

## 2. Metabolic Rates

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### Pre-class materials

 Read ahead

Before class, you can prepare by reading the following materials:

1. [Discussion Questions and reading assignment] Note that there are readings from your textbook (Withers, 1992) as well as Hill Wise and Anderson [[\(HWA\)](#)]. (These are on the shared google drive).

### Announcements/Reminders

- HW1 is [posted](#)
- You should have your book. \$20 from SoLS Office St. John 101.
- Turn in your Library Day worksheet in class.
- Please friend me on Discord/ **Always tag your partners on anything group-related**
- Labs this Week - Meet at Honolulu Zoo at 1:30pm. LMK if you need a ride from campus.  
[Read Lab 2](#). Bring:
  - Your lab notebook
  - A timing device (e.g. your phone)
  - Sun screen, hat, and sunglasses. It will be hot and sunny!
  - Water
  - One hardcopy of Lab 1 to turn in

### Week 2 Discussion Groups

| Group | Partner 1 | Partner 2 | Partner 3 |
|-------|-----------|-----------|-----------|
| 1     | Adry      | Kirsten   | Maisie    |
| 2     | Justin    | Mayuka    | Alvin     |
| 3     | Anna      | Krystal   | Morgan    |
| 4     | Matthew   | Christina | Sasha     |
| 5     | Logan M   | Richard   | Logan B   |
| 6     | Kylie     | Garrett   | Jessica   |

## Successful Discussions

- Encourage equal participation
  - Take turns going first
- Dig deeper into a subject
- Bring out everyone's ideas
- Explore and evaluate arguments
- Provide a forum for pitching ideas and practicing vocabulary
- Are interactive, evaluate strengths and soft-spots

## 2a. Metabolism and how do we measure the cost of being alive?

<https://youtu.be/NRrgZQrEiWc?si=1jk4xxtXYrrzjq5N&t=90>



### Discussion Questions

1. What is BMR and SMR? Why do we need both? What is the difference between BMR/SMR and RMR? What is AMR and MMR?
2. What is absolute aerobic scope and factorial aerobic scope? Is it specific to an activity? Why? What are the rough rules of thumb for how much higher RMR, AMR, and MMR are above BMR or SMR for active endotherms vs ectotherms? (Look in Withers). If you knew an animal's RMR and the types of activity it did, what strategy could you use to estimate DMR (Daily Metabolic Rate)?
3. We know that MR varies by animal size and taxonomic group. If we knew the cost of running in a 70kg human (let's say approximately 10x BMR), how can we use this information to estimate the cost of the same activity in a different animal? What is the justification?
4. What is direct and indirect calorimetry? Why can we measure metabolism by measuring an animal's heat production (think thermodynamics)? When we try to measure metabolism by measuring heat, or O<sub>2</sub>, or CO<sub>2</sub> – which methods are good for aerobic vs. anaerobic metabolism?

## AEROBIC RESPIRATION -- SUMMARY



**(Aerobic) Metabolic Scope**

describes the # times increase in max MR above BMR



Figure 2: An example of Metabolic Scope

TABLE 4-10

| Human basal metabolic rate and metabolic rate with various forms of graded activity. Values are $\text{J min}^{-1}$ .<br>(Data from Passmore and Durnin 1955.) |       |
|--|-------|
| Basal  | 4.2   |
| Lying at ease  | 6.3   |
| Sitting at ease  | 6.7   |
| Standing at ease   | 7.1   |
| Walking: 1 km $\text{hr}^{-1}$   | 8.4   |
| Driving car  | 11.7  |
| Walking: 4 km $\text{hr}^{-1}$   | 14.2  |
| Walking: 6 km $\text{hr}^{-1}$   | 20.9  |
| Cricket batting  | 25.1  |
| Walking: + 15% incline/3 km $\text{hr}^{-1}$   | 26.4  |
| Tennis   | 29.7  |
| Walking: 8 km $\text{hr}^{-1}$   | 33.5  |
| Rapid marching   | 40.6  |
| Squash   | 42.7  |
| Climbing vertical ladder   | 48.1  |
| Walking in loose snow: 20 kg load  | 84.5  |
| Ax work: 51 blows $\text{min}^{-1}$  | 100.9 |
| Carrying 60 kg upstairs  | 128.4 |

MR's are not directly comparable between individuals (differ in mass, sex, etc.)

But you can use the scope to calculate how many X some activity elevates BMR.

Figure 3: Table 4-10 from Withers 1992

## Direct Calorimetry

Lavoisier & Laplace (1780)

heat loss calculated from mass of water and latent heat of melting ice.

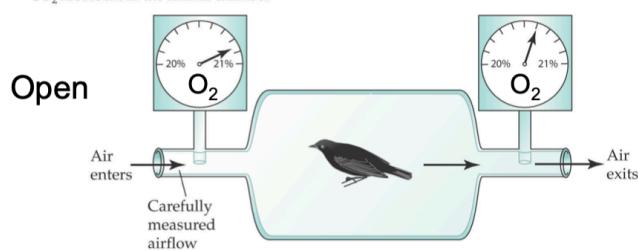
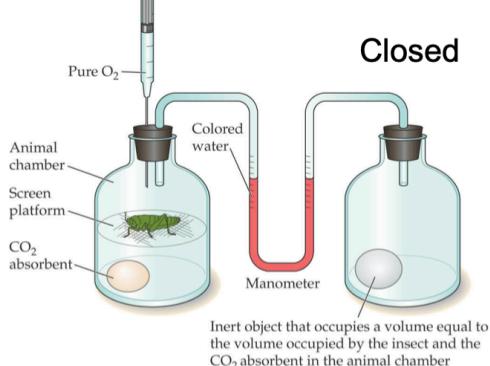


# Indirect Calorimetry: Bomb Calorimeter



Energy content of:  
food intake - waste excretion = metabolic rate (heat produced)

## Indirect calorimetry: Respirometers



## For Next Time

- Meet at the Honolulu Zoo at 1:30pm - in front of main entrance
- Add your fossil [here](#)
- Continue the discussion! NOTE: We will discuss Anaerobic metabolism last (Friday)
- HW1 due Friday

## 2b. Size and Scaling

### Reminders and materials

1. [\[Scaling Example\]](#)
2. [\[Discussion Questions\]](#) Jump to Q6
3. [\[Slide Deck\]](#)
4. An exciting addition to our teaching team: Allison Fisher
5. Friday Class will be held on [\[Zoom\]](#) Please join using your UHID
6. [\[HW1\]](#) Due Friday at midnight, written by hand. Submit in person or on Laulima
7. After Friday class, please fill out *Discussion Evaluations* - look for email from **TEAMMATES**

### Scaling Podcast

[https://youtu.be/\\_NDNa\\_3Bon8](https://youtu.be/_NDNa_3Bon8)

### If you would like some more review (optional)

#### A walk through of BMR scaling equations

<https://youtu.be/uqGEBgspTI0>

#### Refresher on log<sub>10</sub>, lines, and how much to feed your elephant

<https://youtu.be/sO9fLmkaVB8>

## For Next Week

- Holiday on Monday
- Labs will be back in EDM101
- Look ahead to the lecture post for 3. Temperature. Watch podcasts, etc.
- Add your fossil [here](#)
- HW1 due Friday Sept 1 at midnight
- Due in two weeks [[Background Bullet Points](#)]