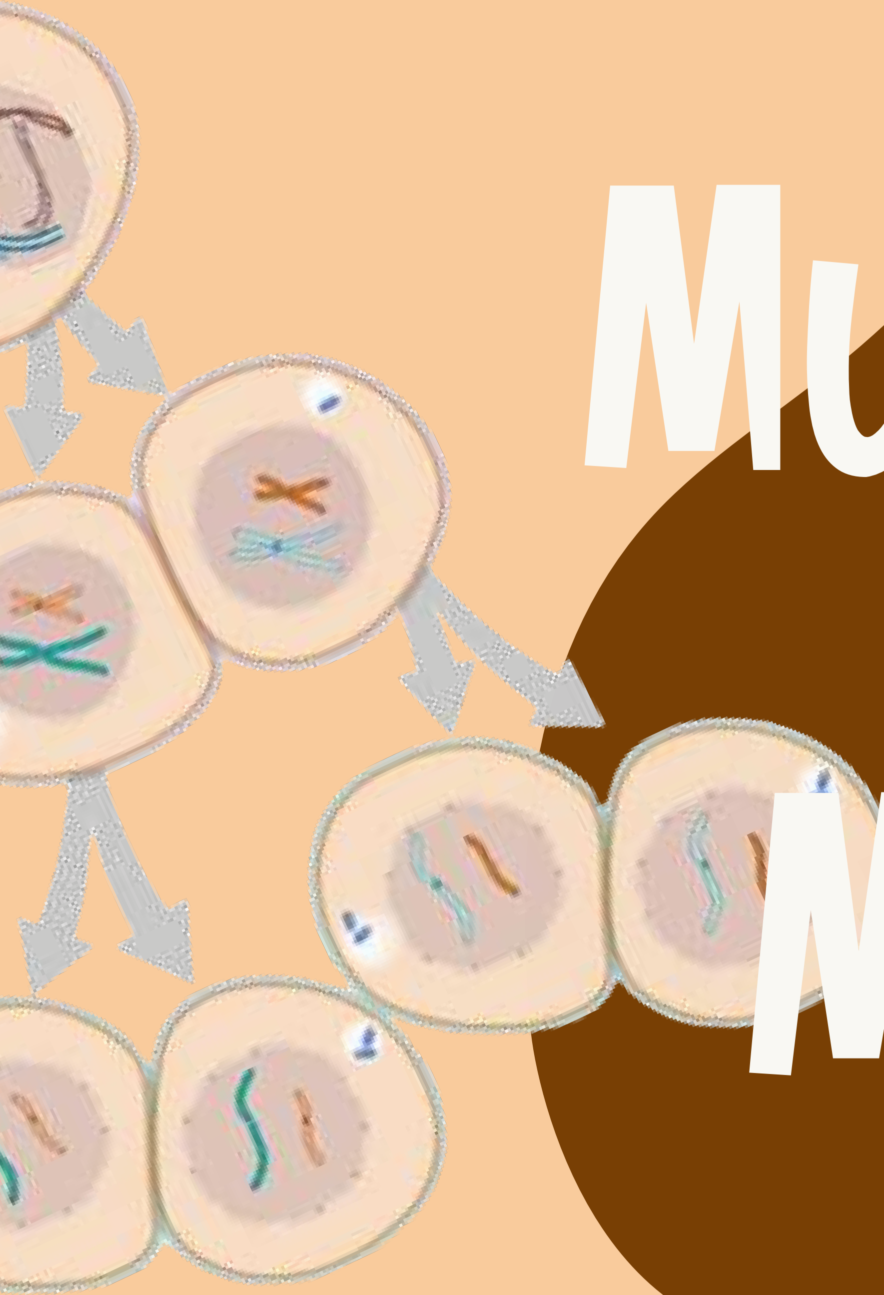
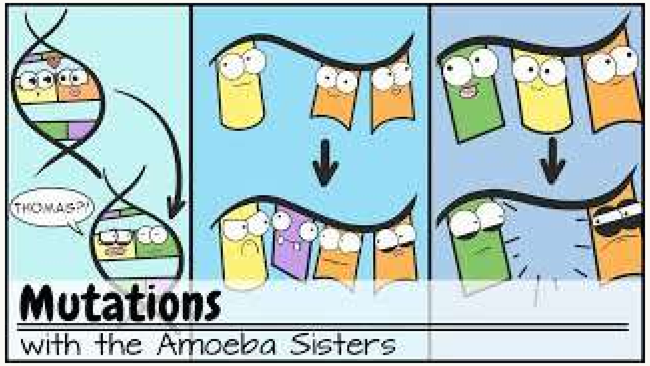


