



## Evidence of Evolution

### EVO-1.M.1

Evolution is supported by scientific evidence from many disciplines (geographical, geological, physical, biochemical, and mathematical data).



## Evidence of Evolution

### EVO-1.N.1

**Molecular, morphological, and genetic evidence from extant and extinct organisms adds to our understanding of evolution—**

- a. Fossils can be dated by a variety of methods. These include:**
  - i. The age of the rocks where a fossil is found**
  - ii. The rate of decay of isotopes including carbon-<sup>14</sup>**
  - iii. Geographical data**
- b. Morphological homologies, including vestigial structures, represent features shared by common ancestry.**



## Evidence of Evolution

### EVO-1.N.2

A comparison of DNA nucleotide sequences and/or protein amino acid sequences provides evidence for evolution and common ancestry.

### EVO-2.B.1

Many fundamental molecular and cellular features and processes are conserved across organisms.

### EVO-2.B.2

Structural and functional evidence supports the relatedness of organisms in all domains.



**Which of these structures demonstrate common ancestry?**

- A. Analogous structure**
- B. Convergent structure**
- C. Homologous structure**
- D. Nucleotide structure**

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**Which of these structures demonstrate common ancestry?**



**C. Homologous structure**

**Homologous structures are structures that are structures due to common ancestry. These structures do not always look the same or function the same.**

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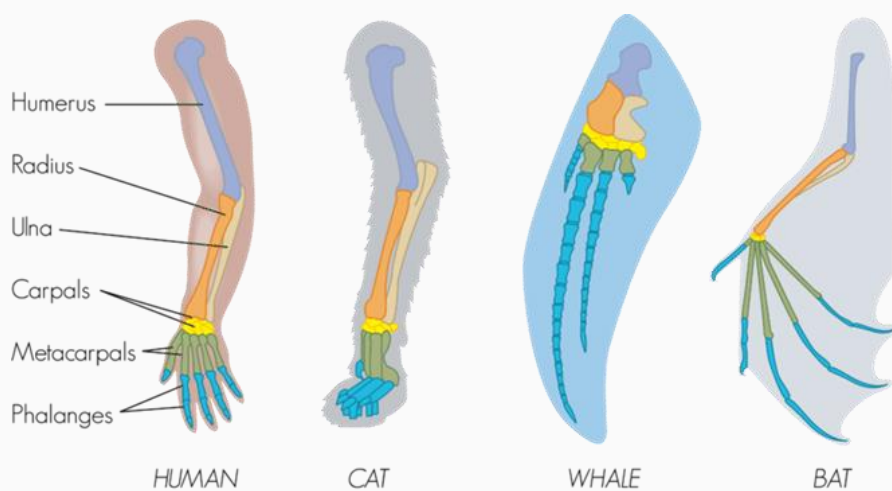


**What are homologous structures?**

## What are homologous structures?



**Structures from common descent. As seen in the image, all these organisms have the same bones in their arm, fin, wing, etc. The bone structures are slightly different as changes occurred due to evolution, but they are similar enough to show common descent.**



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**Extant organisms are...**

- A. Ancestors**
- B. Current Living**
- C. Future Species**



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**Extant organisms are...**

**B. Current Living**

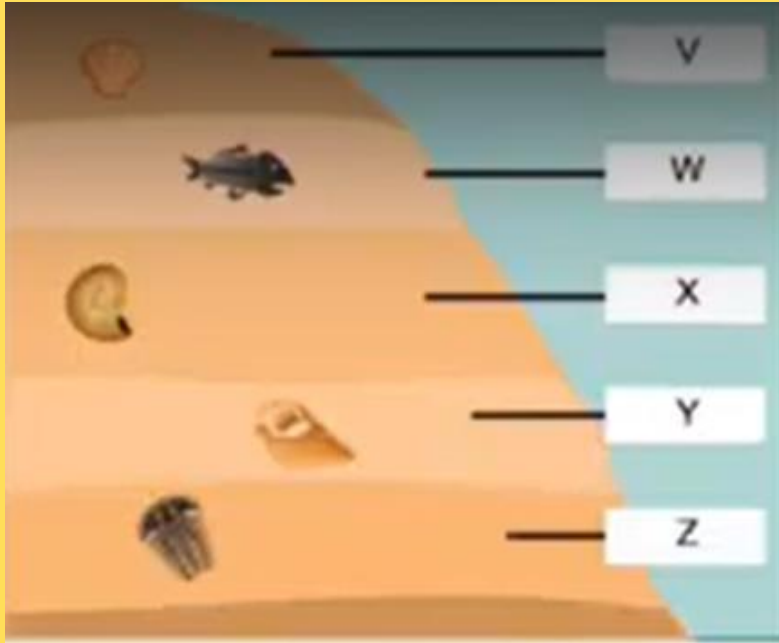


**Extant organisms are organisms that are currently living versus extinct species have died out.**

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**Which fossil is the oldest?**

