**Understanding the relationship between body**

**mass and metabolic rate in endotherms**

<http://animaldiversity.ummz.umich.edu>

Homeothermy is thermoregulatory process that maintains a stable internal body temperature regardless of external influence. This temperature is often, though not necessarily, higher than the immediate environment. Homeothermic endotherms, such as birds and mammals, maintain their internal temperature by heat production and increased metabolic rate. Basal metabolic rate (BMR) is the amount of energy expended by an animal at rest (measured in cm3 O2/hr). The relationship between the size of an animal (body mass [g]) and metabolic rate has been extensively examined and research shows both standard applications across taxa (see **Kleiber’s Law**) and ecological adaptive variation within a taxon.

In this assignment you will extract data from a compiled database called the **Animal Diversity Web** from U of M using the ADW search tool called **Quaardvark.** You will use these data to test the relationship between body size and metabolic rate in two endothermic animal groups; birds and mammals.

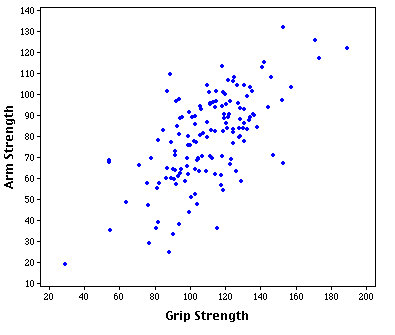
**Open this following website**

<http://animaldiversity.ummz.umich.edu/quaardvark/>

1. Use the Query Section to define the species you want information for. Search for all data records for Aves in “Animal Group” in the **Query section**. Click **Edit** next to “Animalia,” and enter Aves instead. Then click **Save**.
2. Use the Report Section to determine what kinds of data you want for the species that you designated in Query. You’ll get these data in the form of a table.
3. In the **Report section**, select “**Add more data**” and then “**Physical Description**.” Select “**mass**,” then select the average mass and make sure the units are in grams. Make sure the box “only include species with data matching this measure” is selected. Be sure to click **Save Changes** enter your selection.
4. Select “**Add more data**” again and again click on **Physical Description**, then “Basal Metabolic Rate” section. Choose Watts for units, and Average values, and then **Save Changes** again
5. Once you’ve selected all the data you want to appear in a report, hit the big “**Submit**” button in the lower right corner of the page. The report will appear on the web page and you can **DOWNLOAD** it (top right corner) or **save it** to your “backpack” (your personal workspace) – if you are registered and logged in to Quaardvark.

Once the export is complete and you have downloaded it to your desktop, open and **SAVE** the worksheet in **Microsoft Excel**. You’ll now sort the data so that it is useful for analysis. You will want to delete the rows that only contain mass or only metabolic rate data. **ONLY** keep and graph those species that have **both** mass and metabolic rate. You can accomplish this by clicking on the row number at the far left of the spreadsheet to highlight that individual species and hit delete. If you delete additional rows by accident, simply click the “**undo arrow**” at the top of the page to try again.

Next you’ll use the graphing tools in **Microsoft Excel**. If you don’t have Microsoft Windows and/or Excel, the computers in the WCC library or GM201 are equipped with the appropriate software. Ask the personnel in that area before any software is added or altered! In Excel, select all rows for the two data columns (mass and basal metabolic rate) **except** for the rows that contain the column labels and the species names. Once you’ve selected the two data columns of interest, go to the **Insert** menu and pull it down to **Scatter** (with markers only). You will want to produce a scatterplot that compares mass (g) on the **X-axis** and metabolic rate on the **Y-axis** (see *hypothetical* sample below).



Mass (g)

Basal Metabolic Rate (BMR) ( in Watts)

Add a trendline to look at the slope for patterns in the data. Click on **Layout** under the tab for **Chart Tools** and select **Trendline**, then choose **Linear Trendline**. You can click directly onto the trendline, the scatterplot, or the tabs on the upper control bar to edit the appropriate headings/titles. **SAVE** both the excel data and the graph as both will need to be submitted as part of the assignment!

Next you will need to perform a similar function as above, but this time looking at data specific to **mammals**. Open up a new **Query Setup** and instead of the default “Animalia”, type or select “**Mammalia** and **Save**. Under the Report Section, select “**Class**” for taxonomic rank. As before, hit “**Add More Data**” and select under “**Physical Description**” both **Mass** and **Basal Metabolic Rate**. Once you’ve selected all the data you want to appear in a report, hit the big “**Submit**” button in the lower right corner of the page. The report will appear on the web page and you can **DOWNLOAD** it (top right corner) or **save it** to your “backpack” (your personal workspace) – if you are registered on Quaardvark.

Once the export is complete and you have downloaded it to your desktop, open the worksheet in Microsoft Excel. You’ll now sort the data so that it is useful for analysis. You will want to delete the rows that only contain mass or only metabolic rate data. **ONLY** graph those species that have both mass and metabolic rate. When done correctly, you should have 32 species total. Create a scatterplot with a trendline as outlined above and **SAVE** both the excel spreadsheet and the graph for analysis and submission!

Using the data tables and the graphs generated above, answer the following questions on a separate sheet of paper. You will need to reference your text **AND** additional sources to answer completely and accurately. Attach both data sets and graphs!

1. Define the following terms:
   * 1. thermoregulation
     2. metabolism
     3. homeothermic
     4. poikilothermic
2. Basal metabolic rate (BMR) can be measured in Watts, or in volume of oxygen consumption. Why would it be measured in units of oxygen volume? (**Hint:** relate this directly to cell respiration and ATP).
3. Given your data, how would you describe the relationship (*i.e.* the pattern) between body size and metabolic rate? Was there a difference in this relationship between birds and mammals? Describe why or why not.
4. Would a similar relationship be observed in ***ectotherms***? Why or why not.
5. Describe two advantages to being homeothermic and give specific examples.