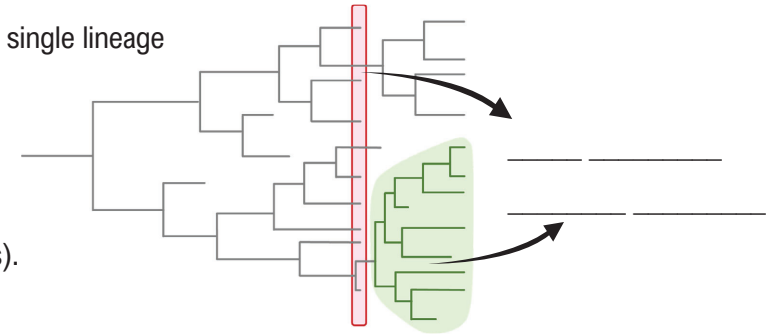
TOPIC: ADAPTIVE RADIATION

Adaptive Radiation

- **Adaptive Radiation:** evolutionary events where a single lineage gives rise to _____ diverse species.
  - Rapidly _____ the tree of life.
  - Lineage diversifies to fill many ecological _____ (often after mass extinctions).



- Why does adaptive radiation occur?

Ecological opportunity:

Species fill open _____.

e.g., Hawaiian *Drosophila* (~1000 species)

Evolutionary innovation:

_____ trait that __ fitness.

e.g., angiosperms (flowering plants)

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EXAMPLE

The phylogenetic tree below shows the relationships of most modern mammal *orders*. Placental mammals are highlighted in the blue box. Diversification *within orders* is shown using triangles. An example organism from each order is illustrated.

a) The K-T extinction event occurred ~66 million years ago. Draw a line across the phylogenetic tree indicating when the extinction event occurred.

b) At the *order* level, does the placental mammal adaptive radiation seem to begin before or after the K-T extinction event? _____

c) Did diversification *within* orders of mammals occur before or after the K-T extinction event? _____

d) Based on these data, did the K-T extinction lead to an adaptive radiation that included new orders of mammals or new species within existing orders?

_____

e) Circle 3 orders on the tree where the K-T extinction event seems most closely linked with the adaptive radiation of placental mammals.

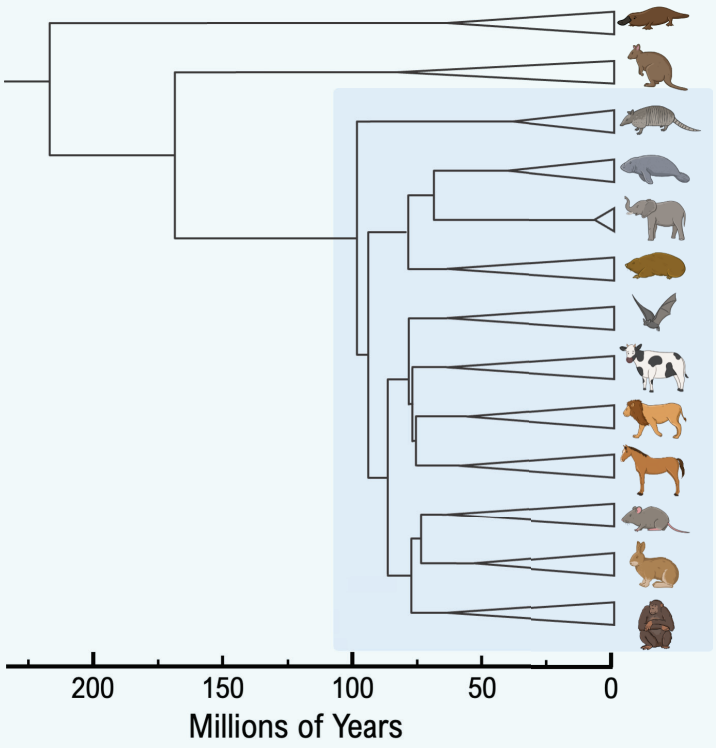

Image adapted from: Foley Nicole M., Springer Mark S. and Teeling Emma C. 2016 Mammal madness: is the mammal tree of life not yet resolved? *Phil. Trans. R. Soc. B* 371:20150140.

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PRACTICE

Which of the following statements are true?

I) Adaptive radiations often follow mass extinction events as organisms adapt to fill previously occupied niches.

II) Adaptive radiations are common on new volcanic islands where organisms can occupy many new environments.

III) The evolution of a new trait can trigger adaptive radiation as organisms are able to outcompete resident organisms in many different environments.

a) I & II only. b) I & III. c) II & III. d) I, II, & III.

PRACTICE

Which of the following would be considered an example of an adaptive radiation?

a) Finches on the Galapagos are thought to have evolved into many different species from an original founder population.

b) The peppered moth evolved to have dark coloration in response to an environmental change in industrial England.

c) Native human populations tend to have less genetic diversity the further away they are from Africa.

d) Mass extinction events are usually caused by worldwide habitat destruction from things such as meteorites or extreme volcanic activity.

