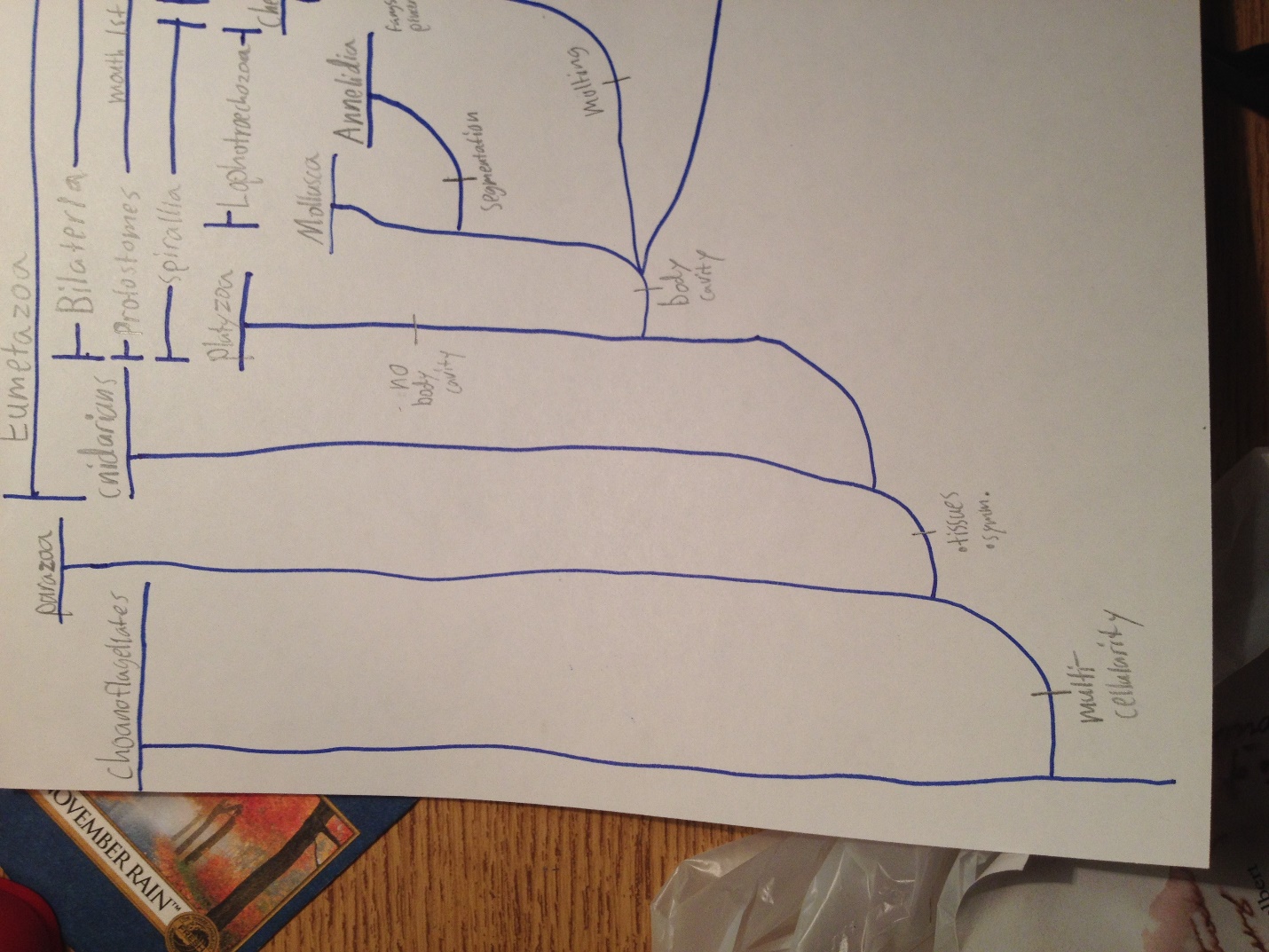
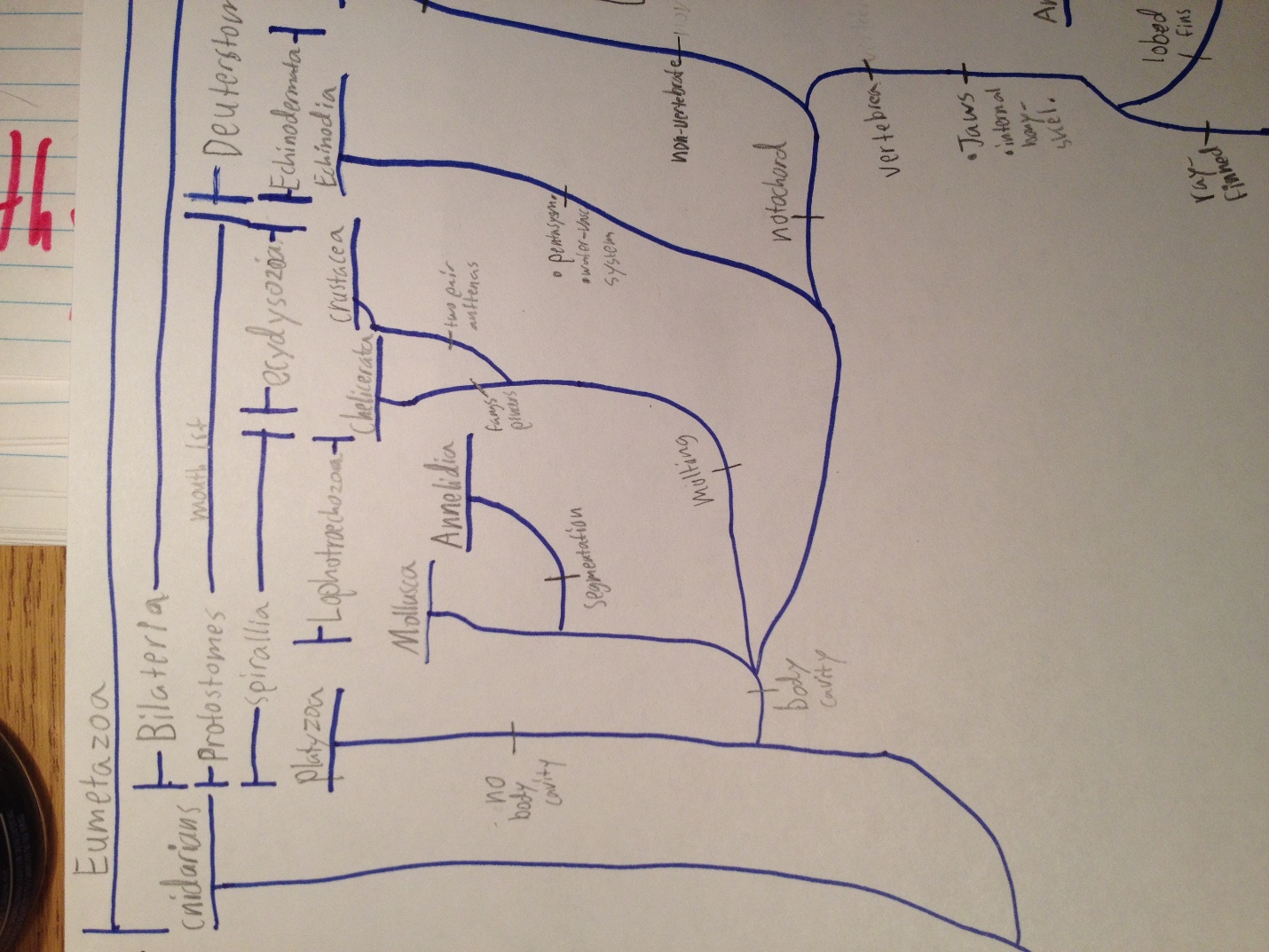
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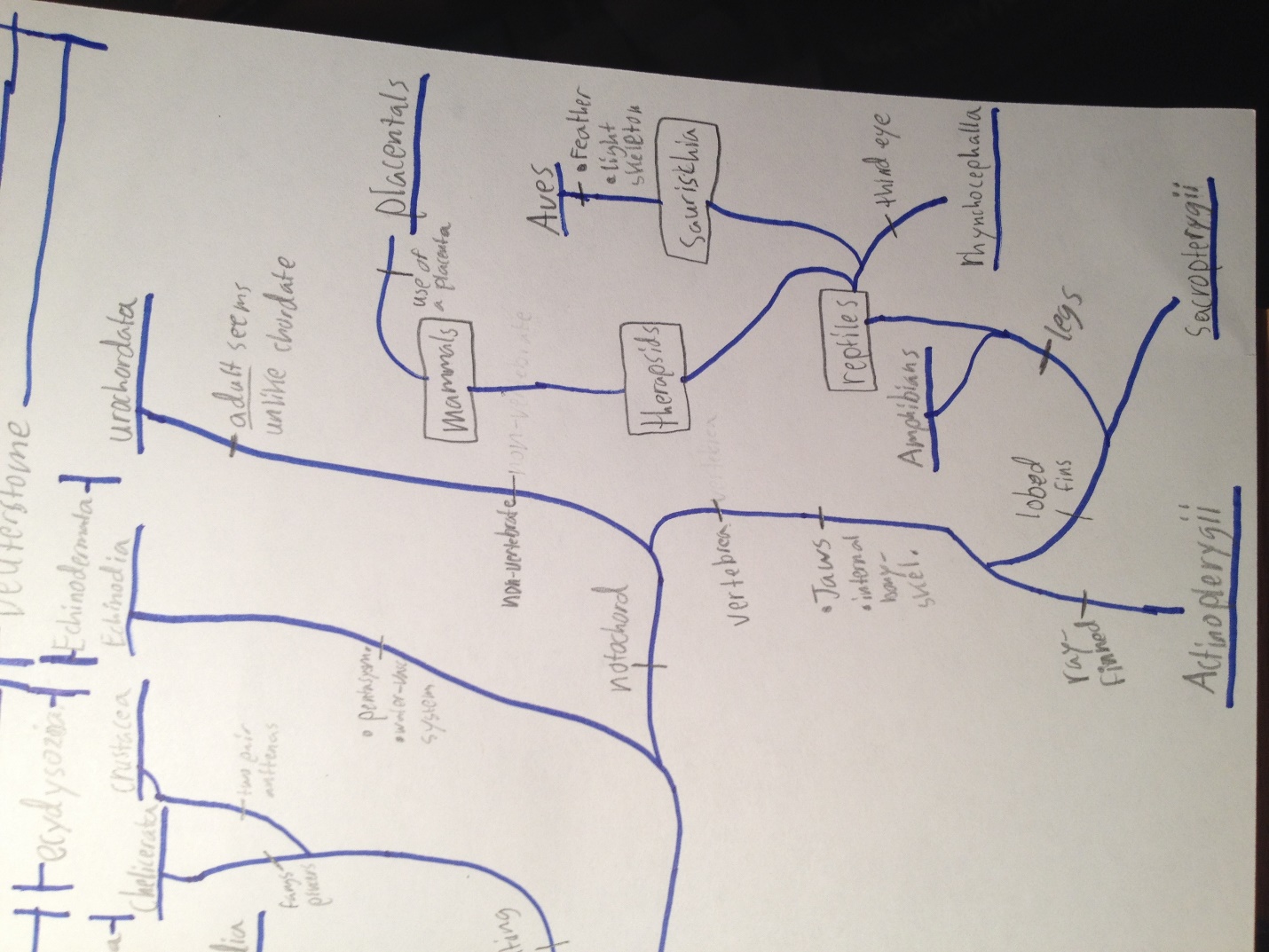
Exam 2

1. For the sake of answering this first exam question, I will go through the group in their evolutionary order, starting with the Choanoflagellates. This group begins our journey through the animal progression to its present day diversity. The Choanoflagellates are a part of the bigger group called the Protista, and are acknowledged as the closest common ancestor to animals (KF, lecture). What allowed animals to break away from these ancestors was the formation of multi-cellularity, a very important characteristic of the animals (Raven, p 637). Other important characteristics of animals are also important to note, first being heterotrophy. This meant that animals had adapted to using the energy created or stored by other organisms as their own (Raven, p 637). An animal cell is unique in that it has no cell wall, unlike other multi-cellular organisms like plants. This adaptation gave animals a lot more flexibility in their cell shape, giving rise to their ability of active movement, exceeding a lot further in complexity and speed than any other organisms (637). This flexibility also gave animals an edge over other organisms in their amazing ability to diversify themselves to many different habitats (Raven, 638). So moving on from animals in general, we rewind back to this innovation of multi-cellularity and its branching off from the Choanoflagellates. From this first branch we have a group of animals called the Parazoa or “near animals” (Raven, p 647). This group consists majorly of sponge like animals (Porifera) take advantage of a very simple but affective body plan in their environment. Sponges start off as free swimming larvae and eventually grow to become sessile (KF, Lecture). Sponges filter feed water through these openings along their epidermis and use choanocytes to collect the bacteria and organic material contained within it (KF, Lecture). Sponges differ a lot when compared to many animals, with a lack of a anus, organized internal structure, and most importantly specialized tissues it’s no wonder some phylogenies doubt their part in the animal tree (Raven, p 647). The presence of multi-cellularity however is what gives the Parazoa their place with the other animals. Back to this key feature missing from the Parazoa, we can move on to the next branch in the evolutionary tree with the Eumetazoa and the presence of specialized tissues. This group contains every other animal than the Parazoa; animals that have evolved specialized tissues (Raven, p 649). The first group within the Eumeazoa to emerge, were the Cnidarians. These unique animals are entirely carnivore and have a radially symmetrical body with well-defined tissues (Raven, p 649). These Cnidarians have two germ layers, with a singular opening to an internal gastrovascular cavity (KF, Lecture). This cavity acts as multi-function space for digestion, reproduction, respiration, and somewhere the specialized muscle tissues can push against for movement (KF, Lecture). A unique feature of the Cnidarians is their possession of nematocyst, tiny structures along their tentacles that shoot out these stingers at very fast speed, of the fastest cellular movement on earth (KF, Lecture). The Cnidarians are very specialized in their respected environments, but they lacked a key feature that leads us further