Mutations & Meiosis

Task Cards

front

Task 1



Mutation Causes:

List two factors that can cause mutations in an organism.

flip

front

Task 2

From these examples, can you identify and describe the 3 types of Substitution mutations

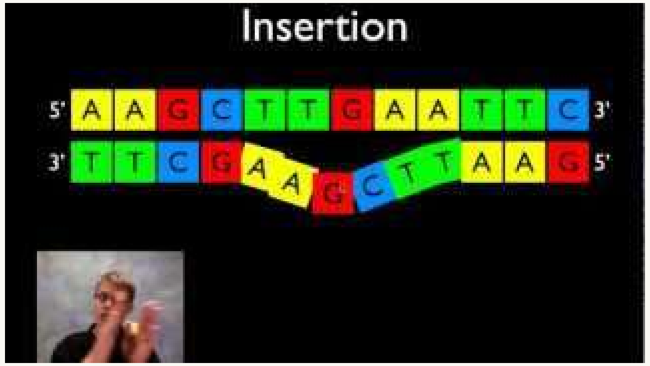
Original **DNA**: 5'- ATG CCT AGG CTA ATA GGC TA -3'
Transcription: 3'- TAC GGA TCC TAT TAT CCG AT -5'
Translation: Met-Pro-Arg-Leu-Ile-Gly-Leu

- **Mutation 1**: 5'- ATG **T**CT AGG CTA ATA GGC TA - 3'
- **Mutation 2**: 5'- ATG CCT AGG CTA **G**TC GGC TA -3'
- **Mutation 3**: 5'- ATG CCT AGG CTA **T**AA GGC TA -3'

flip

front

Task 3



Consequences of Mutations:

Describe one potential consequence of mutations on an organism's protein structure.

Identify and Describe 2 types of Frameshift Mutations

flip

front

Task 4

Meiosis Basics:

Define meiosis and explain its purpose in sexual reproduction.

flip

front

Task 5

Identify and briefly describe the phases of meiosis.

flip

front

Task 6

Compare and Contrast Mitosis Vs Meiosis in terms of: D.I.S.C.O.P.U.G.

- Divisions
- Independent Assortment
- Synapsis
- Crossing Over
- Outcome
- Ploidy
- Use
- Genetics

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front

Task 7

Compare and contrast the impacts of mutations caused by environmental influences and errors in DNA replication.

flip

front

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Task 8

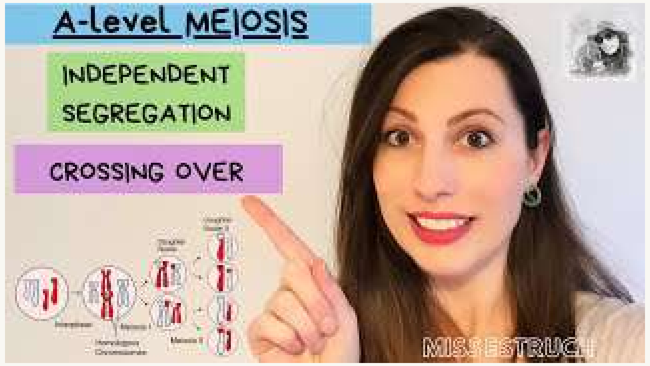
Provide 3 real-life examples of a different type of mutation in an organism and its impact on the population.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front

Task 9



Explain how meiosis contributes to genetic variation in a population.

