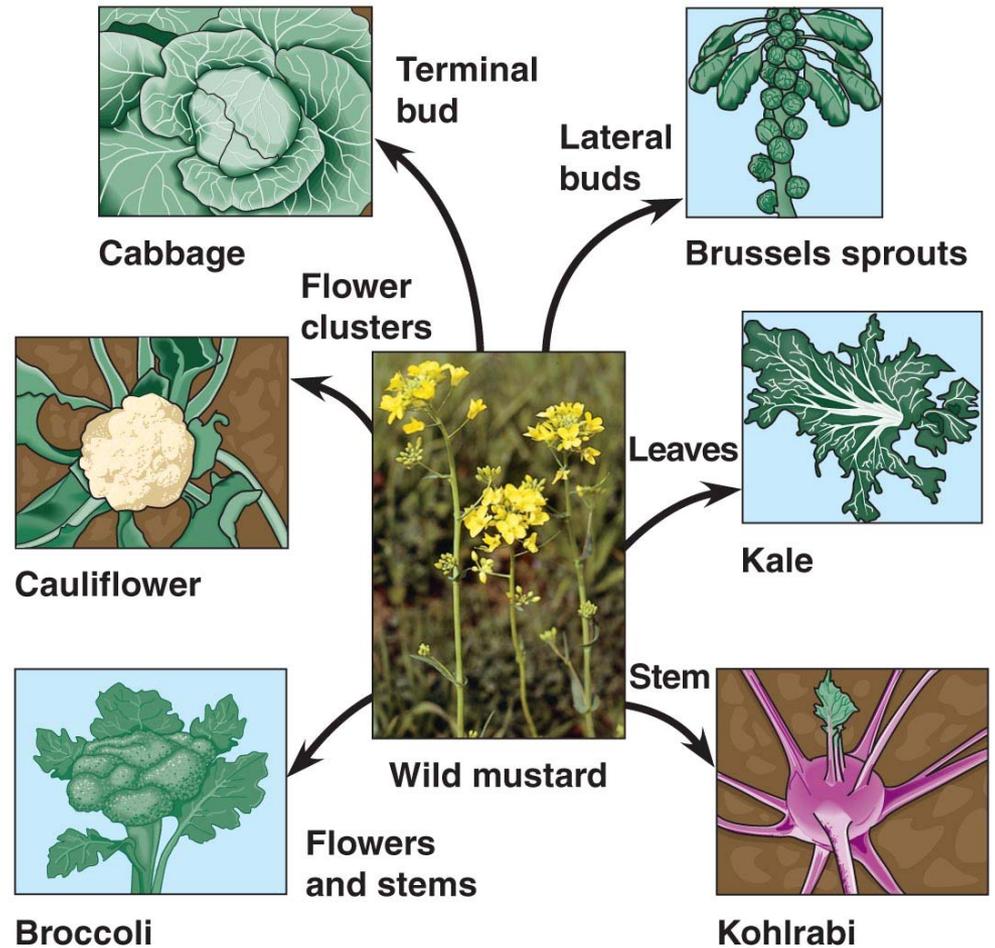


1) If there's "natural selection," what then is "artificial selection"?

- In **artificial selection**, humans have modified other species over many generations by selecting and breeding individuals with desired traits



2) Review of Darwin's phrase "Descent with Modification"

- The phrase *descent with modification* summarized Darwin's perception of the unity of life, and he preferred that phrase rather than "evolution"
- The phrase refers to the view that all organisms are related through descent from an ancestor that lived in the remote past
- In the Darwinian view, the history of life is like a tree with branches representing life's diversity

3) Darwin's observations:

- Darwin described four observations of nature and from these drew two inferences

4) Darwin's 1st observation:

- Members of a population often vary greatly in their traits (Fig.. 22.10)



5) Darwin's observations 2-4:

- Observation #2: Traits are inheritable, transmitted from parents to offspring
- Observation #3: All species are capable of producing more offspring than the environment can support
- Observation #4: Owing to lack of food or other resources, many of these offspring do not survive

6) From these 4 observations, Darwin inferred the following:

