1

Microevolution

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2

Characteristics of a Population

- Variation in populations
  - individual does not evolve – the population evolves by natural selection of best adapted individuals from the population to breed more often and survive

3

Characteristics of a Population

- morphological traits – visible appearance or form of an individual or population
  - body plan
  - wings
  - feathers
  - size
  - shape
  - coloration

4

Characteristics of a Population

- physiological traits – functional characteristics of an individual or population
  - growth
  - reproduction
  - respiration
  - excretion

5

Characteristics of a Population

- behavioral traits – actions or habits characteristic of a type of organism
  - grooming
  - dogs howling at sirens
  - smiling back by babies
  - nursing of babies to mother

6

Characteristics of a Population

- polymorphisms – two or more distinct qualitative differences in a trait
  - rough coat vs. smooth coat on guinea pigs
  - tall vs. short
  - wrinkled seed coat vs. smooth seed coat

7

Characteristics of a Population

- continuous variation – subtle blending along a continuum vs. just two alternatives
  - eye color
  - skin color
  - hair color

8

Gene Pool

- Definition of gene pool – the total number of genes within a population shared by individuals in a population

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Gene Pool

- genes come in pairs – one from mother, one from father

- genes usually come in two slightly different forms or alleles
- each offspring inherits a slightly different combination of genes from parents and this results in biological diversity

10 ## Gene Pool

- phenotype – visual effect of genes - what you see
  - height
  - skin tone
  - color of fur
  - tall
  - short

11 ## Gene Pool

- genotype – actual genes you have which cause the phenotype
- you cannot see a genotype
- you inherit a genotype and others see your resultant phenotype

12 ## Gene Pool

- mutations and crossing over creates new genotypes different even from the parents
- 10^{60} possible gene combinations – no wonder we do not find individuals the same as ourselves
- only identical twins have same genotype

13 ## Gene Frequencies and Hardy-Weinberg *

- you can measure the number of individuals with a given trait in a population by a population survey of some trait (wing color)
- if this value stays the same over multiple generations this is called genetic equilibrium
- If it does not remain the same, it is evidence of evolution!

14 ## Hardy-Weinberg

- Conditions for a stable (non-evolving) population which is rare for all to occur
  - no gene mutations
  - very large population
  - population is isolated from the other populations
  - a particular gene locus has no effect on survival or reproduction
  - all mating is random

15 ## Microevolution

- Definition of microevolution * : small scale changes in allele frequencies brought about by:
  - mutations
  - natural selection
  - gene flow
  - genetic drift

16 ▧ **Mutations**

- Mutation: a change in the DNA that codes for a particular trait. They cause changes in structure, function or behavior.
- A mutation usually decrease a chance for survival!

17 ▧ **Mutations**

- mutation rate – probability of a particular mutation to occur each gene has its own rate
- 1 gamete in 10^5 to 10^6 has a mutation at any site (it is rare, but not that rare)

18 ▧ **Mutations**

- some mutations are positive and provide an advantage to the individual or germ line
- These are rare, but over millions of years populations change or evolve.

19 ▧ **Natural Selection**

- Brief definition of natural selection * :
  - populations have the ability to make more offspring under favorable conditions resources are limited and this will restrict unlimited population growth
  - competition between individuals will occur
  - there is a gene pool of all heritable traits within the population
  - most genes occur in at least two alleles which cause different phenotypes

20 ▧ **Natural Selection**

- Brief definition of natural selection (cont):
  - some phenotypes are better at promoting fitness (better adaptation to the environment)
  - natural selection will occur – survival and reproductive rates will increase for those individuals who have set of genes (traits) that promote the best fitness to the environment

21 ▧ **Natural Selection**

- Definition of biological fitness: a genetically determined tendency to leave behind more reproducing offspring than do competing individuals*

22 ▧ **Directional Selection**

- Definition of directional selection: movement due to natural selection that moves phenotypes in a given population in a certain direction
- MORE FORMALLY - allele frequencies underlying a range of variation tend to shift in a consistent direction in response to a directional change in the environment

23 ▧ **Directional Selection**
Industrial melanism

- Peppered moth in pre-industrial England*
  - before industrial revolution coal and soot was negligible
  - trees had light bark and lichen was pale color
  - peppered moths were mostly light colored with some dark moths

- dark moths were selected against because they were more obvious to predators
- light colored moths had an advantage of camouflage and reproduced more

24 ▧ **Directional Selection**
Industrial melanism

- During industrial revolution
  - coal and other fossil fuels were burned to run factories
  - soot was present and was deposited on the trees
  - lichen were killed by pollution
  - light colored moths now stood out on darkly colored trees and predators could find and eat them
  - if eaten – you cannot reproduce
  - the few darkly colored moths were now camouflaged and survived and bred
  - over time more dark-colored moths bred and the darkly colored population flourished
  - we thus moved the population directionally toward more darkly colored wings

25 ▧ **Directional Selection Pesticide resistance**

- pests are a problem for growing crops and decorative shrubs
- chemical companies create products which kill harmful pests
- there is diversity in the pest population with respect to survival after these sprays
- only those pests able to withstand the pesticides survive and breed

26 ▧ **Directional Selection Pesticide resistance**

- now the pests that are left are said to be pesticide resistant
- we have directionally selected toward pesticide resistant pests

27 ▧ **Directional Selection Pesticide resistance**

- biological engineering may reduce our use of pesticides by making the plants able to kill the pests by some gene product inserted by us
- recently biologically engineered plant pollen has been shown to kill monarch butterflies – not the species we intended to kill!