through the animal tree. The next branch off came around with the innovation of bilateral symmetry. This gave birth to the Bilateria, and to the ability of forming much higher levels of specialization than before (Raven, p 654). From Bilateria, two distinct groups branched off, the Protostomes and the Deuterstomes. We will venture into the Protostome’s branch, consisting of all animals who during their earliest stages of life, develop the mouth before the anus (KF, Lecture). Within the Protostomes there are two subgroups, the first we will discuss is the Spirallia. Animals within the Spirallia develop by having their cells lie on one another at angles oblique to the polar axis, known as spiral cleavage (Raven, p 641). This process allows new cells to fit into the spaces created and pack in very close like (Raven, p 641). Within the Spirallia a group called the Platyzoa branch off. The Platyzoans or flatworms are a group of animals that have no body cavity besides incomplete digestive cavity (Raven, 660). The flatworms are clearly bilateral in their structure, allowing them to develop different complex structures within their body, like an intestine, nerve cord, and even ovary/ testis (Raven, p 660). The flatworms contain only a mouth and no anus, but instead expel wastes and water through pores within their epidermis (Raven, p 661). Most present day flatworms have evolved to become parasites on other animals (even humans), while the other ones are called free-living, which are believed to be the ancestor of their parasitic counterparts (Raven, p 661). Backing away from the Platyzoa, another group within the Spirallia are the Lophotrochozoans, are group that branched off from the Platyzoa with the development of a body cavity. The first group that will be discussed within the Lophotrochozoans, are the Mollusca or Mollusks. The Mollusks evolved from the oceans and took off from there in many different directions of diversity, occupying even freshwater and terrestrial habitats (Raven, p 665). With Mollusks there is again the presence of bilateral symmetry, and with the addition of a body cavity, new complex structures like gills/ lungs, a gut, and even a foot like structure for movement (Raven, p 665). Mollusks have a very efficient respiratory system, with a continuous flow of water running through their gills and out the mantle cavity, also with excrements of the digestive and reproductive system (Raven, p 666). Mollusks have branched off into four different groups, each varying in great detail with body structure, from a giant squid to a tiny little slug (KF, Lecture). A group that branched off from the Mollusca with the adaptation of segmenting their body into specialized parts, are the Annelidia (KF, Lecture). The Annelidia have evolved their bodies to take advantage of segmentation, by specializing certain parts for digestion, excretion, and reproduction (Raven, p 671). The Annelidia are basically just a tube within a tube, a mouth connecting to an anus, so movement is achieved by contracting certain segments at different times, allowing for many complex turns and directions to be achieved (Raven, p 672). Rewinding back out from the Spirallia, we join another branch of the Protostomes called the Ecdysozoans. These animals have adapted the need to molt, or leave their old exoskeleton during excessive growth, for a bigger developed one (Raven, p 659). One branch of the Ecysozoans, and notably the most successful of all the animal groups, are