- Inference #1: Individuals whose inherited traits give them a higher probability of surviving and reproducing in a given environment tend to leave more offspring than other individuals
- Inference #2: This unequal ability of individuals to survive and reproduce will lead to the accumulation of favorable traits in the population over generations

7) Darwin's reasoning, cont:

- Darwin was influenced by Thomas **Malthus** who noted the potential for human population to increase faster than food supplies and other resources
- If some heritable traits are advantageous, these will accumulate in the population, and this will increase the frequency of individuals with adaptations
- This process explains the match between organisms and their environment

8) Darwin's reasoning, cont:

- Individuals with certain heritable characteristics survive and reproduce at a higher rate than other individuals
- **Natural selection** increases the adaptation of organisms to their environment over time
- If an environment changes over time, natural selection may result in adaptation to these new conditions and may give rise to new species

9) Summary of Natural Selection

1. **Natural selection** is differential success in reproduction from interaction between individuals that vary in heritable traits and their environment
2. Over time, **natural selection** produces an increase in adaptation of organisms to their environment
3. If an environment changes over time, **natural selection** may result in adaptation to these new conditions

10) Summary of Natural Selection, cont.

4. Note that *individuals* do not evolve;
populations evolve over time
5. Natural selection can only increase or decrease heritable traits in a *population*
6. Adaptations vary with different environments

11) Summary of Natural Selection, cont.

7. Natural selection does not create new traits, but edits or selects for traits already present in the population
8. The local environment determines which traits will be selected for or selected against in any specific population

12) Evolution is supported by an overwhelming and constantly growing amount of scientific evidence

- New discoveries continue to fill the gaps identified by Darwin in *The Origin of Species*
- The evidence is in the form of direct, measurable, empirical observations

13) Natural Selection in action

- Two examples among many provide evidence for natural selection:
 - the effect of differential predation on guppy populations and
 - the evolution of drug-resistant HIV

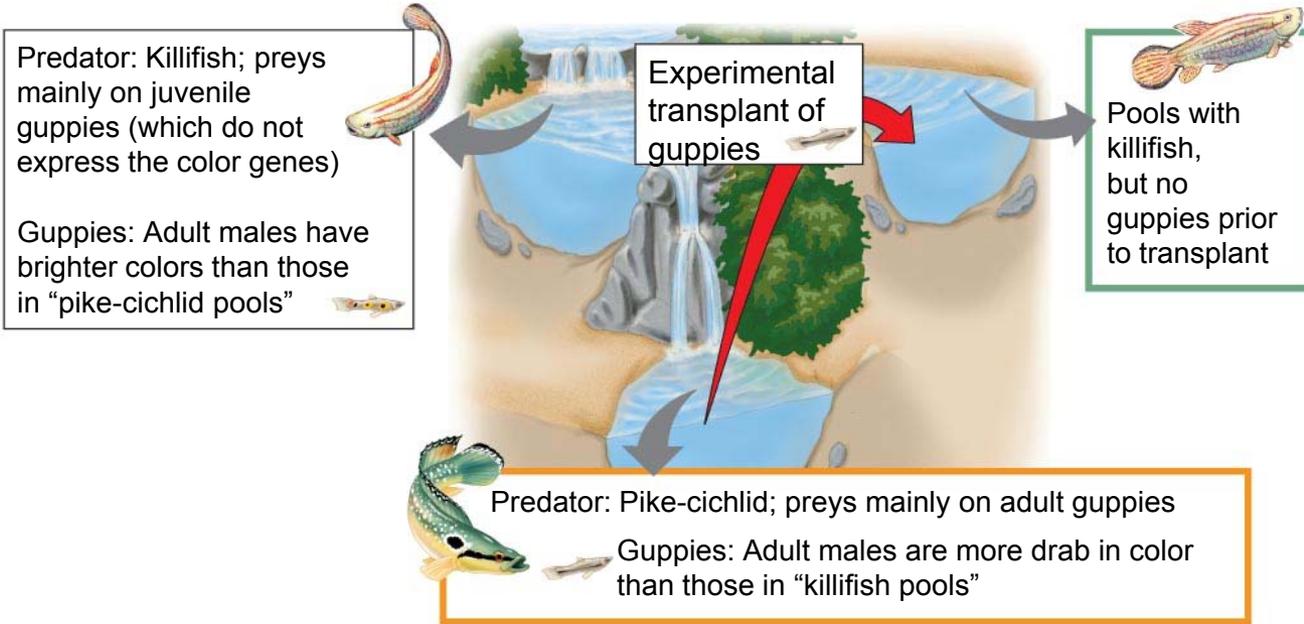
14) Predation and Coloration in Guppies: Scientific Inquiry

