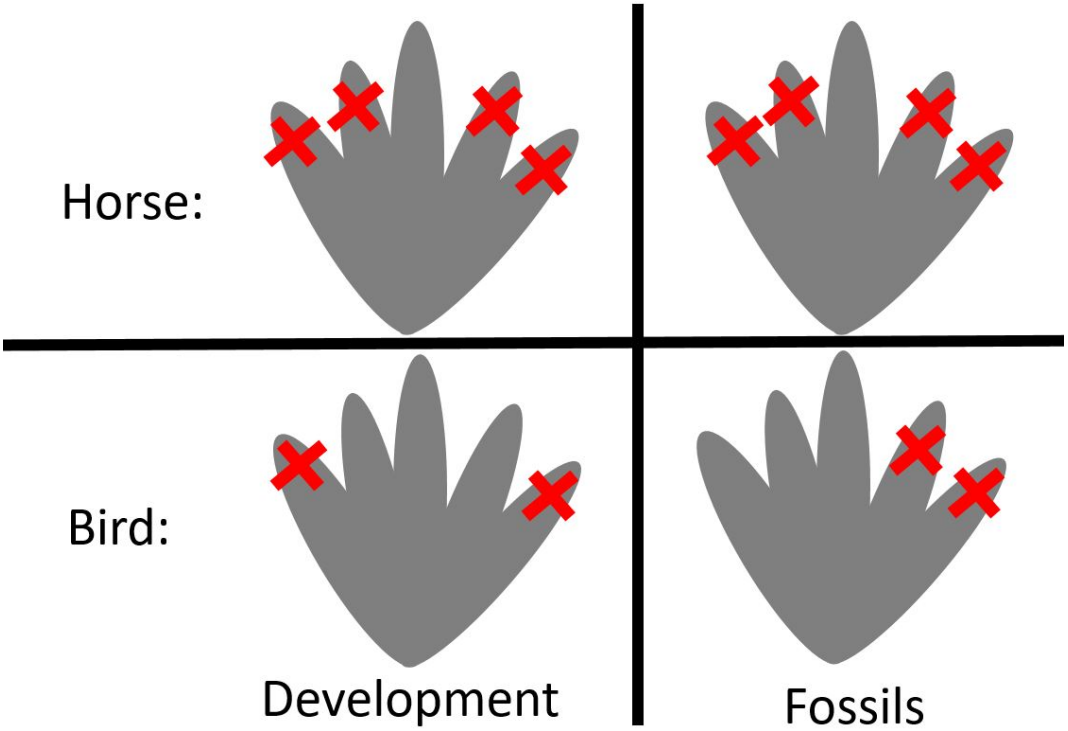
Questions

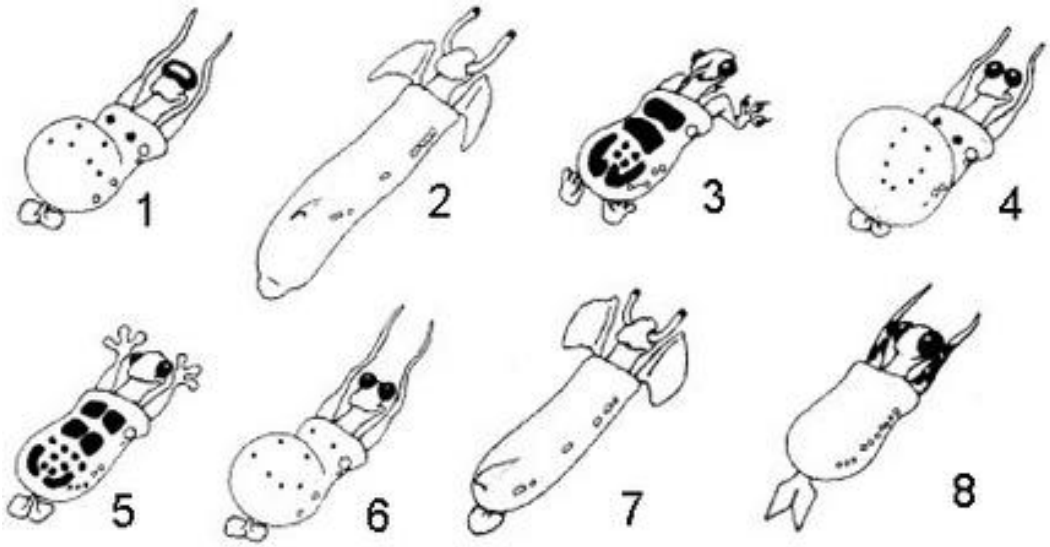
1. *Trees cannot walk. Yet across the Rocky Mountains you find the same high-altitude species spread across each mountaintop. Trees cannot swim, yet if you go to Cuba you'll find trees.* For each of the following pairs of tree traits, describe *why* one trait would increase dispersal probability relative to the other: (a) self-fertilizing & out-crossing plants; (b) wind-dispersed pollen & animal-dispersed pollen; (c) wind-dispersed seeds & bird-dispersed seeds; (d) salt-tolerance & salt-intolerance (a) Neither increases *dispersal probability*. Self-fertilizing, as the ability to reproduce asexually will help mitigate against extinction if only a single colonist is dispersed, but see my comments for part b; (b) Pollen, on its own, can't establish a population in a new place. So neither is a reasonable answer here. Notably, this question asks about dispersal, not survival. A lot of people conflated "dispersal probability" with "dispersal and survival for some unspecified time". Dispersal (immigration) and extinction were *separate* processes in the lectures! (c) Bird-dispersed seeds. Seeds, unlike pollen, can establish a population if they find a suitable environment. In general, a bird is more likely to transport a seed to a new place where it can germinate, as birds target places they can live. Some arguments based on propagule number favoring wind-dispersed could get majority partial credit, though; (d) Salt-tolerance, as all else being equal, greater tolerances promote greater dispersal.

