Founder Effect

- The founder effect is a type of genetic drift that occurs when a new population is established by a few colonizing individuals.
  - The small colonizing group may have different allele frequencies than the original population.
  - When the colonizing individuals mate and multiply, their allele frequencies will tend to persist, making the new population different from the parent population.

Genetic Bottleneck

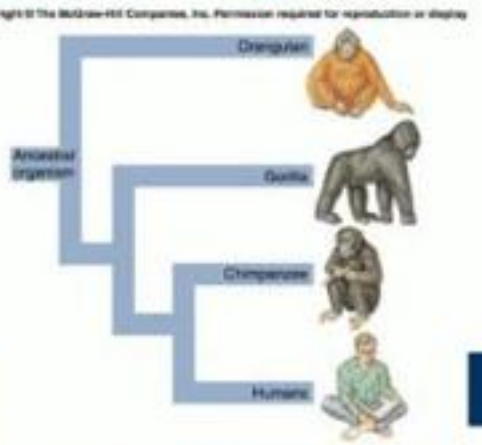
- Genetic bottleneck is another form of genetic drift.
- Occurs when there is a dramatic reduction in population size
  - Usually due to some chance event like a natural disaster
  - Could be due to over-hunting by humans
- The remaining members of the population will mate and pass on their alleles, limiting their genetic diversity.
- Many endangered species are undergoing genetic bottlenecks.

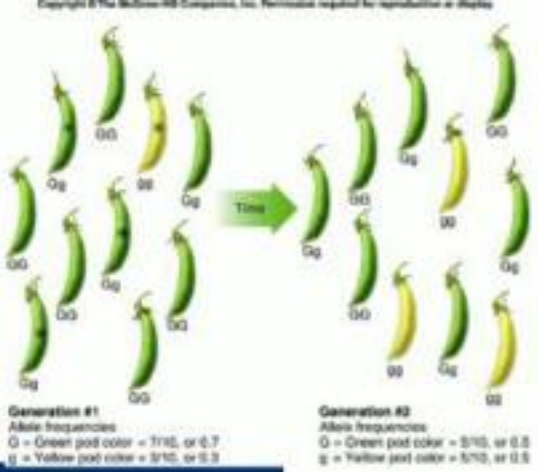
Barriers to Movement

- When migration is limited, populations become geographically and reproductively isolated.
  - Perpetuates the effects of genetic drift caused by founder effect and bottleneck
  - Limits genetic diversity and generates subspecies

The Scientific Concept of Evolution

Microevolution vs. Macroevolution





- Evolution is the change in the frequency of genetically determined characteristics within a population over time.
  - Microevolution involves changes in allele frequencies between populations of the same species.
  - Macroevolution involves major genetic changes that occur over long periods of time that generate new species.
- **The mechanisms of micro- and macroevolution are the same.**

The Theory of Natural Selection

- 1858
  - Darwin and Wallace suggested the theory of natural selection as a mechanism for evolution.
  - Darwin wrote *Origin of Species by Means of Natural Selection.*
- The theory of natural selection
  - The idea that some individuals have genetic combinations that allow them to survive, reproduce and pass their genes on to the next generation

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Assumptions of the Theory of Natural Selection

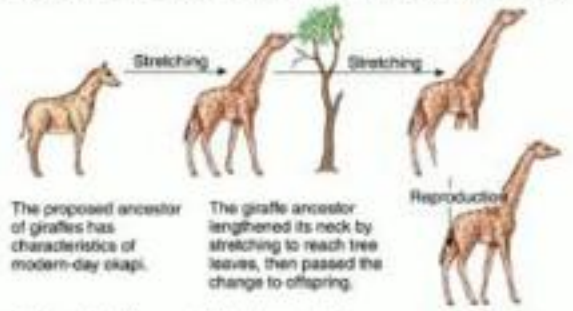
- All organisms produce more offspring than can survive.
- No two organisms are exactly alike.
- Among organisms, there is a constant struggle for survival.
- Individuals that possess favorable characteristics for their environment have a higher rate of survival and produce more offspring.
- Favorable characteristics become more common in the species.
  - Unfavorable characteristics are lost over time.

The Theory of Natural Selection

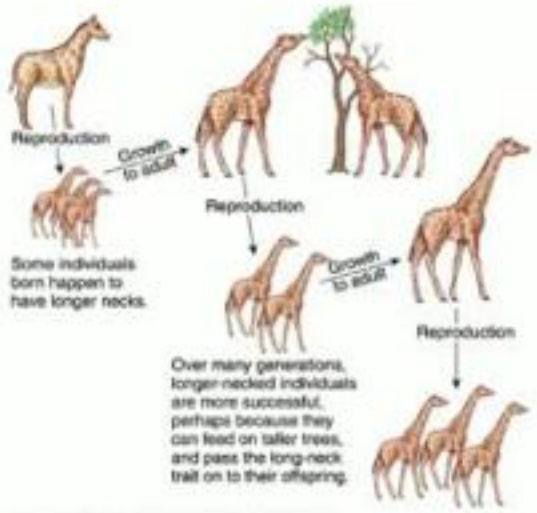
- 1858
  - Darwin and Wallace suggested the theory of natural selection as a mechanism for evolution.
  - Darwin wrote *Origin of Species by Means of Natural Selection*.
- The theory of natural selection
  - The idea that some individuals have genetic combinations that allow them to survive, reproduce and pass their genes on to the next generation

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Natural Selection vs. Acquired Characteristics



(a) Lamarck's theory: variation is acquired.