- John Endler has studied the effects of predators on wild guppy populations
- Brightly colored males are more attractive to females
- However, brightly colored males are more vulnerable to predation
- Guppy populations in pools with fewer predators had more brightly colored males

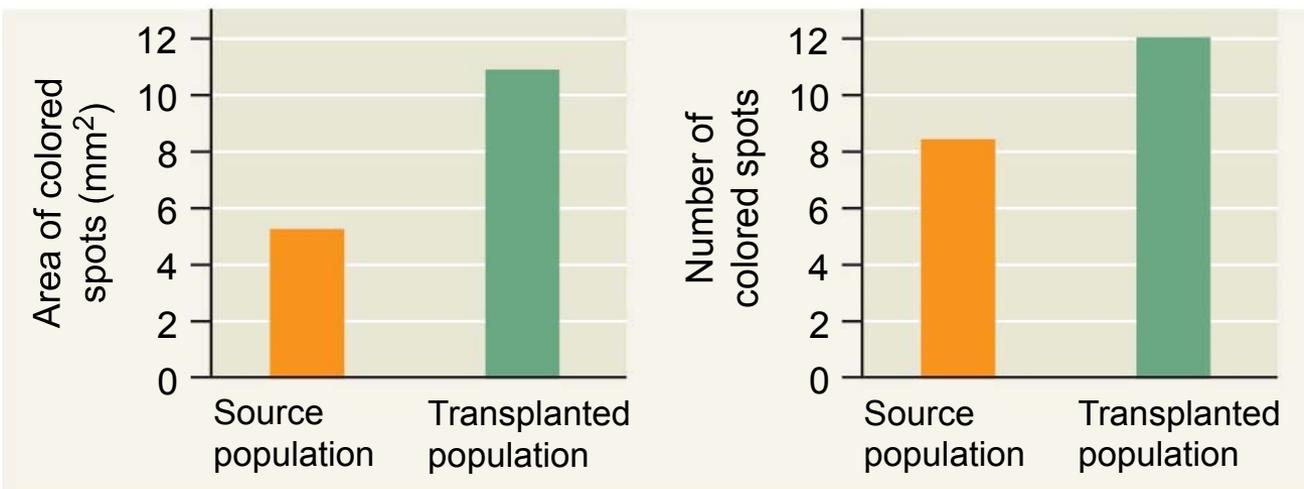
15) Predation and Coloration in Guppies, cont.

- Endler transferred brightly colored guppies (with few predators) to a pool with many predators (pikes and cichlids)
- As predicted, over time the population became less brightly colored
- Endler also transferred drab colored guppies (with many predators) to a pool with few predators
- As predicted, over time the population became more brightly colored