2. *A cancerous tumor is a population of cells within a person's body that have gone "rogue" due to the unique mutations they've accumulated. These rogue cells divide and proliferate, and in so doing accumulate additional mutations causing different lineages within the tumor. Mutations within these cells can effect the rate of cell division, the ability to metabolize nutrients, the recognizability to the immune system, and just about every other aspect of the cell.* What does the above information imply for the prospect of a universal "cure for cancer"? You have to remember what class you're in, and that you're trying to convince me you understand the topics we've covered. This question is linked to the various, "is this evolution" questions we talked about in class (remember the populations of insects). The information presented means that tumors can evolve via natural selection, which implies that any "cure" has to be able to contend with an evolving problem. Any answer that discussed that specifically discussed the fact that an evolving tumor makes a single "cure" difficult to make got basically full credit. Any answer that discussed cancer but ignored the information presented did not receive much credit.

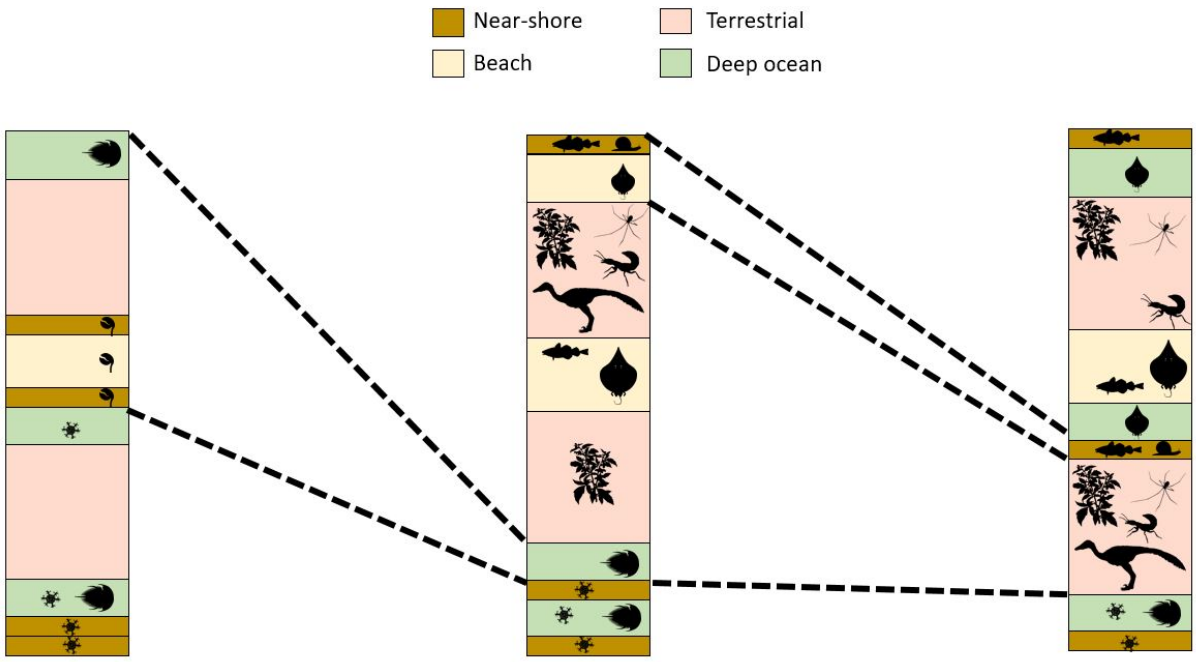
3. *Your coolest friend is hanging out with you, and says, "I've been thinking a lot about memes recently. It seems to me that, for a given like image or gif, there's a bunch of different captions floating around at any given time. Some of those are funnier than others, and people are always tweaking the memes a bit to make new variants. The funnier ones get reposted, which seems like replication, more often than less funny ones. So, even if it seems really unnatural, do you think that these memes evolving by natural selection?"* How do you answer your friend? The word "meme" was coined by an evolutionary biologist because they needed a word for a cultural concept that evolved similarly to a biological unit (e.g., a "gene"). There are many possible answers to this question, but the main thing I was looking for was a thoughtful discussion of natural selection. Basically: the evolution of memes is complicated, with a lot of processes and forces acting on them that have no clear biological analog, but of all the many forces that shape the replication of memes, natural selection must be one of them given it's inevitability when all of its criteria are met (and although inheritance here is different in kind from biological inheritance, it is still inheritance).