flip

front

Task 10

Highlight two key differences between meiosis and mitosis in terms of genetic variation.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front

Task 11

Propose a hypothesis about the outcome of a genetic cross considering crossing over and independent assortment.

flip

front

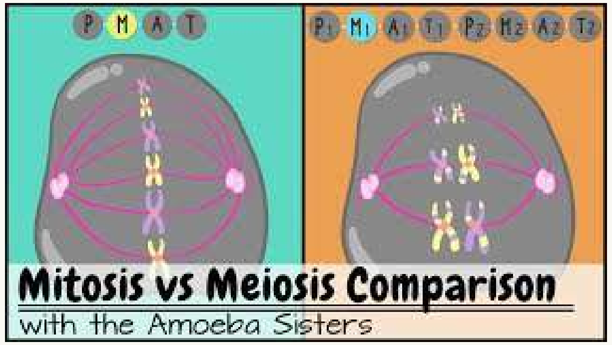
Task 12

Explain how the inheritance of genetic material differs between mitosis and meiosis.

flip

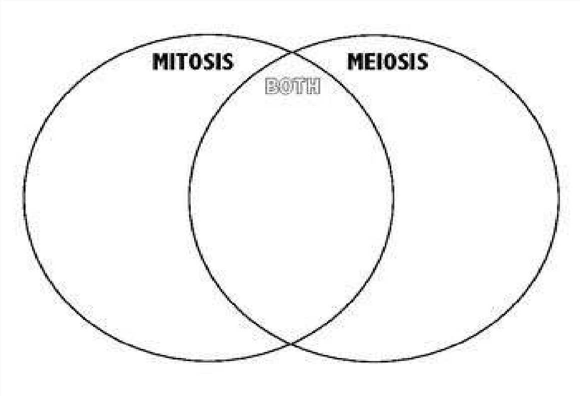
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front



Task 13

Create a Venn Diagram - Comparing Mitosis and Meiosis



- Where it Occurs
- # of Divisions
- # Chromosomes in Daughter Cells
- Genetic Variation in Daughter Cells
- Events in
- Prophase
- Events in Metaphase
- Events in Anaphase
- Events in Telophase

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front

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Task 14

Provide a short constructed response (3-5 sentences) from an article or reliable source discussing the importance of meiosis in generating genetic variation in gene pools. Highlight examples or cases where this variation is crucial for the adaptation and survival of populations.

flip

front

Khan Academy

Task 15

Evaluate how mutations contribute to genetic variation and adaptation in the context of natural selection.

flip

front

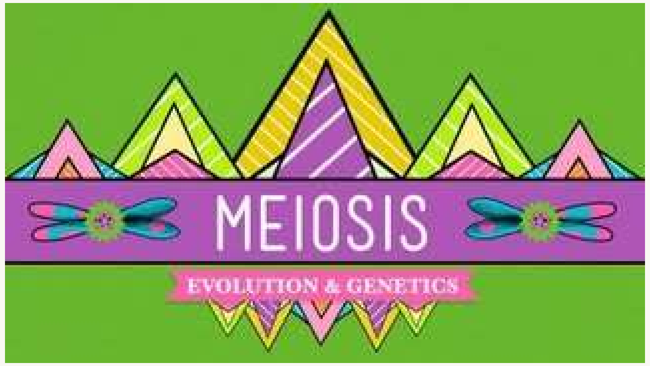
Task 16

Critically analyze the ethical considerations associated with genetic engineering, gene editing technologies, and genetic testing.

flip

front

Task 17



Discuss the role of meiosis in natural selection.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front

