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 (see HWA) on [(shared google drive)]. (These are on the shared google drive > Supplemental_Textboooks). A few of you didn't pick up your textbook rentals, please do so Tuesday! Just for you, just for this time, I put up scans of the Withers readings on the shared google drive in the same folder.
> 2. Optional - take a peek at the [Slide Deck]
> 3. Add your fossil here
> 4. You might want to get a manila folder to put all your class handouts in :).

Announcements/Reminders

- Looking ahead: Due next Tuesday 9/10, HW1
- Due Friday Background Bullet Points (first pass, you can revise).
- You should have your book. Rent from us ($20) at EDM 101.
- Please turn in your Library Day worksheet.
- 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

Introducing Design 1

Please sit with your design partners for this part. Let's discuss a roadmap for the next month.

- Look forward: Design 1
- Is built from Background Bullet Points
- Homeworks 1 and 2 teach you how to do the analysis, from the assumptions you make based on your literature research.
- This week's discussions prepare you for doing the homework. For HW1, you can do as a group with your Week 2 discussion group.
- Need help? Come see me with your partner/group members at office hours https://calendly.com/mbutler808/office-hours

Week 2 Discussion Groups

Group	Partner 1	Partner 2	Partner 3
1	Abby	Kylee	Mohamad
2	Adam	Johsua	Sean
3		James	Tamako
4	Ashton	Ilan	Veronica
5	Christian	Hao	Vivian

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?

[Slide Deck]

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

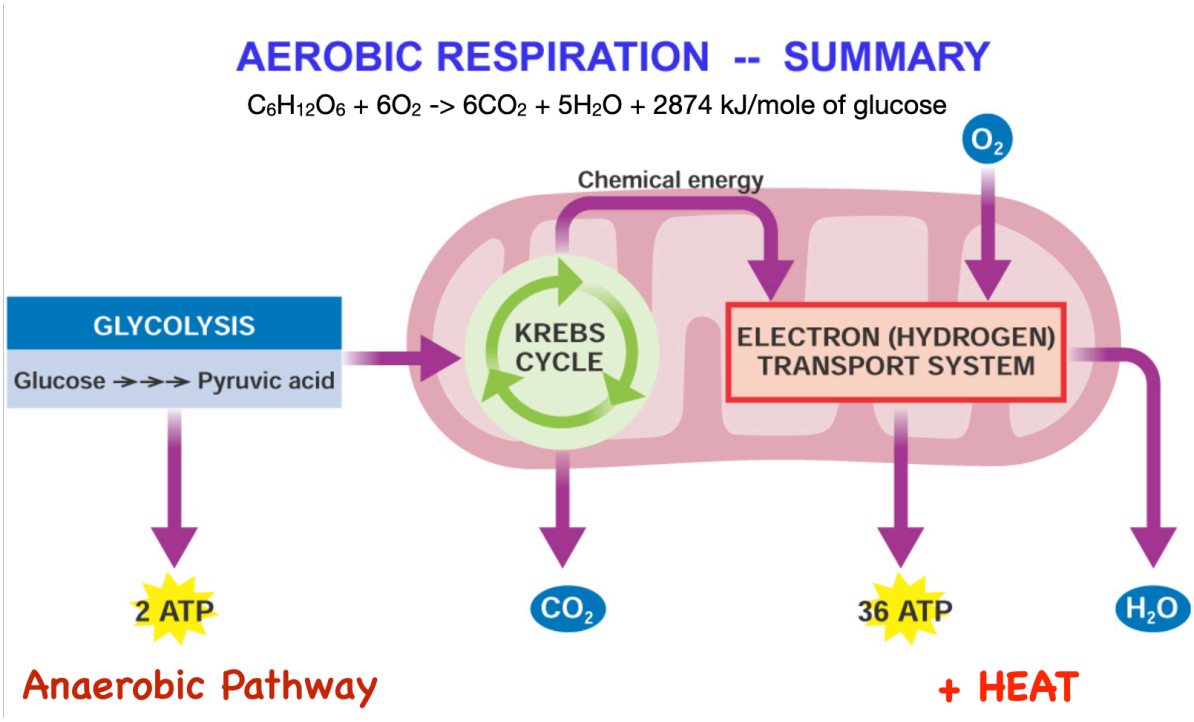


Figure 1: Where metabolism comes from

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)?

