Investigating Your Metabolism

Part One: Basal Metabolic Rate

Basal metabolic rate (BMR) is a measure of the energy needed to sustain life. It is measured when a subject is awake but resting, and includes the energy required to keep the heart beating, sustain breathing, repair tissues, and keep the brain and nerves functioning. BMR does not include energy requirements for digestion and absorption of food. Your BMR is influenced by a number of factors, including age, weight, height, gender, environmental temperature, dieting, and exercise habits.

BMR can be determined by measuring a subject's consumption of oxygen which gives an accurate value for BMR, because oxygen is needed to release energy from food. A cruder measure of BMR estimates the amount of heat given off, some heat being released when food is used up. Tables one and two below list BMR values for males and females of all ages. These values are computed and depend upon gender, height and body mass.

Table 1: Basal Metabolic Rates for a 5'6" Female.

Body Mass *(kg)*	10 to 18 *(Cal/day)*	19 to 30 *(Cal/day)*	31 to 60 *(Cal/day)*	61 to 80 *(Cal/day)*
45	1340	1291	1193	1076
57	1448	1399	1301	1184
68	1555	1506	1408	1291
80	1663	1614	1516	1399
91	1770	1721	1623	1506
102	1878	1829	1731	1614
114	1985	1936	1838	1721
125	2093	2044	1946	1812

Table 2: Basal Metabolic Rates for a 6' Male.

Body Mass *(kg)*	10 to 18 *(Cal/day)*	19 to 30 *(Cal/day)*	31 to 60 *(Cal/day)*	61 to 80 *(Cal/day)*
45	1515	1446	1308	1145
57	1671	1602	1465	1301
68	1827	1759	1621	1457
80	1984	1915	1777	1614
91	2140	2071	1934	1770
102	2296	2227	2090	1926
114	2452	2384	2246	2082
125	2609	2540	2402	2216

Findings

1. Clear any data from lists 1-6 (L_1-L_6) in the STAT EDIT of your calculator.

2. Enter all the data for *your gender* into the STAT EDIT of your calculator according to table 3.

Table 3

L_1 Body Mass (kg)	L_2 Age 10-18 years (Cal / day)	L_3 Age 19-30 Years (Cal / day)	L_4 Age 31-60 Years (Cal / day)	L_5 Age 61-80 Years (Cal / day)

3. Calculate a linear regression for BMR vs. body mass for each set of body masses and record the equation coefficients and units in table 4.

Table 4

	a	**b**
Age 10-18 years		
Age 19-30 Years		
Age 31-60 Years		
Age 61- 80 Years		

4. Explain the significance of the slope of the line for BMR vs. body mass. *Hint: think about the units.*

5. Explain the value of the y-intercept in your calculations. *Hint: Does its value make sense or should it be something else?*

6. What does it tell you about metabolism if the slopes are the same and the intercepts are different? How about if the slopes are different and the intercepts the same?

7. Sketch what you think a graph of BMR vs. mass that includes all four data sets would look like.

8. Construct a graph of BMR vs. mass that includes all four data sets for your gender or consult your teacher for an example. Explain how your prediction compares.

9. Combine your data with someone in your group of the opposite gender to complete table five. *Note: BMR/kg is the slope of the line for BMR vs. body mass.*

Table 5

		Female	*Male*
Group Number	**Age Range**	**BMR/kg**	**BMR/kg**
1	**10-18**		
2	**19-30**		
3	**31-60**		
4	**61-80**		

10. Sketch what you think a graph of BMR vs. mass that includes *all of the data sets for both genders* would look like.

11. The data displayed in table five is describing the aging process upon human metabolism. Write a short paragraph explaining the data. Be sure to highlight how metabolism differs and changes over time for both males and females.

12. Use equations 1 and 2 to calculate your BMR (2.2 lb. / kg).

Equation 1: Female BMR

Cal / day = 665.51 + (weight * 9.463 Cal / kg) + (height * 4.698 Cal / in.) - (age * 4.6756 Cal / yr.)

Equation 2: Male BMR

Cal / day = 66.473 + (weight * 13.751 Cal / kg) + (height * 12.71 Cal / in.) - (age * 6.55 Cal / yr.)