National Institute of General Medical Sciences

Task 18

Compare and contrast the genetic outcomes of mitosis and meiosis in terms of allelic combinations. Discuss how these outcomes contribute to the diversity of traits within a population.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

front

Task 19

Gray Group International

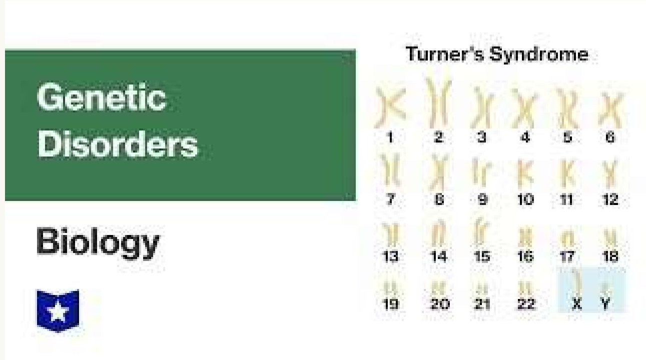
Evaluate the importance of genetic diversity in populations and explain how meiosis plays a pivotal role in maintaining and enhancing this diversity. Provide examples from ecological contexts where genetic diversity has proven crucial for species survival.

flip

front

Task 20

Investigate and discuss specific problems that can arise during meiosis, leading to genetic disorders or developmental issues. Explain the underlying mechanisms behind these problems and how they may impact the health and viability of an organism.



flip

back

Answer 1

Exposure to Mutagenic Agents:

Mutations can be caused by exposure to external agents known as mutagens. These include chemicals, radiation, and certain environmental factors that can induce changes in the DNA sequence.

Errors in DNA Replication:

Mutations can also arise from errors that occur during the process of DNA replication. Mistakes in copying the genetic information can lead to changes in the nucleotide sequence of the DNA molecule.

flip

back

Answer 2

Mutated DNA: 5'- ATGCCTAGGCTAGTCGGCTA - 3'

Transcription: 3'- TACGGATCCTCAGCCGAT -5'

Translation: Met Pro Arg Leu Ser Gly Leu

Missense

Mutated DNA: 5'- ATGCCTAGGCTATAAGGCTA -3'

Transcription: 3'- TACGGATCCTATTTCCGAT -5'

Translation: Met Pro Arg Leu Stop Gly Leu

Nonsense

Mutated DNA: 5'- ATGTCTAGGCTAATAGGCTA - 3'

Transcription: 3'- TACAGATCCTATTATCCGAT - 5'

Translation: Met Ser Arg Leu Ile Gly Leu

Silent

flip

Answer 3

Mutations can result in alterations to an organism's protein structure, potentially leading to functional changes. One consequence is the substitution of an amino acid in the protein sequence. This substitution can impact the protein's shape and function, influencing its ability to perform its designated role within the organism.

Identify and Describe two types of Frameshift Mutations:

- **Insertion** Mutation: In an insertion mutation, one or more nucleotides are added to the DNA sequence. This disrupts the reading frame during translation, causing a shift in the grouping of codons. Consequently, the entire amino acid sequence downstream of the mutation is altered, often leading to a nonfunctional or truncated protein.
- **Deletion** Mutation: Conversely, a deletion mutation involves the removal of one or more nucleotides from the DNA sequence. Like insertion mutations, deletions disrupt the reading frame, causing a shift in codon grouping during translation. This shift can result in a significantly different amino acid sequence and may lead to a nonfunctional or truncated protein.

back

Answer 4

Meiosis is a specialized form of cell division that occurs in sexually reproducing organisms. During meiosis, a diploid cell undergoes two successive divisions, resulting in the production of four haploid cells, each with half the number of chromosomes as the original cell. The primary purpose of meiosis in sexual reproduction is to generate genetic diversity. This is achieved through processes such as crossing over, independent assortment of chromosomes, and random fertilization. By creating genetically distinct gametes, meiosis ensures variability among offspring, contributing to the adaptability and evolution of populations.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

back

Answer 5

Meiosis consists of two main phases: Meiosis I and Meiosis II.

Meiosis I:

- Prophase I: Chromosomes condense, and homologous chromosomes undergo crossing over, exchanging genetic material. The nuclear envelope begins to break down.
- Metaphase I: Homologous chromosome pairs align along the cell's equator, with spindle fibers attaching to each chromosome.
- Anaphase I: Homologous chromosomes separate and move toward opposite poles of the cell, reducing the chromosome number by half.
- Telophase I: Chromosomes reach the poles, and the cell undergoes cytokinesis, resulting in two daughter cells, each with half the original chromosome number.

