c) Structural genes: The genes which are co-regulated by the operon are named structural genes.

Inducible Operon: Inducible operons are operons that are controlled by an inducer. The operon can be turned on or off using an inducer. An example of an inducible operon is the lac operon. Lactose is the inducer of the lac operon and is a substrate of the enzyme beta-galactosidase.

The lac operon's operation is depicted in the diagram below. The repressor attaches to the operator region and suppresses transcription in the absence of an inducer.

Repressor becomes inactive in the presence of an inducer. This enables transcription in the operator region, resulting in mRNA release. Following that, mRNA facilitates translation and protein synthesis occurs.

Question 6

'There is a paternity dispute for a child'. Which technique can solve the problem? Discuss the principle involved.

Solution

Ans: DNA fingerprinting can be used to settle a paternity dispute for a kid. The following principle underpins DNA fingerprinting:

DNA fingerprinting is a technique for identifying a person's This entails finding changes in specific DNA regions. Repetitive DNA refers to the sequence found in these areas. In such sequences, a tiny region of DNA is repeated numerous times.

These sequences are isolated from bulk DNA as various peaks during density, gradient centrifugation. Major peaks are formed by bulk DNA, whereas smaller peaks are known as satellite DNA. Satellite DNA is divided into several categories based on the base makeup, segment length, and a number of repeating units. The sequence's base composition tells whether it's A: T or G: C heavy. These sequences are polymorphic to a high degree and so serve as the foundation for DNA fingerprinting.

DNA from each tissue of an individual has the same degree of polymorphism. As a result, DNA from any tissue can be used to examine an individual's DNA fingerprinting. Polymorphism can also be passed down from parents to children. As a result, DNA fingerprinting can be used to determine a child's paternity.

Question 7

Give an account of the methods used in sequencing the human genome.

Solution

Ans: The human genome was sequenced using two ways.

Using ESTs (Expressed Sequence Tags): All genes that are expressed as RNA are discovered and sequenced using this method.

Blind Methodology: This method entailed sequencing the entire set of genomes and then assigning functions to distinct parts of the sequence. Sequence annotation is the term for this. The steps in this procedure are as follows:

- Total DNA from a cell is isolated and fragmented into smaller pieces at random.

- Using specialized vectors, these fragments are cloned into a suitable host. Cloning causes each fragment to be amplified, making it easier to sequence the fragment. Bacteria and yeast are the most common hosts for this type of experiment. The vectors were dubbed BAC (bacterial artificial chromosomes) and YAC (yeast artificial chromosomes) (yeast artificial chromosomes).
- The fragments were sequenced using automated DNA sequencers. The sequences were then ordered based on the presence of some overlapping sections.
- Because it was impossible for humans to generate overlapping fragments in these sequences, computer tools were used to help. After that, each chromosome's sequences were annotated and assigned to it.
- Polymorphism in some DNA segments was used to create a genetic physical map of the genome.

Question 8

List the various markers that are used in DNA fingerprinting.

Solution

Ans: A DNA marker is a gene sequence that can be used to identify an individual or a species on a known chromosome. A genetic marker, also known as a DNA marker, can be a short or long sequence. The following are some of the most regularly used DNA fingerprinting markers.

- RFLP (Restriction fragment length polymorphism) SSLP

(Simple sequence length polymorphism) AFLP

(Amplified fragment length polymorphism) RAPD

(Random amplification of polymorphic DNA) VNTR

(Variable number tandem repeat)

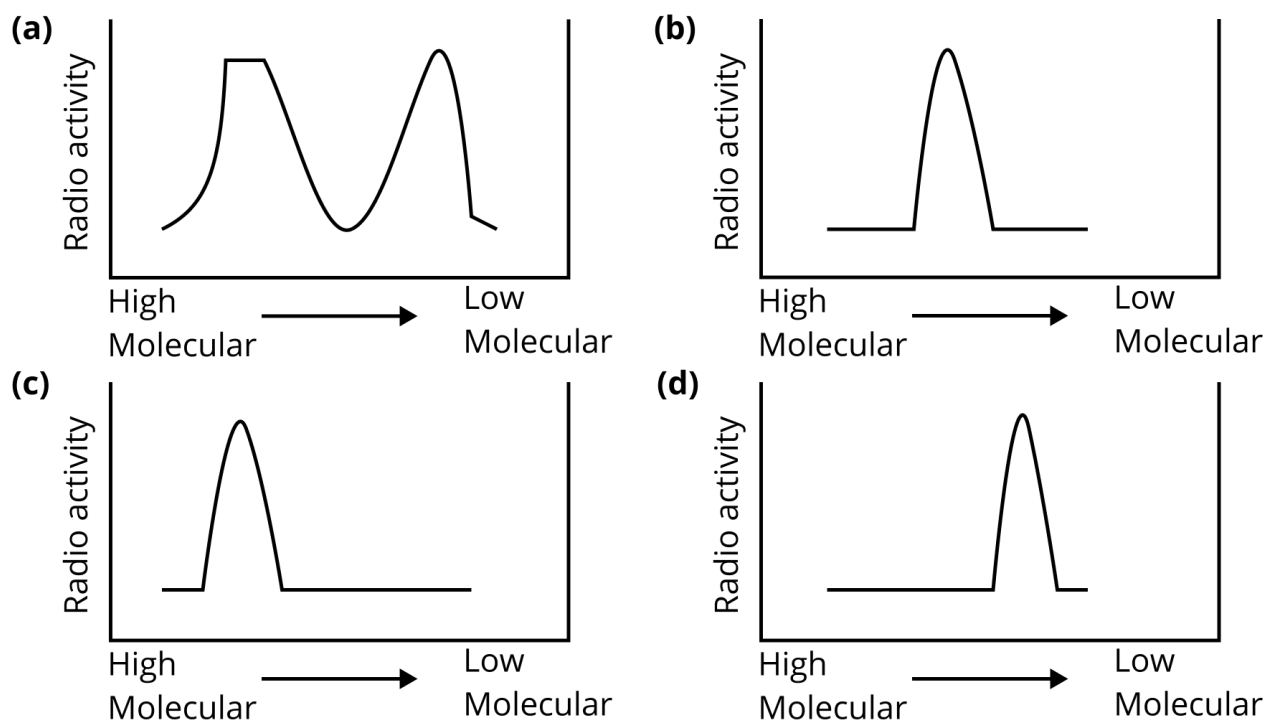
SSR Microsatellite polymorphism, (Simple sequence repeat)

SNP (Single nucleotide polymorphism)

- STR (Short tandem repeat)
- SFP (Single feature polymorphism) DArT
- (Diversity Arrays Technology)
- RAD markers (Restriction site associated DNA markers)

Question 9

Replication was allowed to take place in the presence of radioactive deoxynucleotides precursors in *E. coli* that was a mutant for DNA ligase. Newly synthesized radioactive DNA was purified and strands were separated by denaturation. These were centrifuged using density gradient centrifugation. Which of the following would be a correct result?



Solution

Ans: Option 'a' displays the correct outcome.

The subsequent illustration explains this:

Assume that in this experiment, heavier nitrogen was employed. This nitrogen molecule from the parents' cell would be passed down to the daughter cells in equal amounts. Half of the DNA in each daughter cell will be heavier nitrogen, while the other half will be lighter nitrogen.

Half of the daughter cells in the F2 generation will have a mix of radioactive and non-radioactive DNA. Non-radioactive DNA will be found in the remaining 50% of daughter cells. This is why the graph has two peaks, each reflecting a different type of nitrogen in DNA.