PRACTICE

Which adaptive radiation is correctly matched to the extinction event that preceded it?

a) Adaptive radiation of dinosaurs: late-Devonian extinction event

b) Adaptive radiation of flowering plants (angiosperms): Ordovician extinction event

c) Adaptive radiation of mammals: end-Cretaceous extinction event

d) Adaptive radiation of Cambrian animals: end-Permian extinction event

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Cambrian Explosion

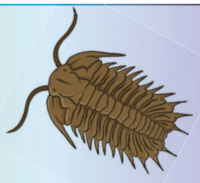
- **Cambrian Explosion:** adaptive radiation that introduced nearly every _____ phyla.
  - _____ million years ago; started the _____ era.

Before Cambrian Explosion:

- _____ bodied.
- Few known _____.
- Many _____ creatures.

After Cambrian Explosion:

- _____ bodied.
- _____ predators.
- Limbs, _____, _____ systems, _____.



- Possible causes for the Cambrian explosion include:
  - __ algae caused 1) rise in ___ and 2) served as a food source.
  - Rise of _____.
  - Diversification created new ecological _____.
  - New animal developmental _____ enabled complex body plans.

EXAMPLE

For each of the possible contributing reasons for the Cambrian explosion below, write why you think they could facilitate adaptive radiation.

a) Rise of predators: _____

b) Increased O_2: _____

c) New animal developmental genes: _____

PRACTICE

Which of the following statements about the Cambrian Explosion are true?

I) Before the Cambrian Explosion, most organisms had soft bodies.

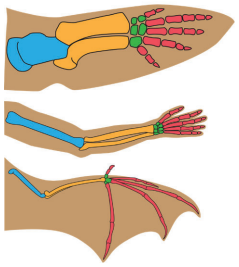
II) The Permian extinction created new ecological niches that were exploited during the Cambrian Explosion.

III) After the Cambrian Explosion, new morphological features like limbs and jaws are observed.

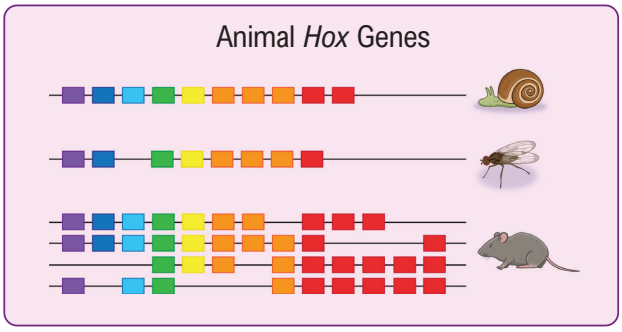
a) I & II. b) I & III. c) II & III. d) I, II, & III.

TOPIC: ADAPTIVE RADIATION

Developmental Genes & Regulation



- Many evolutionary changes are due to changes to gene _____.
  - Small changes _____ in development can have large impacts.
- **Heterochrony:** changes in the _____ or _____ of development.
  - Different structures come from _____ growth rates.
- **Homeotic genes:** determine the _____ organization of body parts.
  - Changes in homeotic genes can create _____ changes in _____ time.
  - _____ genes – control _____ body plans.
    - First seen in _____ phyla.
    - Determine body plan in head to _____ orientation.



PRACTICE

The evolution of the *Hox* gene cluster likely allowed for what key evolutionary innovation?

a) Genes that control development.

b) Complex body plans in animals.

c) Hard-bodied animals in the Cambrian.

d) Transcription factors that control gene expression.

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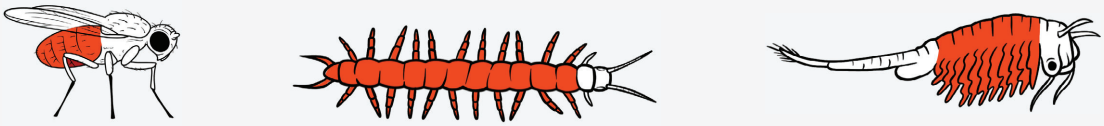
PRACTICE

In arthropods, the *Hox* genes *Ubx* and *abd-A* are largely expressed in the same tissues. The illustrations below show in red which tissues both *Ubx* and *abd-A* are expressed in three species of arthropods. Based on this illustration, which statement is consistent with the data?



Fruit fly Centipede Brine shrimp

a) The gene *Ubx* induces the growth of legs while *abd-A* inhibits the growth of legs.

b) Legs can only grow in tissues with *Ubx* and *abd-A* expression.

c) *Ubx* and *abd-A* repress leg formation in insects but not in crustaceans or centipedes.

d) Duplications of *Ubx* and *abd-A* allowed organisms such as crustaceans and centipedes to grow more legs.

Images adapted from: Jennifer K. Grenier, Theodore L. Garber, Robert Warren, Paul M. Whitington, Sean Carroll
Evolution of the entire arthropod Hox gene set predated the origin and radiation of the onychophoran/arthropod clade,
Current Biology, Volume 7, Issue 8, 1997, Pages 547-553,
ISSN 0960-9822,
https://doi.org/10.1016/S0960-9822(06)00253-3.