Meiosis II:

- Prophase II: A brief phase where chromosomes condense again in each of the two haploid cells.
- Metaphase II: Chromosomes align along the cell's equator in both haploid cells.
- Anaphase II: Sister chromatids separate and move toward opposite poles.
- Telophase II: Chromatids reach the poles, and nuclear envelopes form around each set of chromosomes. Cytokinesis occurs, resulting in four haploid daughter cells.

This process ensures the production of genetically diverse gametes with half the chromosome number, essential for sexual reproduction.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20

back

Answer 6

	Mitosis	Meiosis
Divisions	One	Two
Independent Assortment	No	Yes (metaphase I)
Synapsis	No	Yes – form bivalents
Crossing Over	No	Yes (prophase I)
Outcome	Two cells	Four cells
Ploidy	Diploid	Haploid
Use	Body cells	Sex cells (gametes)
Genetics	Identical cells	Variation

flip

back

Answer 7

Mutations caused by environmental influences and errors in DNA replication exhibit both similarities and differences. Both sources can lead to alterations in the DNA sequence, with environmental influences, such as radiation and chemicals, and errors in DNA replication contributing to genetic changes. Environmental influences often result in sporadic mutations linked to specific exposures, inducing various mutation types, while errors in DNA replication are tightly regulated but can occur during each cell division. Repair mechanisms are activated in response to damage from both sources, with cells possessing the ability to correct errors and mitigate the impact of mutations. However, the predictability, frequency, and consequences of mutations differ; environmental influences may be more predictable based on exposures, while errors in DNA replication can occur spontaneously during the natural replication process, potentially affecting specific genes or proteins.

flip

Answer 8

Sickle Cell Anemia (Point Mutation):

- Type of Mutation: Point Mutation (Substitution)

  Impact on Population: The mutation causing sickle cell anemia is a point mutation where a single nucleotide change in the hemoglobin gene results in the production of abnormal hemoglobin. In regions where malaria is prevalent, individuals with one copy of the sickle cell allele are more resistant to malaria. This has led to a higher frequency of the sickle cell allele in populations from malaria-endemic regions, demonstrating how a mutation can persist due to its selective advantage in certain environments.

Antibiotic Resistance in Bacteria (Insertion/Deletion):

- Type of Mutation: Insertion/Deletion (Frameshift)

  Impact on Population: Bacterial populations can acquire mutations, including insertions or deletions, in their DNA that confer resistance to antibiotics. The introduction of antibiotics exerts selective pressure, favoring bacteria with mutations that allow them to survive antibiotic treatment. Over time, this can lead to the prevalence of antibiotic-resistant strains within bacterial populations, posing challenges for medical treatment and public health.

Coloration in Peppered Moths (Chromosomal Rearrangement):

- Type of Mutation: Chromosomal Rearrangement

  Impact on Population: The peppered moth population in England experienced a notable change in coloration during the Industrial Revolution. Originally light-colored, the population adapted to industrial pollution by developing a dark coloration through a chromosomal rearrangement. This adaptation provided camouflage against soot-covered trees, reducing predation. As pollution levels decreased, the population shifted back to its original light color. This example illustrates how chromosomal rearrangements can drive rapid adaptations in response to environmental changes.

Answer 9

- **Crossing Over (Genetic Recombination)**: During prophase I of meiosis, homologous chromosomes physically exchange segments of genetic material in a process known as crossing over. This results in the creation of new combinations of alleles on the chromosomes, leading to genetic diversity among the offspring.
- **Independent Assortment of Chromosomes**: In metaphase I of meiosis, homologous chromosomes align randomly along the cell's equator. The orientation of each pair is independent of other pairs, leading to a vast number of possible combinations during gamete formation. This independent assortment results in genetically diverse gametes with various combinations of maternal and paternal chromosomes.
- **Random Fertilization**: The combination of genetic material from two parents during fertilization introduces further variability. Since the assortment of chromosomes during meiosis is a random process, the fusion of gametes from different individuals contributes to the creation of unique combinations of genetic material in the offspring.