the Arthropods. Arthropods made use of many successful adaptations like segmentation, jointed appendages and the exoskeleton. The exoskeleton is a structure that not only gave extra protection against external damage, but also against water loss, a huge factor when merging to dry land (Raven, p 680). The Arthropods are divided into four classes, the first being the Chelicerata. This class make use of these modified appendages called chelicerae, which are used primarily as fangs or pincers. Because most Cheliceratains are unable to digest solid foods, they have adapted to using digestive enzymes to liquefy their meals for consumption (Raven, p 681). Another feature of the Cheliceratains is that their body is divided into two segments, one holding the appendages while the other hosts the reproductive organs (Raven, p 681). The next class of the Arthropods that will be discussed is the Crustacea. The Crustacea are mostly within marine environments, with a few reaching out into freshwater areas (Raven, p 682). They are unique from other Arthropods because of their development of two pairs of antennae (KF, Lecture). The Crustacea contain appendages on both segments of their body, and some even become sessile as adult, the barnacles (Raven, p 684). The Crustacea are a very successful class, with a certain species millimeters in length, called the copepods, being one of the most abundant multi-cellular organisms on earth (Raven, p 682). Finally, being done with the Protostomes we move back through the tree to the second branch after the Cnidarians, to the Deuterostomes. These group of animals differ by developing their anus first and then the mouth (KF, Lecture). Moving down this branch we work our way to the Echinoderms, a successful, exclusively marine group of animals that have been around for around 600 million years (Raven, p 691). These animals makes use of the fluids surrounding them for feeding and movement, this is done with the adaptation of a water-vascular system (Raven, p 691). This system is radially organized and extends throughout the body. Water enters the system and into the branched canals, where it can be trapped by a valve and forced to fill these tiny structures called tube feet. After which, muscles can be used to manipulate the extended feet for the use of the animal (Raven, p 692). Another important distinction of the Echinoderms is the switch from bilateral to pentaradial symmetry, larvae however still develop bilaterally till adulthood (KF, Lecture). A class within the Echinodermata, is the Echinoidea, well known by humans as sea urchins or sand dollars. These animals lack any arms but possess many rows of tube feet, and even a movable spine for protection (KF, Lecture). Moving back from the Echinodermata, a different branch evolved called the Chordates, with the appearance of a hollow nerve cord, pharyngeal slits, postanal tail, and most importantly a notochord. (Raven, p 694). The notochord is a flexible rod located beneath the dorsal side of every embryo within the Chordates (Raven, p 694). One branch created from these newly developed adaptations are the non-vertebrates, housing the Urochordata. These group of animals are unique as in they have completely abandoned the need for a notochord or many other specialized structure and reverted to a very simple body plan in their adult form (KF, Lecture). Going back from the non-vertebrate branch, we go the opposite direction into the Vertebrate Chordate branch of