(Aerobic) Metabolic Scope

describes the # times increase in max MR above BMR

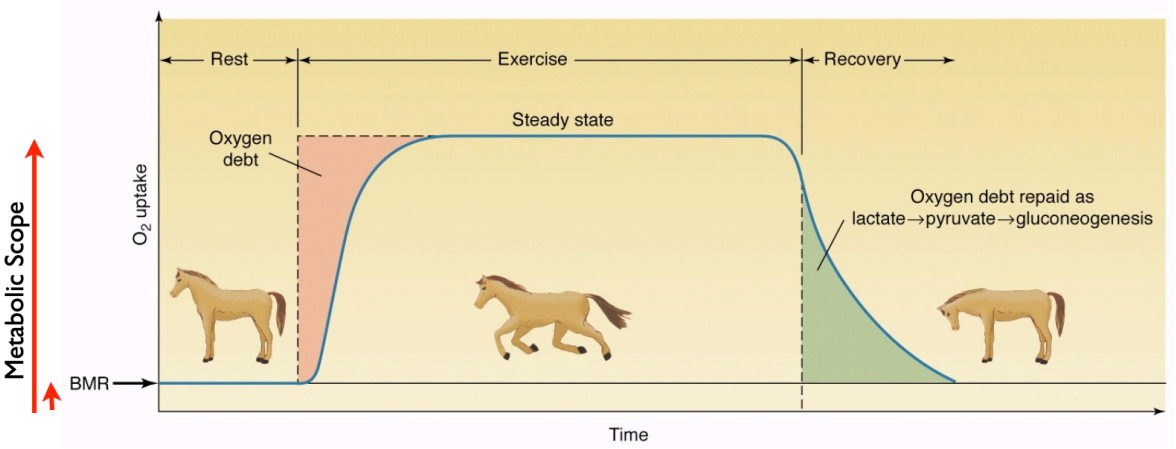


Figure 2: An example of Metabolic Scope

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?

TABLE 4–10

Human basal metabolic rate and metabolic rate with various forms of graded activity. Values are J min^{-1}. *(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 hr^{-1}	8.4
Driving car	11.7
Walking: 4 km hr^{-1}	14.2
Walking: 6 km hr^{-1}	20.9
Cricket batting	25.1
Walking: + 15% incline/3 km hr^{-1}	26.4
Tennis	29.7
Walking: 8 km 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 min^{-1}	100.9
Carrying 60 kg upstairs	128.4

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

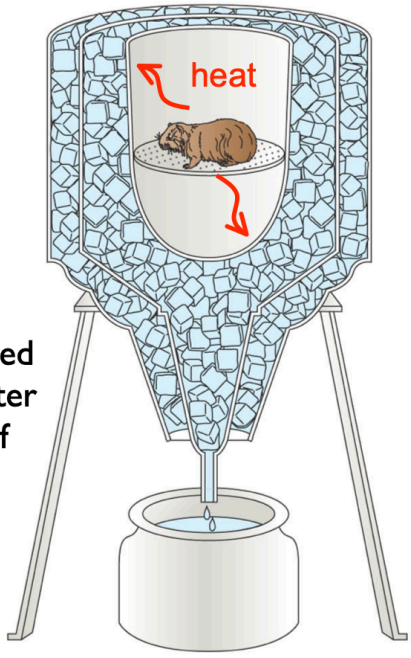
But you can use the scope to calculate how many X some activity elevates BMR.

Figure 3: Table 4-10 from Withers 1992

4. What is direct and indirect calorimetry? Why can we metabolism by measuring an animal's heat production (think thermodynamics)? When we try to measure metabolism by measuring heat, or O2, or CO2 – which methods are good for aerobic vs. anaerobic metabolism?