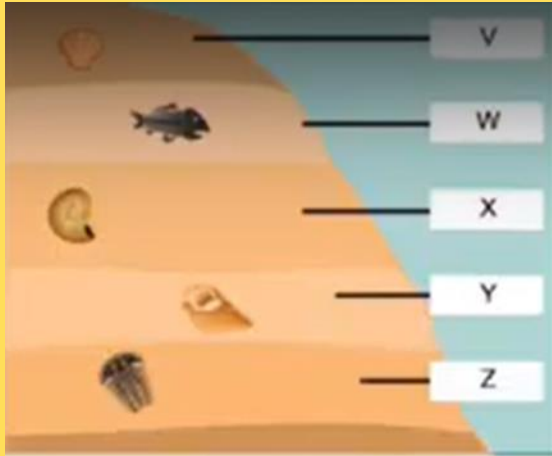
- A. V**
- B. W**
- C. Y**
- D. Z**

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**Which fossil is the oldest?**



**D. Z**

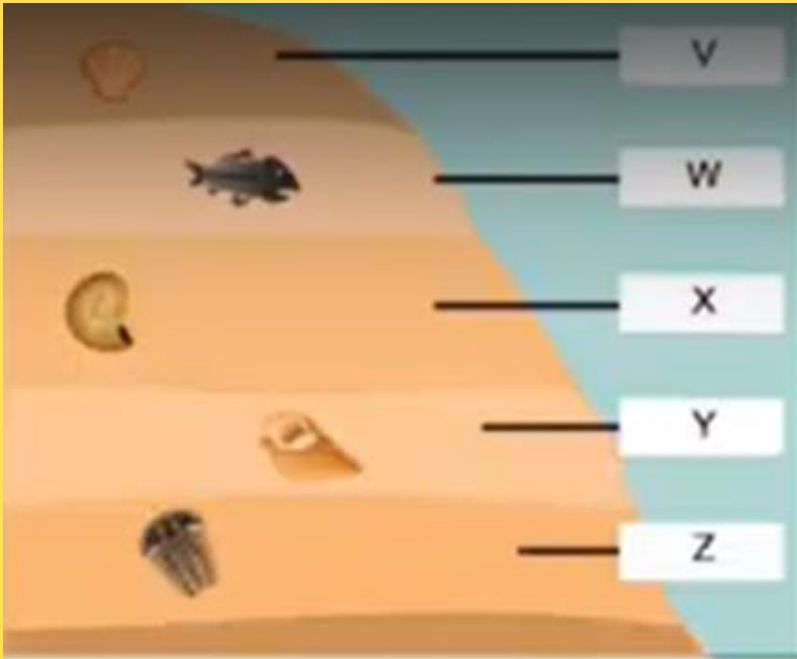


**As time progresses, soil is deposited on top. The oldest fossil would be the deepest fossil to show that it took place the longest time so has more soil on top of the fossil.**

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**If looking for a recent ancestor of the fish, look at**

**A. V**

**B. X**

**C. Y**

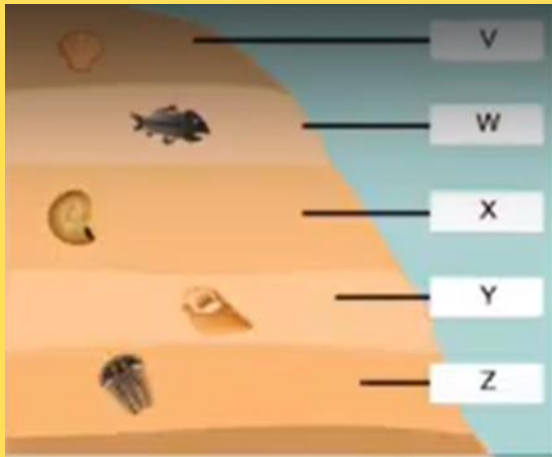
**D. Z**

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If looking for a recent ancestor of the fish, look at



**B. X**



**The fish is in layer W. The V would be a descendant while the X, Y, & Z would be ancestors.**

**The most recent would be the one right before layer W which is X.**

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If the half life of carbon-14 is **5,000** years, how long does it take for **25%** of the carbon to be remaining?