animals. These group of animals have adapted their notochords to develop into a series of vertebrae columns around the nerve chord for protection (Raven, p 697). From this new adaptation, more were able to form, like the development of a jaw, giving animals the ability to catch bigger prey in their mouth (KF, Lecture). Later on, a bony like skeleton developed in some fish, branching off a new group of fish that soon will dominate the water. This is because of this adaptation of a swim bladder, allowing for bony fish to have a stronger, heavier skeleton and still float in water, an important adaptation for the future diversity of animals (Raven, p 702). From the bony fish two branches emerged, the first being the ray finned fish or Actinopterygii. These fish had bones extend out into their fins away from the internal body (KF, Lecture). The other branch, called the lobe-finned fish or Sarcopterygii, more importantly adapted their bones to stay within their internal body, leading to the development of an internal shoulder girdle (Raven, p 703). From this new structure of internal bones, the evolution of legs becomes inevitable for animals. Soon the first amphibians emerge from the water, and eventually evolve into the better land adapted reptiles (KF, Lecture). The reptiles become a powerful dominant force on earth, during their high age (KF, Lecture). Many different orders of reptiles diversified, one in particular being the Rhynchocephalia, an organism still alive to this day (Raven, p 707). These animals possess fused socket less teeth, and a unique third eye underneath a layer of skin located on the forehead (Raven, p 707). From another order of reptiles, called the Saurischia, emerged a group present today called the Aves or Birds (KF, Lecture). The birds carried the adapted the two legs under the body trait from the Saurischia to present day (Raven, p 707). The Aves have adapted two key characteristics giving them their ability of flight, first being feathers, and the second being a thin hollow flight skeleton (Raven, p 714). One particular group of reptiles called the Therapsids emerged with a unique new trait, fur (KF, Lecture). These small reptiles will lay under the radar till the fall of the dinosaurs, when they emerge to dominance and diversify into present mammals (KF, Lecture). The mammals find success in adapting to the different environments of the world with the help of their characteristics, fur, mammary glands, and being endothermic, all very useful for the colder areas of the world (Raven, p 717). With mammals three groups were formed, one maintaining the use of an egg for embryo development, another caring for its young within a pouch extended from its body, and the third being the placental mammals (Raven, p 719). The placental mammals are unique in that they keep their young within them for a period of development, with the mother giving nutrients to the embryo through the use of a placenta, connected between the mother and offspring.