28 ▧ **Directional Selection**
Antibiotic resistance

- three main bacterial killers were once major problems in the US and other countries: tuberculosis, pneumonia and scarlet fever
- enter drug companies who create and manufacture antibiotics (some were found inside microorganisms to kill other microorganisms)

29 ▧ **Directional Selection**
Antibiotic resistance

- Antibiotics killed MOST bacteria, but some bacteria had the ability to live
- directional selection moved the diverse population where most did not have antibiotic resistance and a few did to where now many

have bacterial
resistance

30 ▭ **Directional Selection**
Antibiotic resistance

- now many antibiotics are useless (especially against venereal diseases and MRSA)
- many people think an antibiotic is useful against a cold which is caused by a virus
- doctors have to resist temptation to prescribe when they know the drug would do more ultimate harm due to resistance
- Consume all antibiotics when prescribed!

31 ▭ **Directional Selection**

- Stabilizing selection – intermediate forms are favored and extremes are selected against

32 ▭ **Directional Selection**

- Disruptive selection – extremes are favored over intermediate forms
- (aka diversifying selection)

33 ▭ **Special Types of Selection**

- Sexual selection – favors traits with no advantage for survival, but opposite sex prefers this trait

34 ▭ **Special Types of Selection**

- Sexual dimorphisms – characteristics associated with one sex or the other
  - male birds have brighter feathers (peacock and hummingbird)
  - larger males are often chosen first for mating
  - aggressive behavior may also be desired

35 ▭ **Special Types of Selection**

- Balancing selection – maintains both alleles for a given trait

36 ▭ **Special Types of Selection**

- Sickle cell anemia and malaria
  - HbA - normal hemoglobin gene
  - HbS - sickle cell hemoglobin
  - homozygous dominant - HbA HbA - normal hemoglobin
  - heterozygous - HbA HbS – carrier of hemoglobin trait – partial activity, partially normal hemoglobin
  - homozygous recessive - HbS HbS – sickle cell anemia

37 ▭ **Special Types of Selection**

- Sickle cell anemia and malaria
  - in Africa and many other regions around Mediterranean Ocean malaria was deadly – caused by a parasite which lives in RBC (where you find the hemoglobin)
  - oddly individuals with sickle cell trait (HbA HbS) survived better and had hybrid vigor?
  - partially sickled hemoglobin was less favorable to malaria organisms called Plasmodium

38 ▢ **Special Types of Selection**

- Sickle cell anemia and malaria
  - both homozygotes died more often and the heterozygotes were selected by the environment to live!

39 ▢ **Gene Flow, Genetic Drift, Bottlenecks & Founder Effects**

- Gene Flow – emigration and immigration bring in or move genes to new locations
- This can increase genetic diversity (migration to US by people from around the world)
- It will decrease genetic diversity – constantly seed from one strain of corn

40 ▢ **Gene Flow, Genetic Drift, Bottlenecks & Founder Effects**

- Genetic drift * – random change in allele frequencies due to chance (without selection)
- large affects on small isolated populations
- smaller effects or negligible on very large populations

41 ▢ **Gene Flow, Genetic Drift, Bottlenecks & Founder Effects**

- Genetic drift
  - you can get genetic fixation or loss of an allele even without selection
  - genetic fixation – an allele becomes homozygous and thus standard equipment in all members of a population
  - gene loss – a gene becomes absent in the population (no individuals have it)
  - you need large samples to approach random results from random events (coin flip)

42 ▢ **Gene Flow, Genetic Drift, Bottlenecks & Founder Effects**

- Bottlenecks – severe reduction in a population and then reestablishment of the large population from this smaller group of individuals

43 ▢ **Gene Flow, Genetic Drift, Bottlenecks & Founder Effects**

- Bottlenecks –
  - allele frequencies are markedly changed
  - some traits may be universally found in all individuals because the few who restarted the population had these traits

44 ▢ **Gene Flow, Genetic Drift, Bottlenecks & Founder Effects**

- Founder effect – special kind of bottleneck where a new population is started in a new location by a few founders
- For example
  - a variety of colorful flowers exist on the mainland
  - birds eat the seeds and a few of the seeds get lodged in the feathers
  - birds visit on offshore island and seeds drop off feathers of leave in feces
  - the few seeds may not adequately represent the original alleles in the mainland population of flowers
  - the island population may appear very different in variety than the mainland

45 ▢ **Inbreeding**

- Definition of inbreeding – breed with relatives
  - usually socially taboo
  - most religions are highly against this too

46 ▧ **Inbreeding**

- we do it with dogs/cats and it has led to a decrease in strength for inbred dogs/cats
- many of the recessive traits now become homozygous
- we do it a lot with zoo animals and endangered species where we have so few to breed with in the first place

47 ▧ **Inbreeding**

- halibut breeding program in Santa Monica Bay – they are always trying to get fish from as far away as possible to prevent inbreeding
- genetic diversity is good!

48 ▧ **Analogous vs. Homologous**

- Analogous structures * : Anatomical structures that show similar function, but dissimilar in embryonic and evolutionary background are said to be analogous. Convergent evolution has made these structures appear similar. Examples of analogous structures are: wing of bat and wing of an insect.

49 ▧ **Analogous vs. Homologous**

- Analogous structures
  - unrelated in embryonic development
  - convergent evolution was caused by the environment

50 ▧ **Analogous vs. Homologous**

- Homologous structures * are related by embryological origin, but may have changed due to divergent evolutionary pressures. Examples of homologous organs are: wing of bat, forelimb of horse; flipper of dolphin and the arm of man/woman.

51 ▧ **Analogous vs. Homologous**

- Homologous structures

52 ▧ **Analogous vs. Homologous**

- Homologous structures