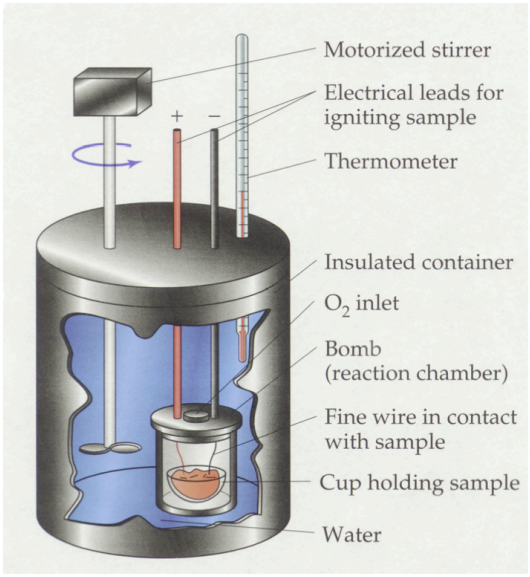
Direct Calorimetry

Lavoisier & Laplace (1780)

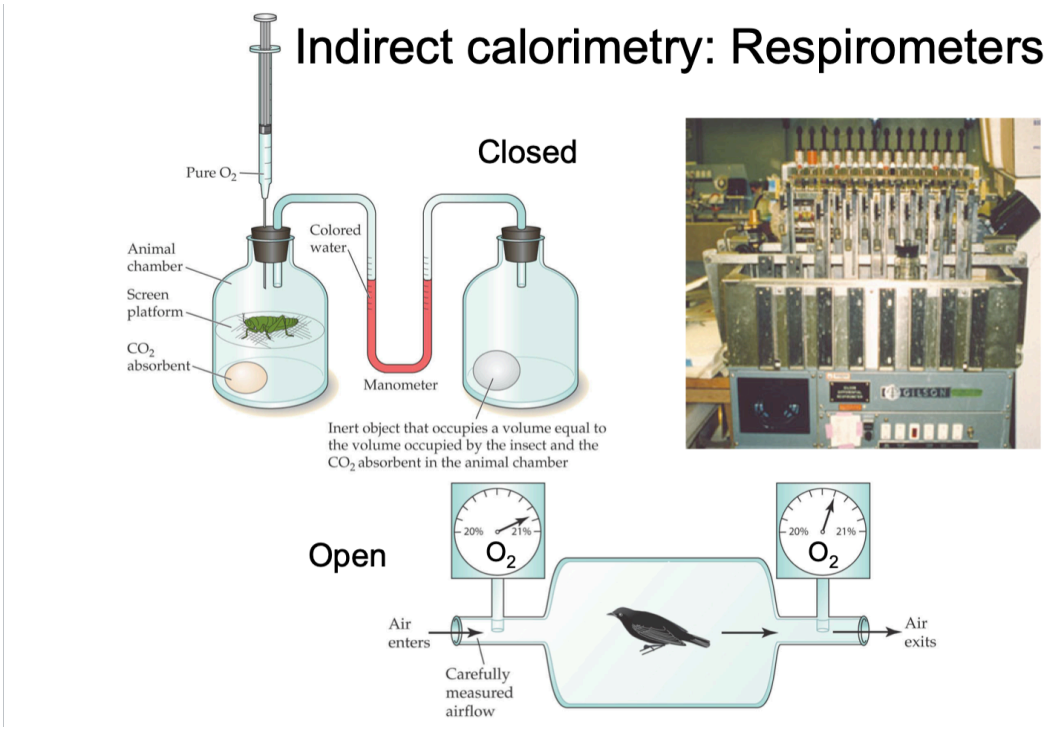


heat loss calculated from mass of water and latent heat of melting ice.

Indirect Calorimetry: Bomb Calorimeter



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



For Thursday 2b. Size and Scaling

Read ahead

Before class, you can prepare by reading the following materials: 1. [Continuing the Discussion Questions] Jump to Q6
2. Watch the Scaling Podcast
https://youtu.be/_NDNa_3Bon8

Reminders and materials

1. Add your fossil here
2. Background Bullet Points due Friday
3. [Scaling Example]
4. [Slide Deck]
5. After Thursday's class, please fill out *Discussion Evaluations* - look for email from **TEAMMATES**

If you would like some more review (optional)

A walk through of BMR scaling equations

https://youtu.be/uqGEBgspTI0

Refresher on log_10, lines, and how much to feed your elephant

https://youtu.be/sO9fLmkaVB8

For Next Week

- Labs will be back in EDM101
- Look ahead to the lecture post for 3. Temperature. Watch podcasts, etc.
- [HW1] Due Tuesday 9/10, written by hand. Submit in person