2. Answering this question will be split into three parts, each dealing with individual groups assigned. The first group will be the Cnidarians, for which a simplified body plan has been adapted for food and movement. The body has been molded to have one singular opening into the gastrovascular cavity, which in affect gives the Cnidarians some regulation to what goes into their digestive structure, differing from their filter feeding ancestors (KF, Lecture). Within this cavity, digestive, reproductive, respiratory, and muscular processes are carried out, not giving very much specialization for any of those systems (KF, Lecture). Because of this design, only food that can fit through the mouth of the Cnidaria can be digested for energy, putting some limitations on what can be obtained for consumption. Also, because of this multi-functioning cavity, limitations are put on what can be achieved within that limited space. Therefore, once something is being digested within the cavity, less room is available for more food until the first has been properly digested and excavated. This is because of only one opening that is available in and out of the cavity (KF, Lecture). Another adaptation for obtaining food is through the use of tentacles to move the food towards the mouth to be eaten, and then also the use of nematocysts not only for defense, but also to kill or paralyze the prey so it can then be captured and moved with much more ease (Raven, p 651). The Cnidarians can develop into two different body forms, one being the medusa, a free floating body capable of moving to find its food, while the other is called the polyp, a sessile group that have adapted to wait for food to come to them for their tentacles to retrieve (Raven, p 650). Movement for the medusa form of the Cnidarians is achieved by sucking water into the gastrovascular cavity, and then using muscles to push the water out at enough force to push the organism forward through the water (Raven, p 653). The second group being assessed are the Arhropoda. Without a doubt the most successful group on the planet, and this is of course because of its body plan and traits. The first characteristic that is very important to the Arthropoda functional ability, is its exoskeleton (Raven, p 679). This structure provides both new horizons and limitations. The new horizons refers to the exoskeleton providing extra protection against more dangerous environments, while also containing more water within the organism’s body, allowing for expansion over dry land to be possible (Raven, p 680). The cost of these benefits however are that because of this hard exoskeleton, movement has been greatly restricted for Arthropods, leading to the need of more adaptations so that food can be obtained (KF, Lecture). A key adaptation of the Arthropods for movement is use of jointed appendages. This innovative structure made movement not only easier but cost less energy to do too (Raven, p 680). this is because of the simple concept of contracting a muscle on the join will move the entire appendage in that direction with little effort, and this was then manipulated by the Arthropods for many complex movements. Another limitation put on the Arthropods’ movement ability is with the respiratory system, and their use of a tracheae. This structure transports oxygen within the body, but for a certain area of the body to retrieve said oxygen, it must have direct contact with a passage or tracheoles (Raven, p 681). This restricts movement because in order for the leg muscles to work they must be arranged in such a way that they are connected to the tracheae, and have enough oxygen available for the appropriate amount of movement needed. Eating habits within Arthropods are relatively diverse because of differently adapted body plans, the first being that of the Chelicerata. These animals are unique in that most of them have lost the ability to digest solid foods and have adapted to the use of chelicerata (fangs/ pincers) and digestive enzymes for the consumption of food (Raven, p 681). Other members of the Chelicerata have adapted in other ways, such as mites who became herbivorous, or daddy long-legs who obtained the ability to eat small particles for energy (Raven, p 681). The Crustacea have adapted their body around being, for the most part, in a marine environment. They developed three pairs of appendages for the use of obtaining and manipulating their food for consumption, and some have also have adapted specialized appendages for swimming and even breathing, with the use of feathery gills (Raven, p 683). Lobsters and crayfish have even adapted their posterior appendages to a paddle like structure for quick bursts of movement to be available to them (Raven, p 683). The Hexapoda or insects, are the most successful group on the earth, this is because of their well-adapted, specialized segments of their body (KF, Lecture). These segments help insects adapt certain parts of their body to their environments instead of having to change their whole body layout, giving rise to unique ways of obtaining food. The different eating mechanisms of the insects are as followed: chewing/ biting mouthparts (beetles, bees, crickets, dragonflies, and termites), sucking/ piercing mouthparts (flies, butterflies, wasps, bedbugs, and fleas). All insects have three segments, each with a pair of legs, in their thorax region, some even possessing one/ two pairs of wings for efficient transportation (Raven, p 685). The last of the insects are extremely unique, but rather simple in concept with their body plan, the Myriapoda. These insects have taken segmentation to new heights with many repeating segments making up most of their body, each holding one or two pairs of legs (Raven, p 687). The centipedes have adapted a pair of poisonous fangs for capturing its prey, while millipedes have adapted to becoming herbivores (Raven, p 687). The final group of animals that will be assessed is the Echinodermata. The focal point of interest when addressing how this group eats and moves is found with the unique adaptation of a water-vascular system. This specialized structure makes use of water to fill these special little structures called tube feet to a stiff usable state. At this point, the organism can use muscles to manipulate the tube feet in different direction to obtain food or for movement (Raven, p 692). The body of echinoderms are relatively very flexible in its movement ability, because of its loosely joined endoskeleton (Raven, p 692). Sea stars extend their digestive cavity into its branched arms to allow for more digestion of food to be possible because of its flat body’s limited space availability (Raven, p 693). The brittle stars adapted their tube feet for strictly feeding purposes, and uses their tapered arms for a rowing or swimming movement (Raven, p 693). The sea dollars have adapted their bodies to have no use for arms and instead uses many rows of tube feet for movement and feeding (Raven, p 693).