EXPERIMENT



RESULTS



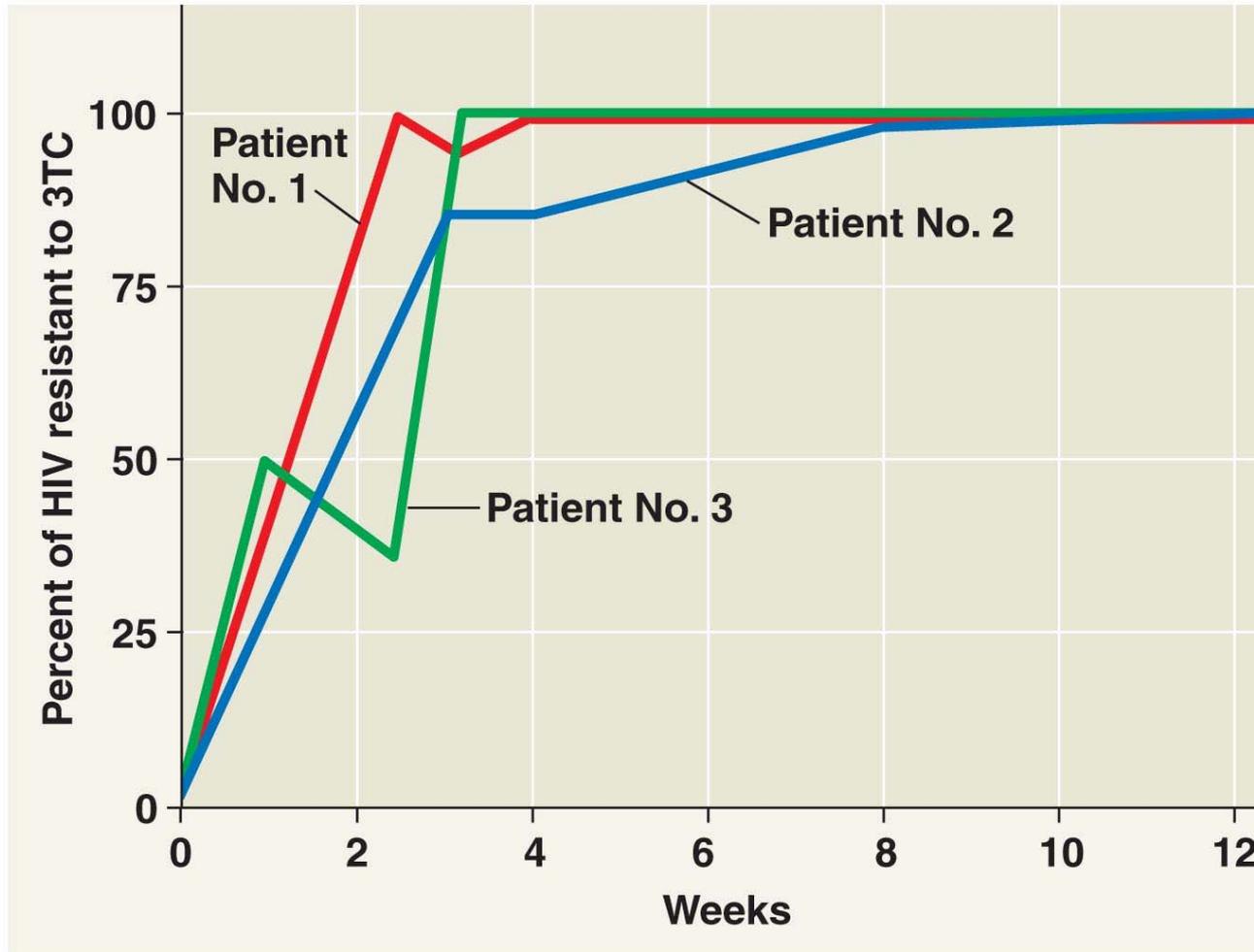
17) The evolution of drug-resistant HIV

- The use of drugs to combat HIV selects for viruses resistant to these drugs
- HIV uses the enzyme *reverse transcriptase* to make a DNA version of its own RNA genome
- The drug 3TC is designed to interfere and cause errors in the manufacture of DNA from the virus

18) The evolution of drug-resistant HIV, cont.

- Some individual HIV viruses have a variation that allows them to produce DNA without errors
- These viruses have a greater reproductive success and increase in number relative to the susceptible viruses
- The population of HIV viruses has therefore developed resistance to 3TC
- The ability of bacteria and viruses to evolve rapidly, poses a challenge to our society