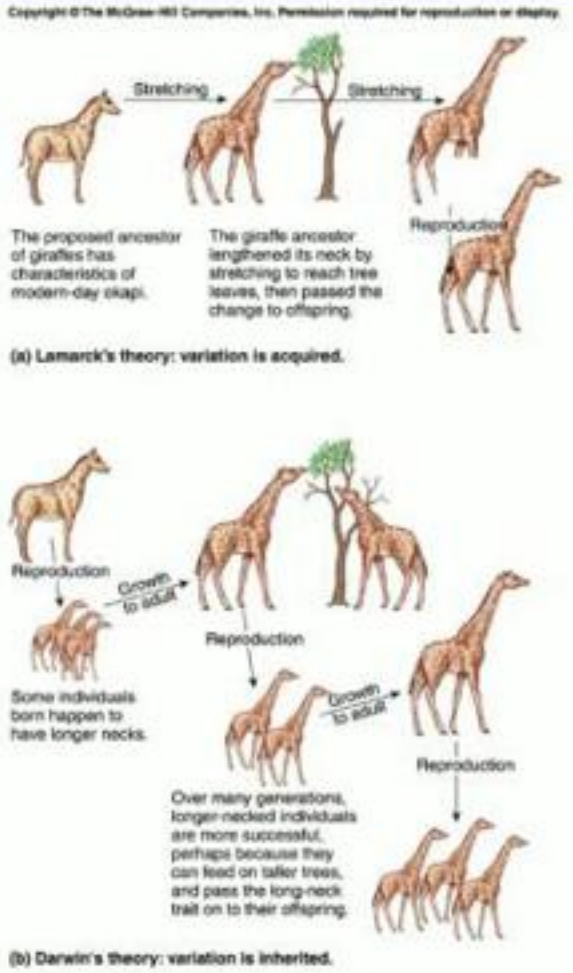


(b) Darwin's theory: variation is inherited.

Assumptions of the Theory of Natural Selection

- All organisms produce more offspring than can survive.
- No two organisms are exactly alike.
- Among organisms, there is a constant struggle for survival.
- Individuals that possess favorable characteristics for their environment have a higher rate of survival and produce more offspring.
- Favorable characteristics become more common in the species.
  - Unfavorable characteristics are lost over time.

Natural Selection vs. Acquired Characteristics



Modern Interpretations of Natural Selection

- Darwin and Wallace's theories were not immediately accepted because meiosis, genes and inheritance were poorly understood.
- Mendel's discovery provided an explanation for how characteristics could be transmitted from one generation to the next.
- Knowledge of mutation, gene flow and reproductive isolation supported Darwin/Wallace's theory.
- Now we can integrate Darwin and Wallace's hypothesis with what we know about meiosis, genes and inheritance.

Darwin and Wallace's Basic Assumptions can be Updated

- An organism's ability to overproduce results in surplus organisms.
- Due to mutation, new traits enter the gene pool and due to meiosis new combinations of alleles can be generated.
- Resources such as food, soil nutrients, water, etc. are in short supply, so some individuals will not survive.
  - Disease, predators, etc. will also affect survival.
  - These are called selecting agents.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Darwin and Wallace's Basic Assumptions can be Updated

- Selecting agents favor individuals with the best combinations of alleles.
  - They will be more likely to survive and reproduce and pass their alleles on to the next generation.
- Allele combinations that favor survival and reproduction will be more common in a population.

The Role of Natural Selection in Evolution

- Natural selection will select for individuals with certain alleles.
  - When allele frequencies change over time, evolution has occurred.
- Natural selection works on individuals, but only populations evolve.
- **Three factors work together to determine how a population changes over time.**
  - **Environmental factors that affect individuals**
  - **Sexual reproduction among the individuals**
  - **Genetic diversity within the gene pool**

Reproductive Success

- Individuals that have the combinations of alleles that allow them to successfully reproduce will pass on their alleles.
  - This success is measured as fitness.
  - Fitness is a relative measure.
    - An individual can successfully reproduce, but be less fit than another individual.
    - Involves the number of offspring produced and their viability

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

The Importance of Genetic Diversity

- A large gene pool with great genetic diversity is more likely to contain genetic combinations that will allow some individuals to adapt to changing environments.
- Characteristics that may allow individuals to adapt include
  - Structural, behavioral, biochemical or metabolic characteristics

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

What influences natural selection?