3. To answer this question, I will start from the beginning of the vertebrates and move through their evolutionary history of adaptations and extensions. The vertebrates make their introduction into the world starting from the sea around 545 million years ago. Certain fish began to form these vertebral columns around their nerve chord, and early signs of a head forming with a developed jaw allowed for a whole new array of food to be made available (Raven, p 697). These jaw gave these vertebral fish an advantage over many other organisms at the time, and through natural selection the greater fitness of these fish led to their dominance of the waters. This went on until the development of a swim bladder and stronger boney skeleton of a new branch of fish, giving them the advantage of a stronger body that could still maintain a floating status (KF, Lecture). Once again a new group through natural selection of more adaptive traits out compete the former dominant non-bony fish in competition and dominate the waters. These bony split into two groups, neither one with a greater fitness over the other. This went on until the development of legs through the lobe-finned fish, and then the amphibians began to invade dry land around 400 MYA (KF, Lecture). The amphibians were just good enough to dominate dry land for around 100 million years, up to their peak at around 280-248 MYA (Raven, p 705). This was because of the lack competition on the dry land, this was until the better adapted reptiles began their emergence and dominance. At around 248-213 MYA, the terrestrial amphibians were on a huge decline to extension, this was due to the fact that a new better adapted group of animals had out competed them, the reptiles, including the therapsids (Raven, p 705). The amphibians were only able to survive this genetic drift due to their well-adapted aquatic traits, still in use with present day amphibians (KF, Lecture). The drift gave rise to the genetics of reptiles as most dominant, leading to the diversity of the dinosaurs. Also around this time period, the mass extinction of both the spiny fish and armored fish had acquired. This genetic drift has completely destroyed the genes and traits of these two groups from the earth (FK, Lecture). During the beginning of the reptile dominance, the synapsids ruled the earth for 50 million years, with the dominance of the other animals with their newly adapted long, razor sharp teeth, making their fitness above all the other organisms (Raven, p 708). Then about 250 MYA, the synapsids were out competed by a new group, the therapsids. This is because of longer and cooler winters growing over the years, and the therapsids had adapted to become endothermic and develop fur for better insulation than the synapsids (Raven, p 708). Because of this advantage, the therapsids were able to go obtain food for longer periods of time than their competitors and even travel during the cold nights, soon, thanks to natural selection, the therapsids became dominant. However, this would only last for about 20 million years until the arrival of a new adaptive trait outcompeted the therapsids, the placement of bipedal feet directly under the body, around 220 MYA (Raven, p 708-9). This new trait gave the new group of diapsids or dinosaurs the physical advantage of being much faster and agile with their new leg positioning, made them fearsome, dominate predators over the other animals. This increase in fitness of the faster and more deadly animals, decreased the fitness of the helpless therapsids, leading to their extinction around 170 MYA, but a group of descendants did survive to keep the therapsid genetic code alive (Raven, p 708). The dinosaurs dominated earth with their dominate traits till about 65 MYA, when a famous genetic drift occurred, most likely caused by an asteroid impact on the earth (FK, Lecture). This almost entirely destroys the dominate traits possessed by the now gone dinosaurs, but