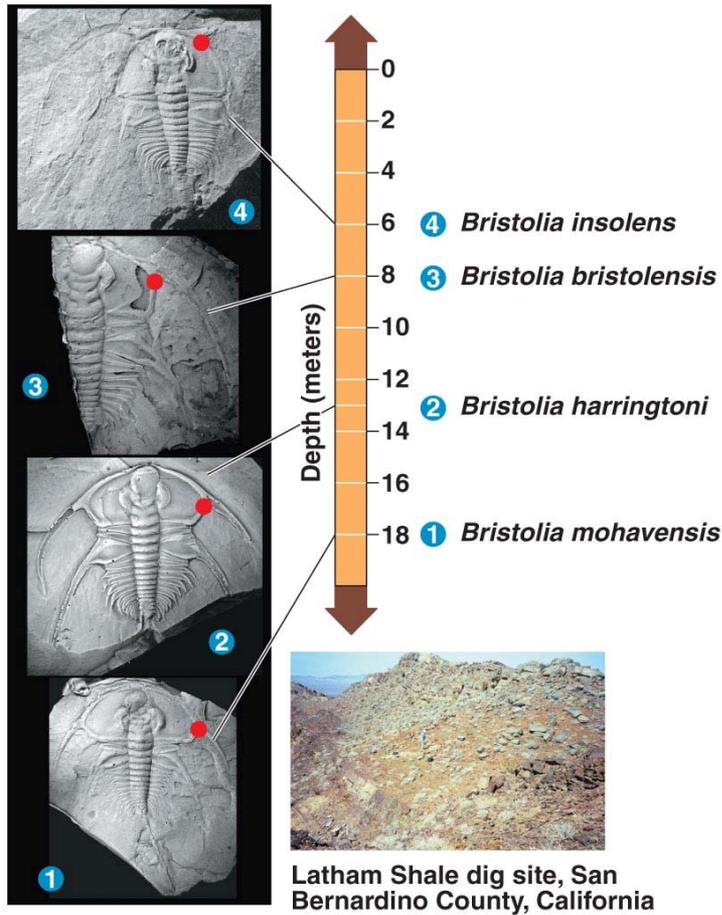
19) Note how quickly the drug-resistant HIV evolves:.



20) The Fossil Record

- The fossil record provides evidence of the extinction of species, the origin of new groups, and changes within groups over time

21) The fossil record, cont.



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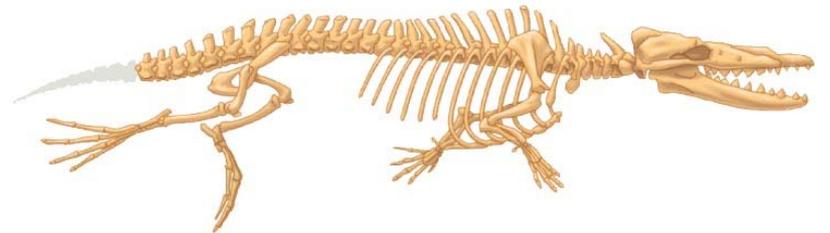
- Trilobites show changes in their spination angle (red dots) over time
- The Latham shale collection site is dated from 513 to 512 MYA
- The site is right close by in San Bernardino County

22) More evidence of change in the fossil record:

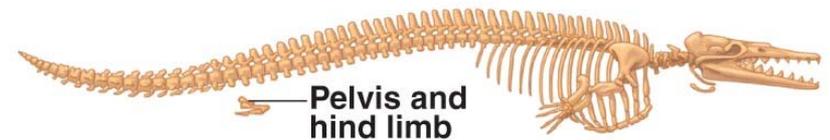
- The Darwinian view of life predicts that evolutionary transitions should leave signs in the fossil record
- Paleontologists have discovered fossils of many such transitional forms
- Here are a few of the sequence of changes among whales



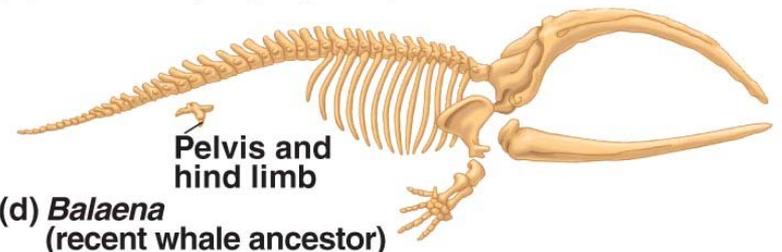
(a) *Pakicetus* (terrestrial)



(b) *Rhodocetus* (predominantly aquatic)