- Genetic diversity within a species
- Genetic recombination as a result of sexual reproduction
- Gene expression
- The ability of a species to reproduce excess offspring

Mechanisms that Affect Genetic Diversity

- Natural selection cannot occur in a population in which all of the individuals are genetically identical.
- Genetic diversity is essential for natural selection.
- Several mechanisms generate genetic diversity in a population.
  - Mutation, migration and sexual reproduction

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Mutations and Migration

- Spontaneous mutations are changes in DNA that cannot be tied to a specific cause.
  - Mutations alter existing genes and generate new alleles.
  - Most mutations are harmful.
    - Some mutations are helpful.
  - Mutations are only relevant to natural selection if they happen in cells that give rise to gametes.
- Migration results in alleles entering and leaving a population.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Sexual Reproduction and Genetic Recombination

- Sexual reproduction generates new combinations of alleles in individuals (genetic recombination).
  - Crossing over during meiosis generates new combinations of alleles in homologous chromosomes.
  - Independent assortment generates new combinations of alleles from non-homologous chromosomes.
  - Random fertilization results in a genetically unique individual.
- Genetic recombination can generate a new combination of alleles that would give an individual a selective advantage.

The Role of Gene Expression

- In order for genes to be selected for, they must be expressed in phenotype.
- Genes are expressed to different degrees in different individuals.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Different Degrees of Expression

- *Penetrance* describes how often an allele is expressed.
- *Expressivity* describes situations in which the allele is penetrant, but not expressed equally in all individuals.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Why Some Genes May Avoid Natural Selection

- Some alleles are only expressed during certain stages of life.
  - If an organism dies before the allele is expressed, then it cannot contribute to fitness.
- Some genes need environmental triggers to be expressed.
  - If the trigger is not encountered, then the gene will not be expressed and will not contribute to fitness.
- In heterozygotes, recessive alleles are not expressed.
- Some alleles will not be expressed because an unrelated gene is required.

Natural Selection Works on the Total Phenotype

- One good allele is not enough to give an individual greater fitness.
- Natural selection acts on the total phenotype which involves a combination of characteristics.

The Importance of Excess Reproduction

- Successful organisms reproduce at a rate in excess of that necessary to merely replace them when they die.
  - However, population size remains relatively constant.
  - A high death rate offsets the high reproductive rates.
- Even though a population remains constant in number, the individuals that make up the population change.
  - Therefore, there are many genetically unique individuals.
  - Some of these individuals will survive and reproduce, even if the environment changes.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

The Conditions Necessary for H-W Equilibrium

- If these five conditions are met, then gene frequencies will not change.
  - Random mating
  - No mutation
  - No migration
  - Very large population size
  - No natural selection
- Hardy-Weinberg equilibrium provides a null hypothesis for evolution in a population.
  - Gives us a way to compare two populations, or two generations of a population to determine if evolution is occurring.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Determining Genotype Frequencies

- Genotypic frequencies in a population can be calculated with a modified Punnett Square.
  - In this Punnett square, allele frequencies must be used to determine the likelihood of particular genotypes occurring in the next generation.

		Possible female gametes	
		$A = 0.6$	$a = 0.4$
Possible male gametes	$A = 0.6$	Genotype of offspring $AA = 0.6 \times 0.6 = 0.36 = 36\%$	Genotype of offspring $Aa = 0.6 \times 0.4 = 0.24 = 24\%$
	$a = 0.4$	Genotype of offspring $Aa = 0.4 \times 0.6 = 0.24 = 24\%$	Genotype of offspring $aa = 0.4 \times 0.4 = 0.16 = 16\%$

Why Hardy-Weinberg Conditions Rarely Exist

- Since the gene pools of most populations are changing over time, H-W equilibrium rarely exists.
- Why?
  - Random mating rarely occurs.
  - Spontaneous mutations occur.
  - Immigration and emigration introduce new alleles.
  - Populations are not infinitely large.
  - Natural selection does occur.

The Conditions Necessary for H-W Equilibrium

- If these five conditions are met, then gene frequencies will not change.
  - Random mating
  - No mutation
  - No migration
  - Very large population size
  - No natural selection
- Hardy-Weinberg equilibrium provides a null hypothesis for evolution in a population.
  - Gives us a way to compare two populations, or two generations of a population to determine if evolution is occurring.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Determining Genotype Frequencies

- Genotypic frequencies in a population can be calculated with a modified Punnett Square.
  - In this Punnett square, allele frequencies must be used to determine the likelihood of particular genotypes occurring in the next generation.

		Possible female gametes	
		$A = 0.6$	$a = 0.4$
Possible male gametes	$A = 0.6$	Genotype of offspring $AA = 0.6 \times 0.6 = 0.36 = 36\%$	Genotype of offspring $Aa = 0.6 \times 0.4 = 0.24 = 24\%$
	$a = 0.4$	Genotype of offspring $Aa = 0.4 \times 0.6 = 0.24 = 24\%$	Genotype of offspring $aa = 0.4 \times 0.4 = 0.16 = 16\%$

Using the Hardy-Weinberg Concept to Show Allele-frequency Changes

TABLE 13.2

Differential Reproduction

The percentage of each genotype in the offspring differs from the percentage of each genotype in the original population as a result of differential reproduction.