one group survives to later evolve into the present day birds (FK, Lecture). The massive change in trait dominance, pointed back to the same traits expressed by the therapsids, now being possessed by a new group of animals, the mammals. Because of this random genetic drift, the once less adaptive traits of the mammals, had lost their competition of the more fit dinosaurs and soon regained their dominant fitness. This will then allow them diversify their mammalian traits to adapt to the newly emptied environments of the world, and become the new branches of mammals in the present day.
4. To answer this question affectively, I will first start by stating what the “traits” needed to develop life, first being the need for cells, the most basic unit of all life. In order for cells to appear, there was a need for organic molecules, which in turn needed inorganic molecules to create (Raven, p 511). From the big bang to the formation and cooling of the earth to solid rocks, at around 4000 MYA, there was no sign of life or organic matter (Raven, p 508). However, now that earth had cooled to a solid surface, with a newly formed CO2 atmosphere and liquid ocean (Raven, p 509). In these newly formed oceans, a theory for how organic molecules arouse was that all the needed components were already available mixed together in the liquid (Raven, p 511). Or another theory is that the molecules needed to make organic ones were brought to earth by chance of asteroids or comets just crashing down (Raven, p 511). This then led to the formation of organic molecules, like proteins, nucleic acids and etc. but this was not enough for the formation cells to occur (Raven, p 511). From these organic molecules, at some point gave rise to these autotrophs that would make bonds between organic molecules to create glucose for energy storage, this wasn’t enough however for a cells to form (Raven, p 512). Another important ingredient was needed, that being enzymes. With the right molecules present, the enzymes needed were eventually forming together on the earth with early ribosomes (Raven, p 512). Nucleotides were also needed, but this was soon answered when it was discovered that nucleotides can bond together on clay surfaces or the ice crystals in salty water (Raven, p 512-13). At this point, the right tools needed for a cells are present except for a membrane containing a newly formed cell, but it was soon discovered that fatty acids could have function as early membranes for cells (Raven, p 513). The parts needed for a cell to be made were proven to be able to be present before the first signs of life were found, proving how a cell would of came about on Earth. Another key trait needed for life is the availability of oxygen. At one point the earth had a CO2 rich atmosphere and the oxygen was trapped in the oceans for nearly 200 million years (Raven, p 516). But somewhere along, the cells evolved to use photosynthesis and the oxygen levels rose into the atmosphere, moving towards the oxygen rich atmosphere of present day Earth (Raven, p 516). With the necessary materials needed for life to begin and thrive, organic compounds, oxygen, and water, abundantly available on Earth, the rise of the earliest organisms was possible. Once the evolution of photosynthesis occurred within the prokaryotes, did the atmosphere of Earth start changing towards the evolution of more complex organisms.

**Diagram made for question 1**

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