Answer 10

Independent Assortment:

- **Meiosis**: During meiosis I, homologous chromosomes align independently along the cell's equator, and their distribution to daughter cells is random. This independent assortment results in a multitude of possible combinations of chromosomes in the gametes, significantly increasing genetic variation.
- **Mitosis**: In mitosis, there is no independent assortment of homologous chromosomes since the goal is to produce genetically identical daughter cells. Each daughter cell receives an identical set of chromosomes to the parent cell.

Crossing Over (Genetic Recombination):

- **Meiosis**: Crossing over occurs during prophase I of meiosis, where homologous chromosomes exchange segments of genetic material. This process leads to the creation of new combinations of alleles on the chromosomes, further increasing genetic diversity among the resulting gametes.
- **Mitosis**: Crossing over does not occur in mitosis. Since mitosis involves the division of somatic cells and the goal is to produce genetically identical daughter cells, there is no exchange of genetic material between homologous chromosomes.

back

Answer 11

Let's consider a hypothetical genetic cross involving two heterozygous individuals for two different genes, AaBb. The genes are located on different chromosomes. The hypothesis will involve the outcomes of crossing over and independent assortment during meiosis.

Hypothesis:

If crossing over and independent assortment occur during meiosis in the heterozygous individuals AaBb, we hypothesize that the resulting gametes will exhibit a variety of combinations for the A and B alleles. Crossing over may lead to the exchange of genetic material between homologous chromosomes, creating new combinations of alleles on the chromatids. Additionally, independent assortment ensures that the assortment of alleles for gene A is not dependent on the assortment of alleles for gene B. As a result, we expect to observe a diverse array of gametes with different combinations of alleles for both genes A and B. The predicted genetic ratios among the offspring, when these gametes are involved in fertilization, would reflect the outcomes of both crossing over and independent assortment, contributing to genetic diversity within the progeny.

flip

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

back

Answer 12

The inheritance of genetic material differs significantly between mitosis and meiosis, reflecting their distinct roles in cell division and reproductive processes.

- **Mitosis**:

  In mitosis, cells divide to create two identical daughter cells, each having the same genetic information as the original cell. This process is crucial for growth and repair in the body.

- **Meiosis**:

  Meiosis, on the other hand, is a special kind of cell division for making sex cells (sperm and egg). It involves two rounds of division, resulting in four unique cells, each having half the number of chromosomes. This process adds variety to the genetic makeup, important for creating diverse offspring during sexual reproduction.

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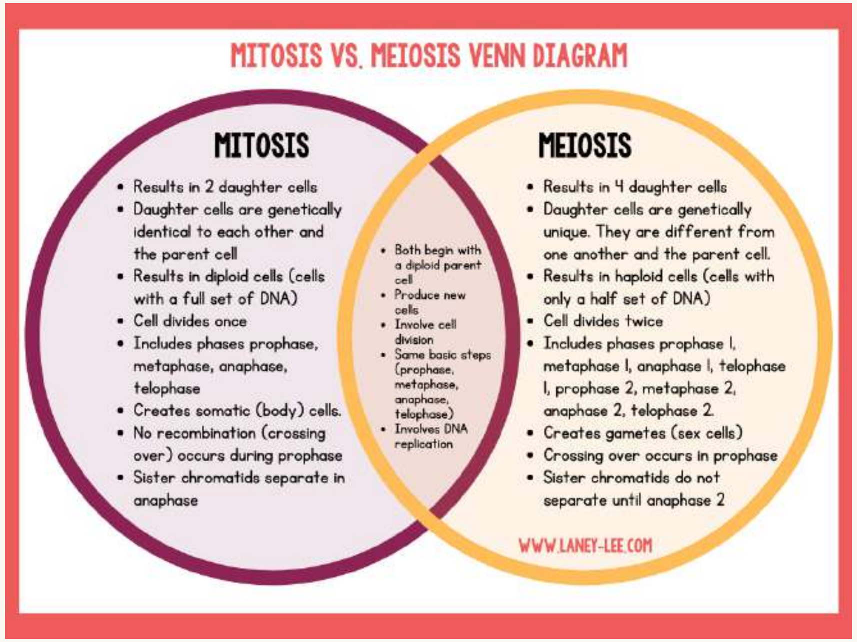
16 17 18 19 20