Original Frequency of Genotypes	Total Number of Individuals Within a Population of 100,000 with Each Genotype	Number of Each Genotype Not Reproducing Subtracted from the Total	Total of Each Genotype in the Reproducing Population of 58,000 Following Selection	New Percentage of Each Genotype in the Reproducing Population
$AA = 36\%$	36,000	36,000		$\frac{18,000}{58,000} = 31.0\%$
		$-18,000$		
		18,000	18,000	
$Aa = 48\%$	48,000	48,000		$\frac{24,000}{58,000} = 41.4\%$
		$-24,000$		
		24,000	24,000	
$aa = 16\%$		16,000	16,000	$\frac{16,000}{58,000} = 27.6\%$
		$-\ 0$		
	16,000	16,000		
100%	100,000		58,000	100.0%

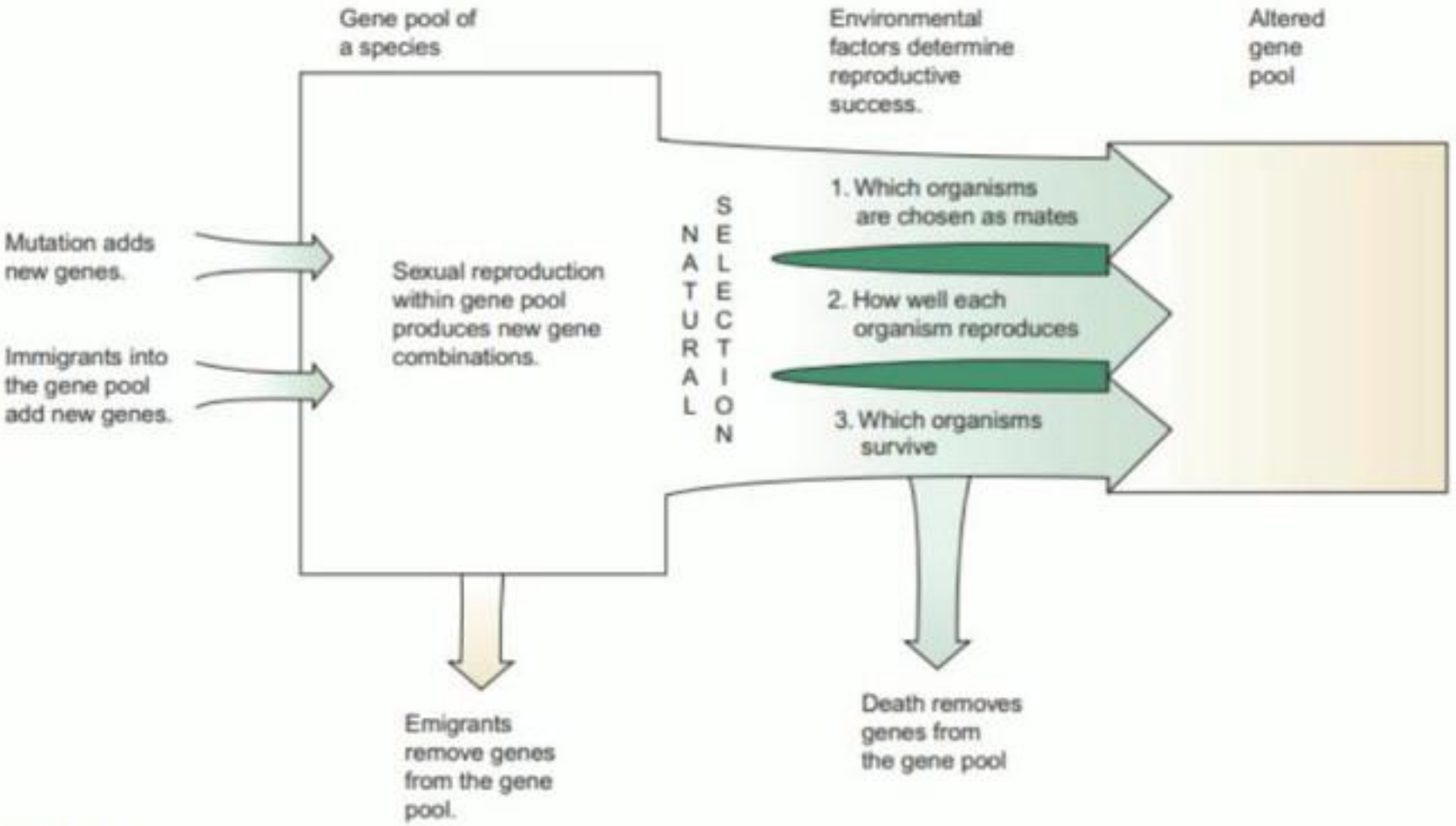


FIGURE 13.14 Processes That Influence Evolution

Several processes cause gene frequencies to change. New genetic information enters populations through immigration and mutation. Genetic information leaves populations through emigration and death. Natural selection operates within populations through death, mate selection, and rates of reproduction. Genetic drift can also result in evolutionary change but is not shown in this diagram.