**\*Note: I am rounding the half-life for easy math\***

- A. 2500**
- B. 5000**
- C. 7500**
- D. 10000**

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If the half life of carbon-14 is **5,000** years, how long does it take for **25%** of the carbon to be remaining?

\*Note: I am rounding the half-life for easy math\*

**D. 10000**



After **1** half-life, the **100%** is **50%**.

After **2** half-lives, the **100%** is **25%**.

Since it is **2** half-lives, the half-life (**5,000**) is multiplied by **2**.

The amount of time is **10,000**.

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How many half-lives to get to  $\frac{1}{32}$  of the original amount?

- A. 4
- B. 5
- C. 6
- D. 7



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How many half-lives to  
get to  $\frac{1}{32}$  of the  
original amount?

**B. 5**



$1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8}$   
 $\rightarrow \frac{1}{16} \rightarrow \frac{1}{32}$

Count the number of arrows.  
There are **5** arrows so there  
were **5** half-lives.

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**Vestigial structures show  
common ancestry...**

- A. True**
- B. False**

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**Vestigial structures show  
common ancestry...**

**A. True**



**Vestigial structures are traits inherited from ancestors that are no longer or less functional or less elaborate. These demonstrate common ancestry.**



**Which is more accurate  
molecular data?**

- A. Amino acid sequence**
- B. Nucleotide sequence**

**Which is more accurate  
molecular data?**

**B. Nucleotide sequence**



**Due to silent mutations, there  
can be changes in the nucleotide  
sequence without a change in  
the amino acid sequence.**

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**Why is nucleotide sequence  
more accurate?**

**Why is nucleotide sequence more accurate?**



**Nucleotides refer to the DNA sequence. There can be a change in the DNA that doesn't change the amino acid (silent mutation). There can be change in the DNA that is not coded (introns, noncoding DNA, etc).**

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TABLE 1. AMINO ACID DIFFERENCES IN THE LYST PROTEIN AMONG BEAR SPECIES

	Panda	Black	Brown	Polar
Panda	–			
Black	33	–		
Brown	34	1	–	
Polar	40	7	8	–

**Which two bears are most closely related?**

- A. Brown & Black**
- B. Brown & Polar**
- C. Black & Polar**
- D. Black & Panda**





**Which two bears are most closely related?**

TABLE 1. AMINO ACID DIFFERENCES IN THE LYST PROTEIN AMONG BEAR SPECIES

	Panda	Black	Brown	Polar
Panda	–			
Black	33	–		
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Polar	40	7	8	–

**A. Brown & Black**

**Based on the amino acid differences in the chart, there is 1 difference between black and brown bears while there are more differences between the other bears.**

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TABLE 1. AMINO ACID DIFFERENCES IN THE LYST PROTEIN AMONG BEAR SPECIES

	Panda	Black	Brown	Polar
Panda	–			
Black	33	–		
Brown	34	1	–	
Polar	40	7	8	–

**Which bear is the outgroup?**

- A. Black**
- B. Brown**
- C. Panda**
- D. Polar**

## Which bear is the outgroup?

TABLE 1. AMINO ACID DIFFERENCES IN THE LYST PROTEIN AMONG BEAR SPECIES

	Panda	Black	Brown	Polar
Panda	–			
Black	33	–		
Brown	34	1	–	
Polar	40	7	8	–

**C. Panda**



**The outgroup is the least related organism. Based on the largest number of differences between all of the bears and the panda bear, the panda bear is the outgroup.**

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**What is biogeography?**

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**What is biogeography?**



**Study of the distribution of  
species and ecosystems in  
geographic space and through  
geological time**

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**Identify TWO evidences of evolution for organisms**

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**Identify TWO evidences of evolution for organisms**

### **Biogeography:**

**Two organisms are located in the same area**

### **Geological:**

**Two organisms lived in a similar time period**

### **Homologous structures:**

**Two organisms have the same structure due to a common ancestry**

### **Embryology:**

**Two organisms have the same structures during embryonic development to demonstrate common ancestry**

### **Biochemical:**

**Comparison of proteins or nucleic acids between two organisms to determine the number of differences**

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**Identify TWO evidences of evolution for organisms**

## **Biogeography:**

**Two organisms are located in the same area**

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**Identify TWO evidences of evolution for organisms**

## **Embryology:**

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## **Biochemical:**

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**What is more accurate to determine relatedness?**

- A. DNA**
- B. Protein**

What is more accurate to determine relatedness?