Answer 13


MITOSIS VS. MEIOSIS VENN DIAGRAM
MITOSIS
• Results in 2 daughter cells
• Daughter cells are genetically identical to each other and the parent cell
• Results in diploid cells (cells with a full set of DNA)
• Cell divides once
• Includes phases prophase, metaphase, anaphase, telophase
• Creates somatic (body) cells.
• No recombination (crossing over) occurs during prophase
• Sister chromatids separate in anaphase
• Both begin with a diploid parent cell
• Produce new cells
• Involve cell division
• Same basic steps (prophase, metaphase, anaphase, telophase)
• Involves DNA replication
MEIOSIS
• Results in 4 daughter cells
• Daughter cells are genetically unique. They are different from one another and the parent cell.
• Results in haploid cells (cells with only a half set of DNA)
• Cell divides twice
• Includes phases prophase I, metaphase I, anaphase I, telophase I, prophase 2, metaphase 2, anaphase 2, telophase 2.
• Creates gametes (sex cells)
• Crossing over occurs in prophase
• Sister chromatids do not separate until anaphase 2
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back

Answer 14

Meiosis plays a crucial role in creating genetic diversity within populations, which is essential for helping species adapt and survive. This diversity is generated through processes like crossing over, independent assortment, and random fertilization. Consider the example of the peppered moths during the Industrial Revolution: the genetic variation produced by meiosis allowed some moths to develop a darker color, helping them blend in with soot-covered trees and avoid predators. In environments that change or present new challenges, having a range of genetic traits due to meiosis increases the likelihood of individuals possessing characteristics that enhance their chances of survival and adaptation.

flip

back

Answer 15

Mutations are key drivers of genetic variation, influencing the process of adaptation through natural selection. Natural selection acts on existing genetic variation within populations, and mutations provide the raw material for this variation. When a mutation arises, it introduces a change in the DNA sequence, potentially altering traits.

In the context of natural selection, certain mutations may confer advantages in specific environments, leading to increased survival and reproductive success. Individuals with beneficial mutations are more likely to pass these advantageous traits to the next generation. Over time, the accumulation of favorable mutations in a population enhances its ability to adapt to changing conditions.

Conversely, not all mutations are beneficial. Some may be neutral, and others may be detrimental. Natural selection acts to weed out harmful mutations, preventing them from persisting in the population.

flip

Answer 16

The ethical considerations surrounding genetic engineering, gene editing technologies, and genetic testing are complex and multifaceted. While these advancements hold great promise for addressing medical conditions and improving human health, concerns arise regarding potential misuse, unintended consequences, and the creation of designer babies. Issues of consent, privacy, and the potential for discrimination based on genetic information are significant ethical challenges. Additionally, questions about the long-term effects on ecosystems and the potential for unintended consequences in modifying the genetic makeup of organisms raise ethical dilemmas. Striking a balance between the potential benefits and the ethical implications of manipulating the fundamental building blocks of life is crucial for responsible and transparent implementation of these technologies, ensuring that ethical considerations are at the forefront of decision-making processes.

back

Answer 17

Meiosis plays a fundamental role in natural selection by contributing to genetic diversity within populations. Natural selection acts on existing genetic variation, and meiosis introduces and maintains this variation. Through processes like crossing over, independent assortment, and random fertilization, meiosis generates unique combinations of alleles in gametes. This genetic diversity is crucial for the adaptability of populations to changing environments. Natural selection then acts upon this diversity, favoring individuals with traits that enhance their survival and reproductive success. Meiosis ensures that the gene pool of a population remains dynamic, allowing for the persistence and spread of advantageous traits while weeding out deleterious ones. In this way, meiosis is integral to the ongoing evolutionary process, providing the variation upon which natural selection acts to shape and refine populations over time.

flip

Answer 18

In terms of allelic combinations, the genetic outcomes of mitosis and meiosis differ significantly.