Gene pool of	Environmental	Altered

Gene pool of

Environmental

Altered

12-48

Search

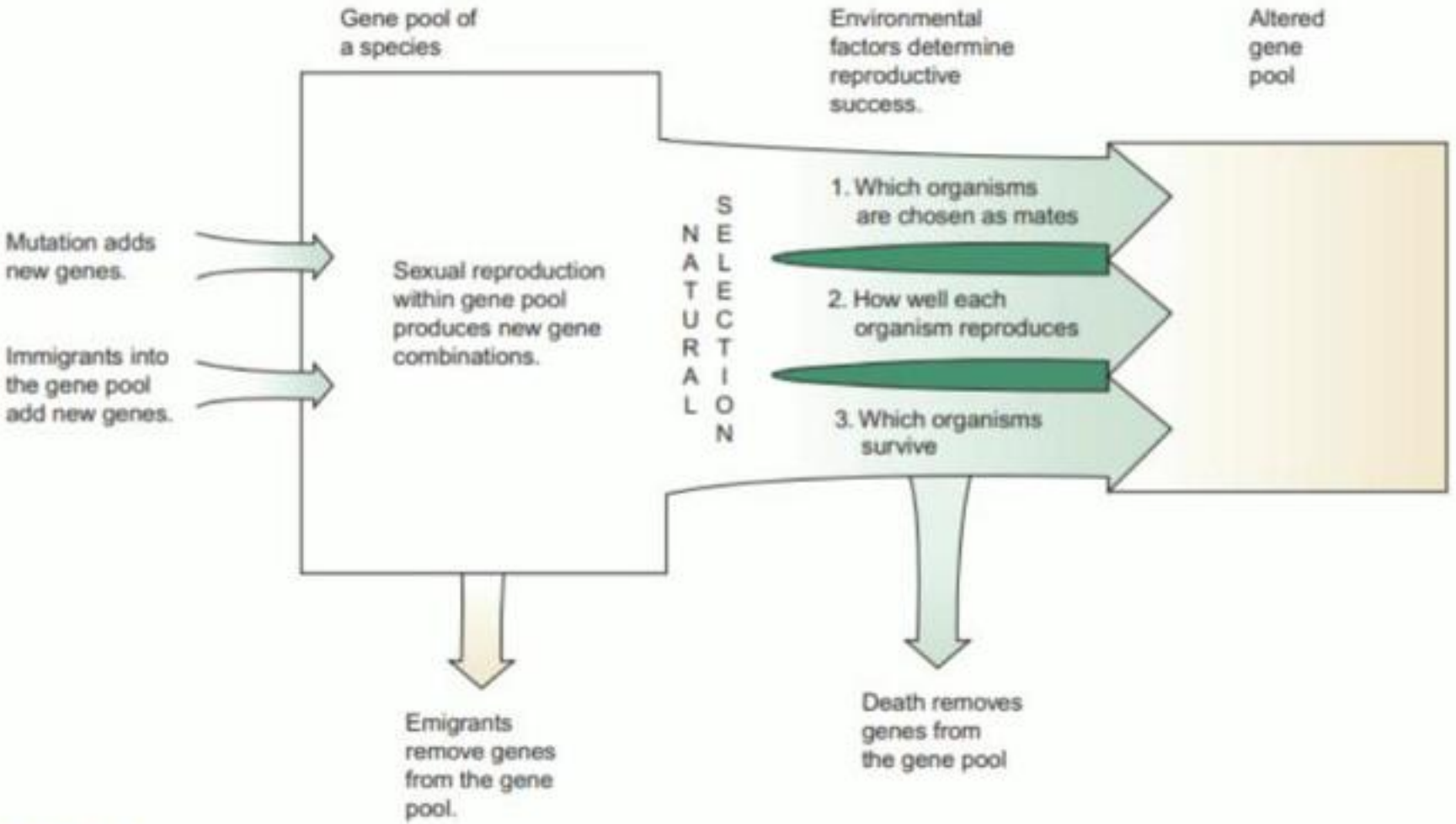
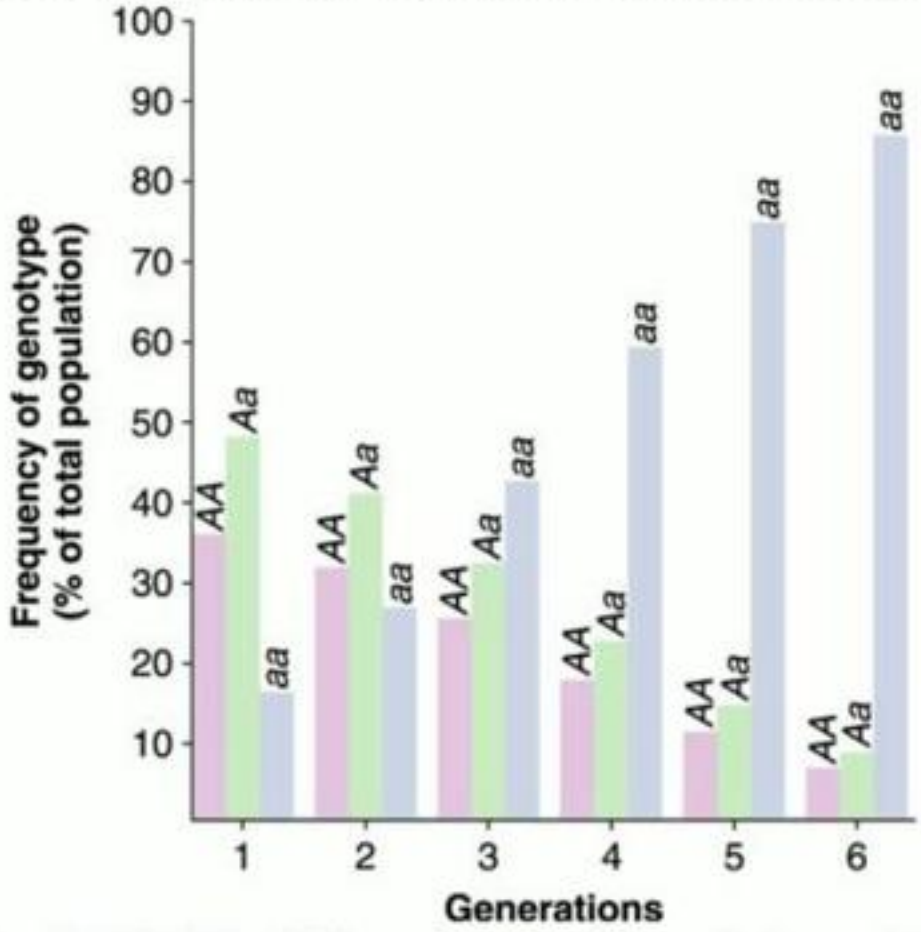