A. DNA



**DNA is more accurate to determine relatedness. The protein is synthesized under the direction of the DNA. Due to multiple codons coding for the same amino acid, there can be a change in the DNA but not in the protein.**



**Why is DNA more accurate than proteins?**

- A. 4 nucleotides make up DNA**
- B. 20 amino acids make up protein**
- C. Introns are removed from mRNA before making protein**
- D. Silent mutations change DNA without change in protein**

**Why is DNA more accurate than proteins?**

**D. Silent mutations change DNA without change in protein**



**Silent mutations involves a change in the codon sequence but no change in the coded amino acid. This allows the DNA to change without a change in the protein.**



**What type of rock are fossils found in?**

- A. Flintstone**
- B. Granite**
- C. Igneous**
- D. Sedimentary**

**What type of rock are fossils found in?**

**D. Sedimentary**



**Sedimentary rocks are types of rock that are formed by the accumulation or deposition of mineral or organic particles at Earth's surface, followed by cementation. After an organism dies, it will be surrounded by this type of rock to form a fossil.**

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How much of a **200 g** sample is remaining after **5** half-lives?

**A. 3.125**

**B. 6.25**

**C. 25**

**D. 40**



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How much of a **200 g** sample is remaining after **5** half-lives?

**B. 6.25**



**200** → **100** → **50** → **25**  
→ **12.5** → **6.25**

**A half-life involves the amount of time for half of the substance to break down.**

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How much time passed if **12.5** g of **100** g sample has decayed if the half-life is **3** years?

- A. **3**
- B. **6**
- C. **9**
- D. **12**

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How much time passed if **12.5 g** of **100 g** sample has decayed if the half-life is **3** years?



**c. 9**

**100 → 50 → 25 →  
12.5**

There are **3** arrows, so there have been **3** half-lives.

If a half-life is **3** years, then **3 x 3 = 9**



**What fossil layer is the oldest?**

- A. Deepest**
- B. Middle Rock**
- C. Surface Layer**
- D. Unable to determine due to natural turn over each season**

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**What fossil layer is the oldest?**

**A. Deepest**



**As sedimentary rock surrounds the organism after it dies, the oldest fossils will be the deepest as more and more sedimentary rock is placed on top of the organism over time.**

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**When comparing protein sequences...**

- A. Two organisms with the greatest differences are more closely related**
- B. Two organisms with the least differences are more closely related**

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**When comparing protein sequences...**

**B. Two organisms with the least differences are more closely related**



**As time increases, the number of nucleotide differences increases. The two organisms with the least differences would be the most closely related due to less time passed.**



## Homologous structures

- A. Show common descent**
- B. Show a convergent event**
- C. Are structures that are similar due to similar environments**
- D. Are structures that are different due to similar environments**



**Homologous structures**

**A. Show common descent**



**Homologous structures are similar structures due to common ancestry. They may differ in form or function but are from common ancestry.**



## Analogous structures

- A. Show common descent
- B. Show convergent evolution
- C. Shares an ancestral trait
- D. Shares the same body structure

## Analogous structures

### B. Show convergent evolution



**Analogous structures are similar structures but do not represent common ancestry.**

**Convergent evolution is due to similar solution to a similar problem. The structures are similar because the selective pressure was similar which led to a similar structure.**

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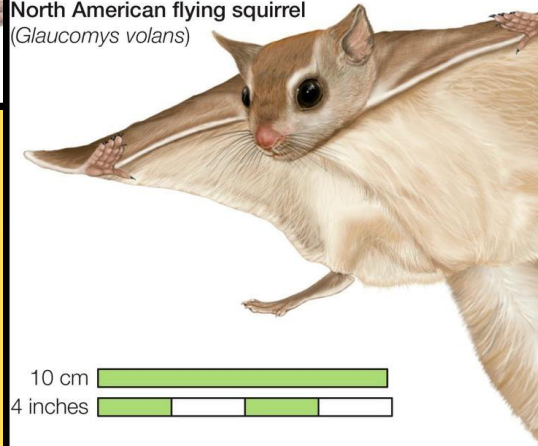
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short-headed glider, sugar glider,  
flying phalanger, flying possum  
(*Petaurus breviceps*)



southern flying squirrel,  
North American flying squirrel  
(*Glaucomys volans*)



## Sugar Glider vs Flying Squirrel

- A. Analogous structure**
- B. Embryological structure**
- C. Homologous structure**
- D. Vestigial structure**

**Sugar Glider vs Flying  
Squirrel**

**A. Analogous structure**



**Although the sugar glider and the flying squirrel look similar, they have different lineages. The sugar glider is a marsupial while the flying squirrel is a placental.**

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**Convergent evolution shows  
common ancestry**

- A. True**
- B. False**

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**Convergent evolution  
shows common ancestry**

**B. False**



**Convergent evolution is due to a similar solution to a similar problem. It does not represent common ancestry.**