Mitosis:

Mitosis results in two genetically identical daughter cells, each with the same allelic combinations as the parent cell. The goal of mitosis is cellular reproduction, ensuring that somatic cells maintain their genetic identity during growth and tissue repair. Therefore, mitosis preserves existing allelic combinations without introducing new variations.

Meiosis:

Meiosis, on the other hand, leads to the formation of four non-identical haploid cells, each with a unique combination of alleles. This occurs due to processes like crossing over during prophase I and the independent assortment of chromosomes during metaphase I. These events create novel allelic combinations, significantly contributing to genetic diversity among the resulting gametes.

The diversity of traits within a population is influenced by the outcomes of meiosis. When these diverse gametes participate in fertilization, the combinations of alleles in the offspring become unique. This variation is essential for the adaptability of populations to changing environments and the ability to respond to selective pressures. The genetic diversity introduced by meiosis forms the basis for natural selection, allowing populations to evolve and thrive over time. In contrast, mitosis maintains genetic consistency, ensuring the stability of somatic cell lineages.

back

Answer 19

Genetic diversity is crucial for the adaptability, resilience, and long-term survival of populations. Meiosis plays a pivotal role in maintaining and enhancing genetic diversity by introducing various mechanisms that generate unique combinations of alleles.

- **Crossing Over and Independent Assortment:** During meiosis, crossing over occurs, where homologous chromosomes exchange genetic material. Additionally, independent assortment ensures that chromosomes align randomly during metaphase I. These processes lead to the creation of genetically distinct gametes with novel combinations of alleles.
- **Significance of Genetic Diversity:**
  - **Adaptation to Changing Environments:** Genetic diversity provides the raw material for natural selection to act upon, enabling populations to adapt to environmental changes. For instance, diverse alleles in a population may confer resistance to diseases, pests, or changing climatic conditions.
  - **Species Survival in Dynamic Ecosystems**: In ecosystems with diverse and shifting ecological niches, species with greater genetic diversity are more likely to have individuals with traits suited to various conditions. This enhances their chances of survival and reproduction, contributing to the overall stability of the ecosystem.
  - **Resistance to Pathogens**: Populations with higher genetic diversity are better equipped to resist the impact of pathogens, as individuals may carry alleles that confer immunity or resistance. This diversity acts as a natural defense mechanism against diseases that can affect entire populations.
  - **Preventing Inbreeding**: Genetic diversity helps mitigate the negative effects of inbreeding, reducing the risk of genetic disorders and improving overall population health.
- **Examples of Species Survival:**
  - **Cheetahs**: Cheetahs have relatively low genetic diversity due to past population bottlenecks. This lack of diversity makes them more susceptible to diseases and reduces their ability to adapt to environmental changes, posing challenges to their long-term survival.
  - **Agricultural Crops**: In crop plants, genetic diversity is crucial for resilience against pests, diseases, and changing climate conditions. Maintaining a diverse gene pool ensures that crops can adapt to different environmental challenges and continue to provide essential food resources.

flip

back

Answer 20

Specific problems during meiosis can lead to genetic disorders or developmental issues, often stemming from errors in chromosome segregation or recombination. Nondisjunction, where homologous chromosomes or sister chromatids fail to separate correctly during meiosis I or II, can result in cells with an abnormal number of chromosomes. Trisomies or monosomies can arise if such cells participate in fertilization. Another issue is chromosomal breakage or incorrect recombination during crossing over, leading to structural abnormalities like translocations or deletions. These genetic aberrations can impact the health and viability of an organism by disrupting normal gene dosage and regulatory mechanisms. Conditions such as Down syndrome, caused by an extra copy of chromosome 21 due to nondisjunction, exemplify the consequences of meiotic errors. These disorders often result in developmental challenges, intellectual disabilities, and increased susceptibility to health issues, underscoring the critical role of accurate meiosis in maintaining genetic integrity and overall organismal health.

flip