FIGURE 13.14 Processes That Influence Evolution

Several processes cause gene frequencies to change. New genetic information enters populations through immigration and mutation. Genetic information leaves populations through emigration and death. Natural selection operates within populations through death, mate selection, and rates of reproduction. Genetic drift can also result in evolutionary change but is not shown in this diagram.

The Effect of Changing Allele Frequencies



Using the Hardy-Weinberg Concept to Show Allele-frequency Changes

TABLE 13.2

Differential Reproduction

The percentage of each genotype in the offspring differs from the percentage of each genotype in the original population as a result of differential reproduction.

Original Frequency of Genotypes	Total Number of Individuals Within a Population of 100,000 with Each Genotype	Number of Each Genotype Not Reproducing Subtracted from the Total	Total of Each Genotype in the Reproducing Population of 58,000 Following Selection	New Percentage of Each Genotype in the Reproducing Population
$AA = 36\%$	36,000	36,000		$\frac{18,000}{58,000} = 31.0\%$
		$-18,000$		
		18,000	18,000	
$Aa = 48\%$	48,000	48,000		$\frac{24,000}{58,000} = 41.4\%$
		$-24,000$		
		24,000	24,000	
$aa = 16\%$		16,000	16,000	$\frac{16,000}{58,000} = 27.6\%$
		$-\ 0$		
	16,000	16,000		
100%	100,000		58,000	100.0%

