Problem set #1 Biology 463

Working individually, correctly answer the following questions. To get credit for your answer, you must show all work in a legible and organized way

1) The average height above sea level of all the continents is 840 m and the average rate of lowering (or "denudation") by erosion is 6 cm per thousand years. If this rate of denudation remains the same even as the land is lowered by erosion, and if no new mountains are formed, how long will it take to bring all the continents to sea level by erosion?

2) The gravitational attraction (Newton's Law of Universal Gravitational attraction) between the Earth and the Moon is equal to the centripetal force associated with the Moon's orbit around the Earth. The orbital period of the Moon around the Earth is 27.26 days, and the gravitational constant (G) is $6.67 \times 10^{-11}$ $m^3 s^{-2} kg^{-1}$. Assume the orbit of the Moon around the Earth is circular and that the Earth is a perfect sphere. Using this information, calculate the density of the entire Earth in $kg/m^3$. Compare the density you calculate for the planet to the typical density of continental crust, and the solid core (see class notes or textbook). What does this tell you about the structure of the Earth? The following formulas and values may be useful:

> Newton's Law of Universal Gravitational attraction = $(G*M_{moon}*M_{Earth})/d^2$
> Centripetal Force = $M_{moon}V^2/d$ where V is the orbital velocity (i.e. the orbital speed)
> Effective distance from Earth to Moon = d = 382,751,000 m
> Radius of the Earth = 6,367,440 m

3) Cooling of oceanic crust causes contraction, leading to the subsidence of the seafloor away from the axis of spreading (i.e. the mid-ocean ridge). As a result, the depth of the ocean floor increases with age according to the following formula which is valid for seafloor < 80 million years old:

$$d = 2500 + (350 \text{ x } \sqrt{t})$$

Where:
- d = depth of ocean floor in meters
- *t* = age in millions of years

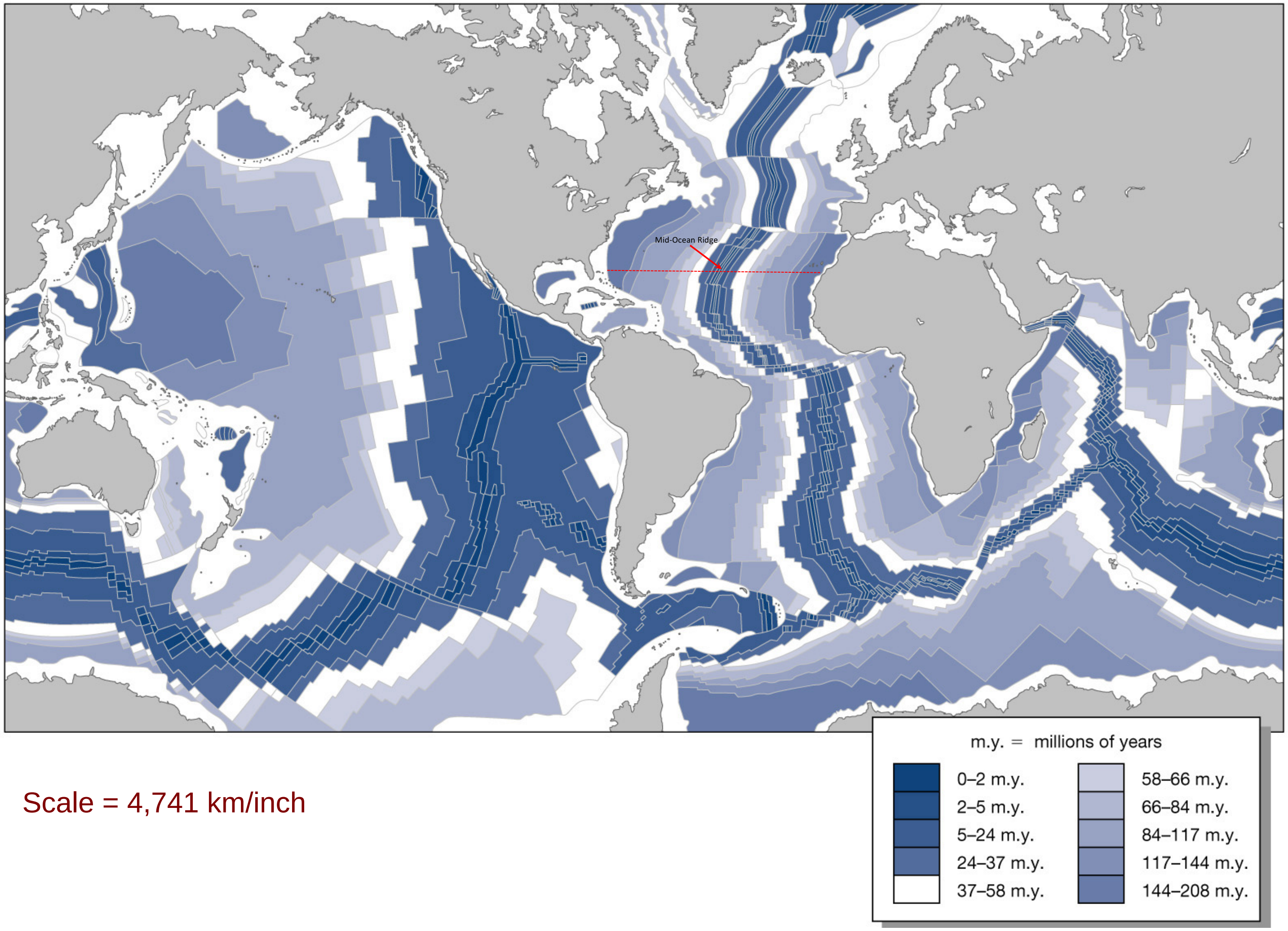
Graph a cross section of a mid-ocean ridge (x-axis = **distance** from ridge vs. y-axis = depth of ocean floor) that is spreading symmetrically in both directions at a rate of 1 cm/yr (10 km/million years). The age of the oldest seafloor shown should be 80 million years, and you should include values for every 5 million years from 0-80 million years. Using a spreadsheet might make this a little easier.

4) Use the figure in the attached PDF file to do the following:

> a. Determine the spreading rate for each geologic interval that is represented, averaging the two values determined for eastward and westward spreading. Graph these values (y-axis) as a function of time (in millions of years, on the x-axis).
>
> b. How has the Atlantic spreading rate varied over the last 200 million years?

Hint: To determine the appropriate distances from the figure, use the scale that is given and the measuring tool that is found in the "Measure" tool set of Acrobat reader (you can search for this in Acrobat Reader or find it under "More Tools". This will let you zoom in to make fairly accurate measurements of the width of each band. Note that the age interval for each band represents the time it took for oceanic crust to spread the measured distance. The ages were determined by reversals in the Earth's magnetic field that were recorded in the cooling magma.

Email your answers to me as a PDF file by **the date indicated on the syllabus**.




Scale = 4,741 km/inch