13. Convert your BMR in the above question to Cal / Hr and record it for use in part two.

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Part Two: Your Energy Expenditure

Think of how you spend your typical 24-hour day. Your activity throughout the day can be classified into one of five levels. Use table 1 to estimate the number of hours in a day that you spend at each of the activity levels. Enter your data into column two of table 2. *Note: Be sure to account for all 24 hours.*

Table 1: Estimating Energy for Activity Level (in Relation to Basal Metabolic Rate)

Activity level	Explanation
1	Resting (sleeping, reclining)
2	Very light (seated and standing activities, painting, driving, lab work, typing, sewing, ironing, cooking, playing cards, playing a musical instrument)
3	Light (walking on a level surface, garage work, carpentry, house cleaning, child care, golf, sailing, table tennis)
4	Moderate (walking 3.5-4 mph, weeding and hoeing, carrying a load, cycling, skiing, tennis, dancing)
5	Heavy (walking uphill with a load, chopping wood, manual digging, basketball, climbing, football, soccer)

Source: Adapted from Recommended Dietary Allowances, 10th Edition

Table 2

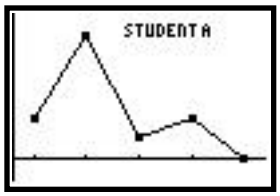
L_1 Activity Level (table 1)	L_2 Hours (24 total)	L_3 BMR (Cal / Hr.) (Activity One)	L_4 Activity Factor	L_5 Total Energy Used (Calories) (L_2x L_3x L_4)
1			1.0	
2			1.5	
3			2.5	
4			5.0	
5			7.0	

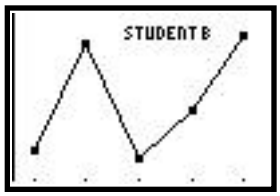
Findings

1. Complete table 2 and determine your total Calorie expenditure for this example day.
2. Clear any data from lists 1-6 (L_1-L_6) in the STAT EDIT of your calculator and enter all the data from table 2.
3. Construct a connected line graph (xyline) of Total Energy Used vs. Activity Level.
4. Explain how your graph describes your lifestyle. Does your graph illustrate a healthy person? Explain.

5. Compare your graph with those of other classmates. Describe a graph for a healthy person your age.

6. Describe the lifestyles for each of the students depicted in the graphs below. Suggest modifications where appropriate.





TEACHER NOTES

Part One: Basal Metabolic Rate

Table 4: FEMALE

	a	**b**
Age 10-18 years	*9.43*	*912.85*
Age 19-30 Years	*9.43*	*863.85*
Age 31-60 Years	*9.43*	*765.85*
Age 61- 80 Years	*9.30*	*657.27*

Table 4: MALE

	a	**b**
Age 10-18 years	*13.70*	*893.83*
Age 19-30 Years	*13.70*	*824.90*
Age 31-60 Years	*13.70*	*687.37*
Age 61- 80 Years	*13.53*	*535.22*

4. The slope represents the BMR / kg of body mass.

5. The y-intercept in this case represents the energy needed for digestion.

6.

8.

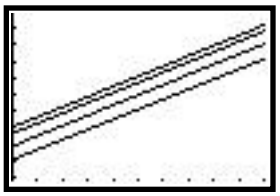
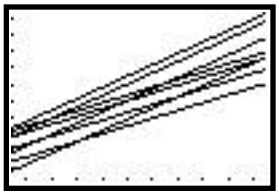


Table 5

		Female	*Male*
Group Number	**Age Range**	**BMR/kg**	**BMR/kg**
1	**10-18**	*9.43*	*13.70*
2	**19-30**	*9.43*	*13.70*
3	**31-60**	*9.43*	*13.70*
4	**61-80**	*9.30*	*13.53*

10.



11. Both data sets describe a steady decrease in the BMR from age 10-80. The values indicate that the males' BMR always increases faster than the females'. Yet, the BMR / kg remains constant up to age 60. Beyond age sixty the BMR / kg drops with the male rate dropping faster.

Part Two: Your Energy Expenditure

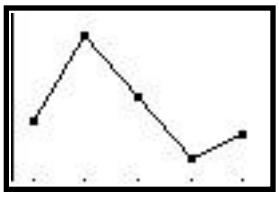
Table 2: Data for an example 30-year-old, 100 kg, 6' male.

L_1	**L_2**	**L_3**	**L_4**	**L_5**
Activity Level (table 1)	Hours (24 total)	BMR (Cal / Hr.) (Activity One)	Activity Factor	Total Energy Used (Calories) (L_2x L_3x L_4)
1	*8*	*90.00*	*1.0*	*720*
2	*10*	*90.00*	*1.5*	*1,350*
3	*4*	*90.00*	*2.5*	*900*
4	*1*	*90.00*	*5.0*	*450*
5	*1*	*90.00*	*7.0*	*630*

Findings

1. 4,050 Cal

3.



4. The above graph describes a person that gets plenty of rest, spends a lot of time in light activity, but gets an adequate amount of heavy activity.

5. The above graph is healthy for a 30-year-old male.

6. Student A does not get enough rest (5 hours). They spend excessive time in light activity and little to no time in any strenuous exercise. Student A has an unhealthy and sedentary lifestyle. This student needs to modify their behavior or face serious health problems down the road.

Student B is a very active person. Their amount of activity gives the appearance that they are lacking sleep. This is not the case. Student B reports 8 hours a night. The only suggestions for student B would be to make sure their diet is balanced to supply the nutrients needed to support their active lifestyle.