Using the Hardy-Weinberg Concept to Show Allele-frequency Changes

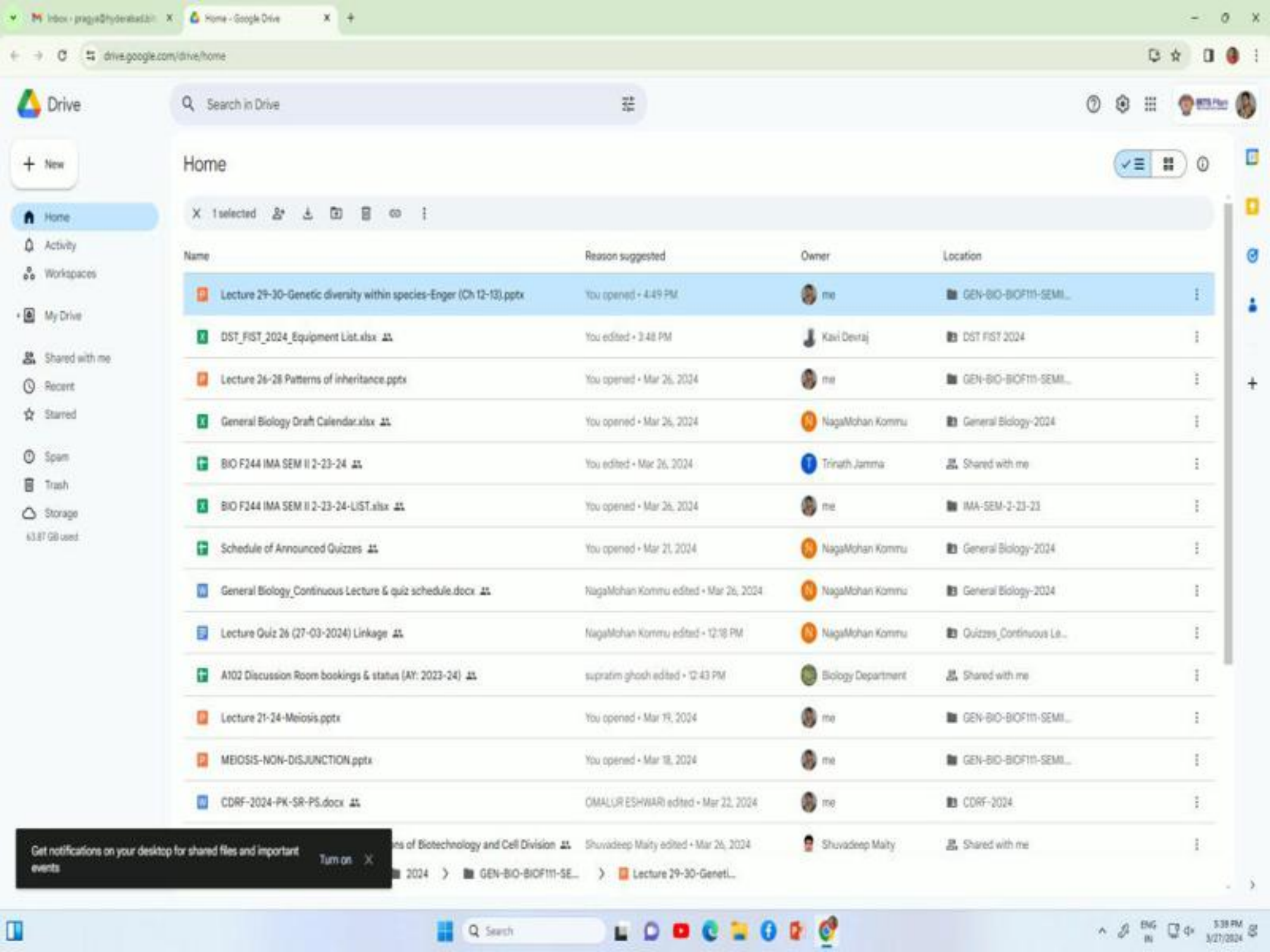
TABLE 13.2

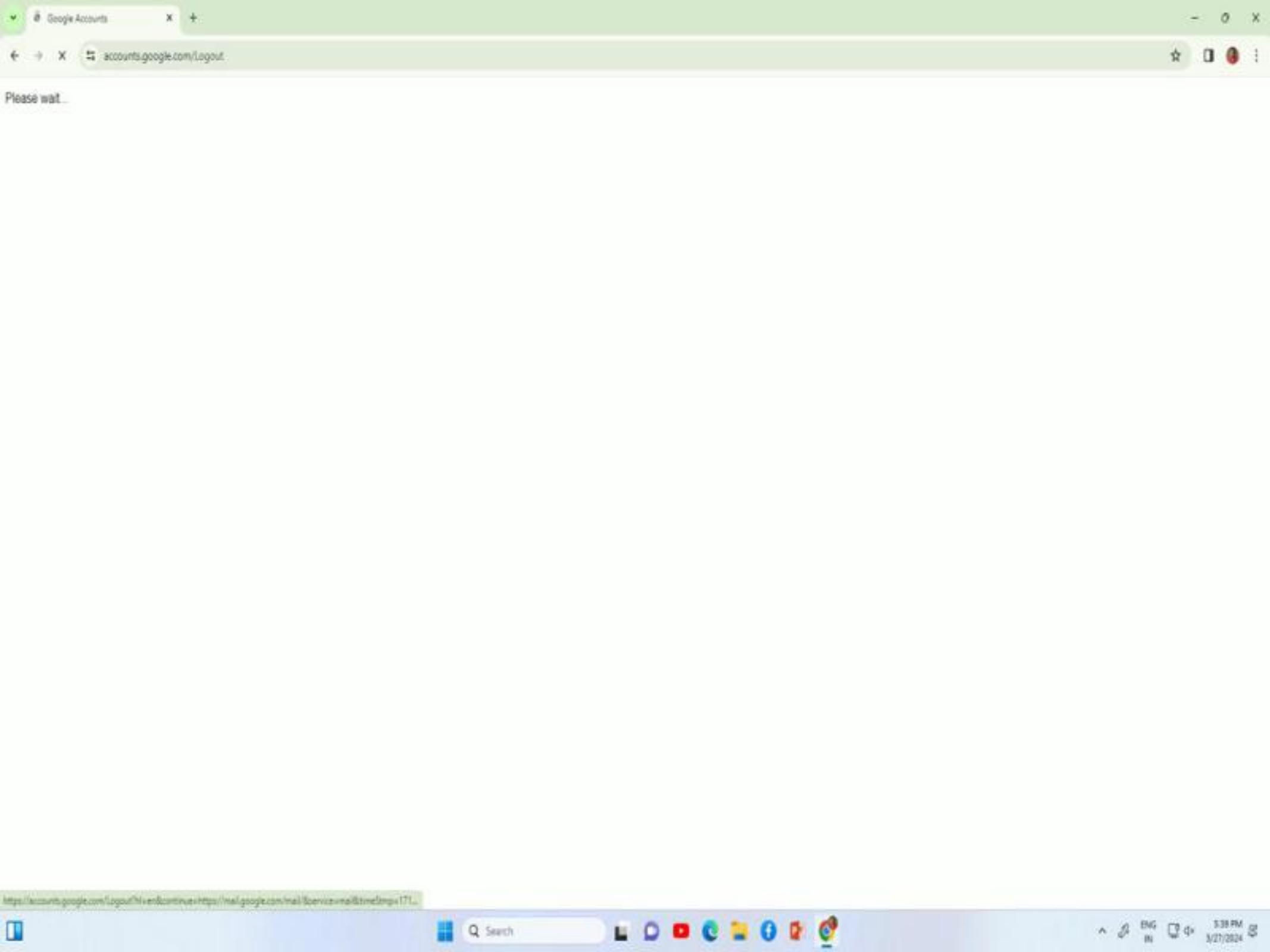
Differential Reproduction

The percentage of each genotype in the offspring differs from the percentage of each genotype in the original population as a result of differential reproduction.

Original Frequency of Genotypes	Total Number of Individuals Within a Population of 100,000 with Each Genotype	Number of Each Genotype Not Reproducing Subtracted from the Total	Total of Each Genotype in the Reproducing Population of 58,000 Following Selection	New Percentage of Each Genotype in the Reproducing Population
AA = 36%	36,000	36,000 − 18,000 18,000	18,000	18,000 / 58,000 = 31.0%
Aa = 48%	48,000	48,000 − 24,000 24,000	24,000	24,000 / 58,000 = 41.4%
aa = 16%	16,000	16,000 − 0 16,000	16,000	16,000 / 58,000 = 27.6%
100%	100,000		58,000	100.0%

Click to add speaker notes


Drive
Search in Drive
New
Home
Activity
Workspaces
My Drive
Shared with me
Recent
Starred
Spam
Trash
Storage
63.87 GB used
Home
1 selected
Name
Reason suggested
Owner
Location
Lecture 29-30-Genetic diversity within species-Enger (Ch 12-13).pptx
You opened • 4:49 PM
me
GEN-BIO-BIOF111-SEMI...
DST_FIST_2024_Equipment List.xlsx
You edited • 3:48 PM
Kavi Devraj
DST FIST 2024
Lecture 26-28 Patterns of inheritance.pptx