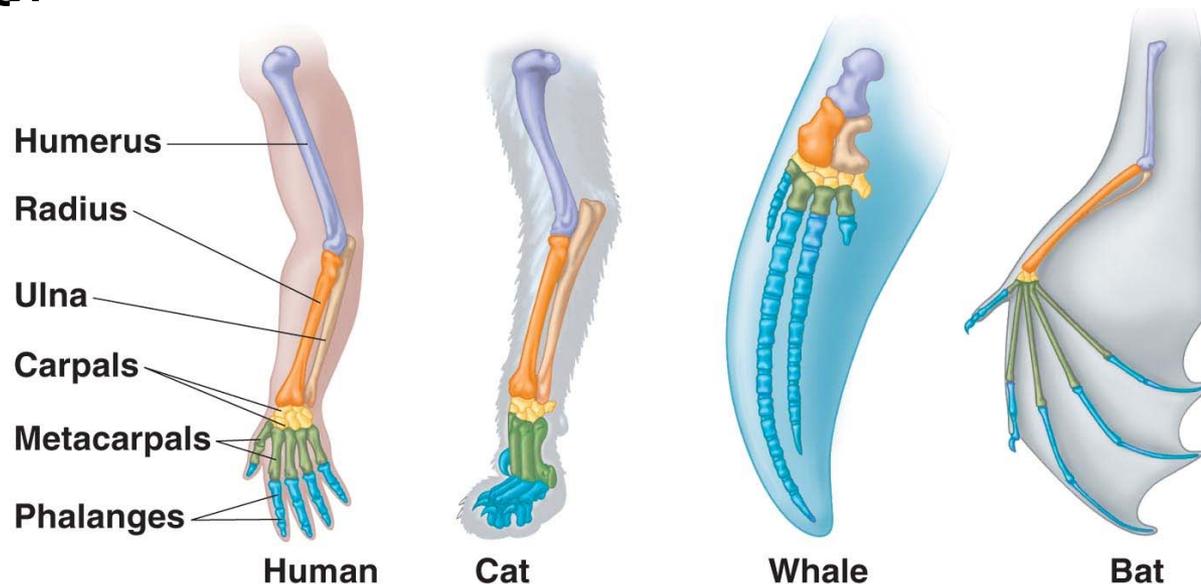
(c) *Dorudon* (fully aquatic)



(d) *Balaena*
(recent whale ancestor)

23) Homologies and homologous structures

- **Homology** is similarity resulting from common ancestry
- **Homologous structures** are anatomical resemblances that represent variations on a structural theme present in a common ancestor

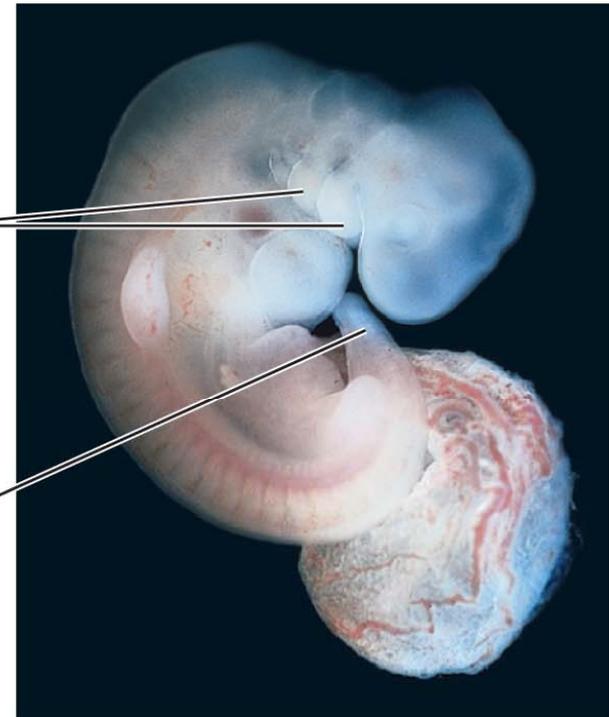


24) Homologies can be more than merely adult anatomical features

- Comparative embryology reveals anatomical homologies not visible in adult organisms



Chick embryo (LM)



Human embryo

**Pharyngeal
pouches**

**Post-anal
tail**

25) Vestigial features

- **Vestigial structures** are remnants of features that served important functions in the organism's ancestors
- Examples include the human appendix, the occasional post-anal tail, wisdom teeth, & others