4. (2 points) *Tetrapods (four-legged vertebrates) ancestrally have five digits on their forelimbs, and they are numbered to establish homology, with Digit I (your thumb) and Digit V (your pinky) being the end ones. Many groups have reduced their digits, though. Early fossil horses have five digits, and as you look at younger fossils the outer four toes (digits I, II, IV, & V) get smaller through time, leaving only digit III in modern horses. Developmental data on horses show all five digits forming, but the outer digits (I, II, IV, and V) disappear later in development. Adult birds have three fingers on their forelimbs. In fossils, the posterior digits (IV & V) are lost through time, but when you look at developing chicken embryos, the lateral digits (I and V) are lost. Thus, fossil data suggests that the last bird digit is homologous to the horse's digit, while develomental data suggests the middle bird digit is homologous to the horse digit.* Propose an experiment to discriminate between these hypotheses. A detailed experiment exploring genetics, developmantal cell populations, or anatomy could get full credit here. Use of "function" in any way to establish homology lost credit. Notably, this question does not ask for a list of homology criteria, or ask you to list lines of evidence. Doing those things did not result in very many points.



5. (2 points) *While on a deep-sea voyage, a colleague of yours discovered a suite of strange creatures from near the bottom of the ocean. Eight species were discovered, and your colleague sent you detailed images of them and asked for your help classifying them.* Propose a hierarchical classification system for these eight species, with a specific trait as evidence for each group you propose. (*Nota bene*: I'd recommend using the back of this sheet as scratch paper, and placing your final diagrammed relationships below). These are Caminalcules. There's no single "correct" clustering, but if your clustering wasn't hierachical or based on traits, you did not get much credit. So you could have something like an Overall group with all of them, then a stalked eye group (2 & 7) and a non-stalked group (1, 3, 4, 5, & 6). Within the non-stalked group you could have Bulbous and Smooth-Shell subgroups (1, 6, & 4 for bulbous; 3, 5, & 8 for smooth-shell). Within smooth-shell you could have a patterned subgroup (3 & 5) and within bulbous you could have a Cyclops group (1). That's one example, but you need not have followed it as long as the groups you proposed were *hierarchical and nested* like real biological groups.



6. (3 points) *While investigating the world, your colleague comes across three different sections of rock from Australia (left), Russia (middle), and Argentina (right), and notes the types of rocks, bed thickness, and fossils found in each section. Your colleague sends you their data, and asks you to help them sort out the relative order and age of the different sections.* Draw lines to propose hypothesized correlations between rock units in each of these three sections. You may explain your reasoning in the space below. (*Nota bene*: as discussed in lecture, the same time period in different places may be represented by both different types, thicknesses, and numbers of beds of rock.) There is a lot of information in these columns. The two things to focus on for this question are 1) species may disappear from the rock record without going extinct, and so absences should be viewed with caution; and 2) all lines you draw need to have clear and direct evidence for them. The five lines unit connections here represent the only correlations that could be supported by the evidence presented.