You opened • Mar 26, 2024
me
GEN-BIO-BIOF111-SEMI...
General Biology Draft Calendar.xlsx
You opened • Mar 26, 2024
NagaMohan Kommu
General Biology-2024
BIO F244 IMA SEM II 2-23-24
You edited • Mar 26, 2024
Trinath Jamma
Shared with me
BIO F244 IMA SEM II 2-23-24-LIST.xlsx
You opened • Mar 26, 2024
me
IMA-SEM-2-23-23
Schedule of Announced Quizzes
You opened • Mar 21, 2024
NagaMohan Kommu
General Biology-2024
General Biology_Continuous Lecture & quiz schedule.docx
NagaMohan Kommu edited • Mar 26, 2024
NagaMohan Kommu
General Biology-2024
Lecture Quiz 26 (27-03-2024) Linkage
NagaMohan Kommu edited • 12:18 PM
NagaMohan Kommu
Quizzes_Continuous Le...
A102 Discussion Room bookings & status (AY: 2023-24)
supratim ghosh edited • 12:43 PM
Biology Department
Shared with me
Lecture 21-24-Meiosis.pptx
You opened • Mar 19, 2024
me
GEN-BIO-BIOF111-SEMI...
MEIOSIS-NON-DISJUNCTION.pptx
You opened • Mar 18, 2024
me
GEN-BIO-BIOF111-SEMI...
CDRF-2024-PK-SR-PS.docx
OMALUR ESHWARI edited • Mar 22, 2024
me
CDRF-2024
ns of Biotechnology and Cell Division
Shuvadeep Maity edited • Mar 26, 2024
Shuvadeep Maity
Shared with me
Get notifications on your desktop for shared files and important events
Turn on
2024
GEN-BIO-BIOF111-SE...
Lecture 29-30-Geneti...
Search


Google Accounts
accounts.google.com/Logout
Please wait...
Search
ENG
IN
3:38 PM
3/27/2024