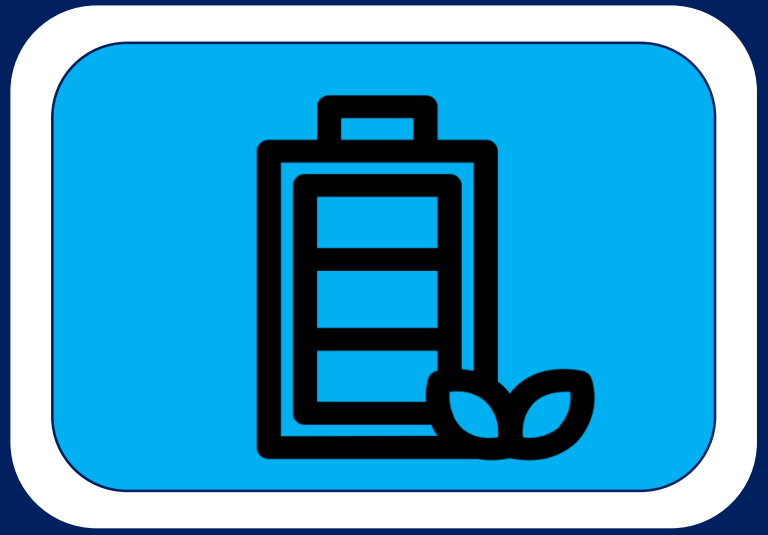
Get More "Bang For Your Buck":
Enhancing the Balance Between Eating and Energy



National Foundation of Swallowing Disorders Webinar: May 13, 2021

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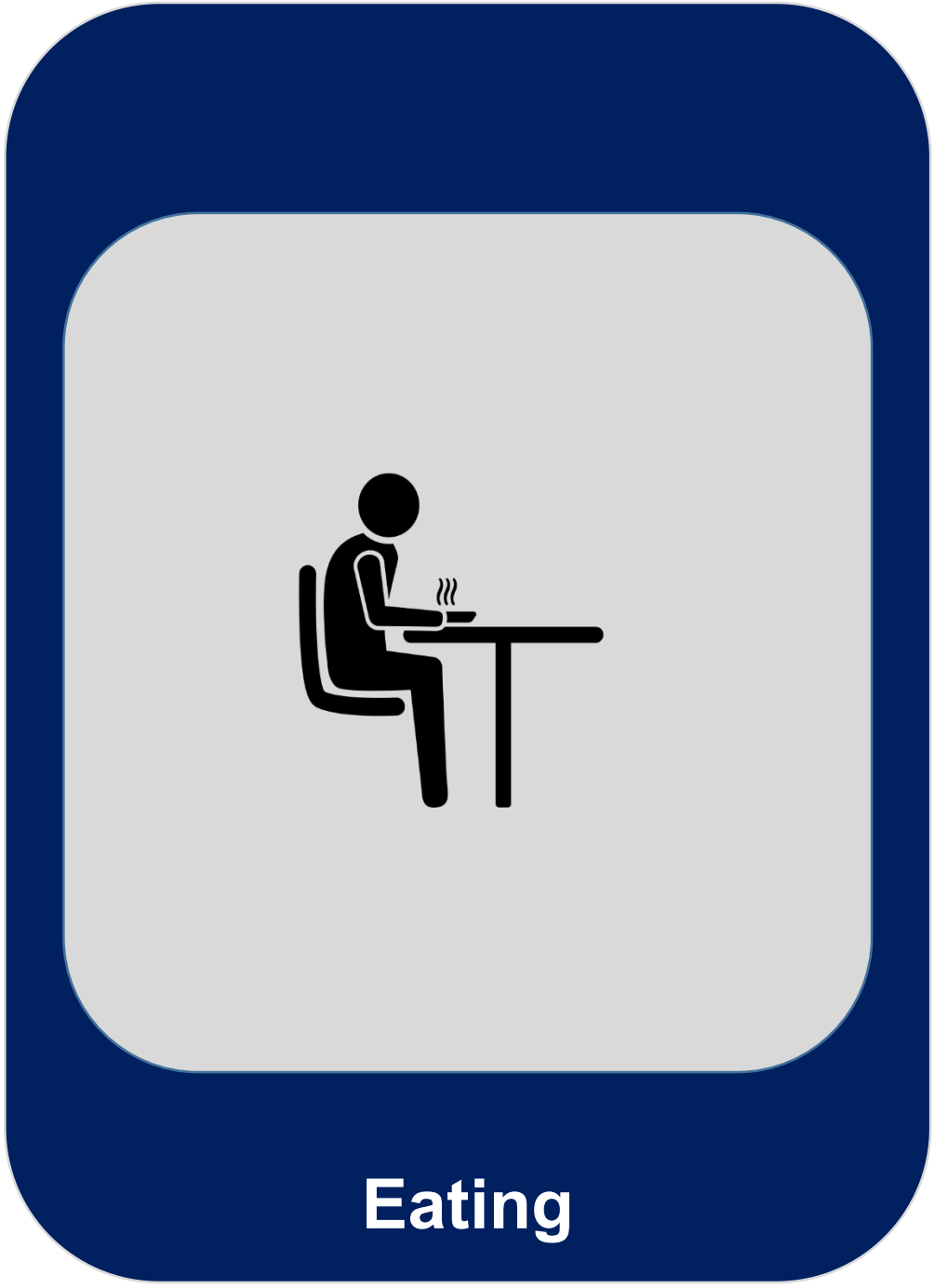
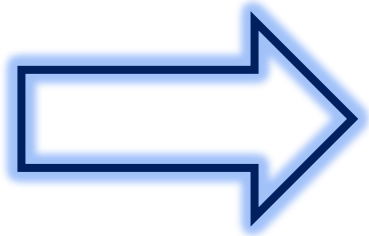
University of Florida

Disclosures

- Dr. Robison: Salary from University of Wisconsin-Madison
- Dr. Vose: Salary from University of Florida



Eating



Energy

What is the ***purpose*** of eating?

What is the purpose of eating?

- Safety
- Social
- Immune Support
- Efficiency
- Nutrition
- Survival
- Energy Intake
- Mood/ Comfort
- Movement
- Energy Expenditure
- Weight Gain
- Hunger

WHAT IS THE PURPOSE OF EATING?

1. PHYSIOLOGICAL

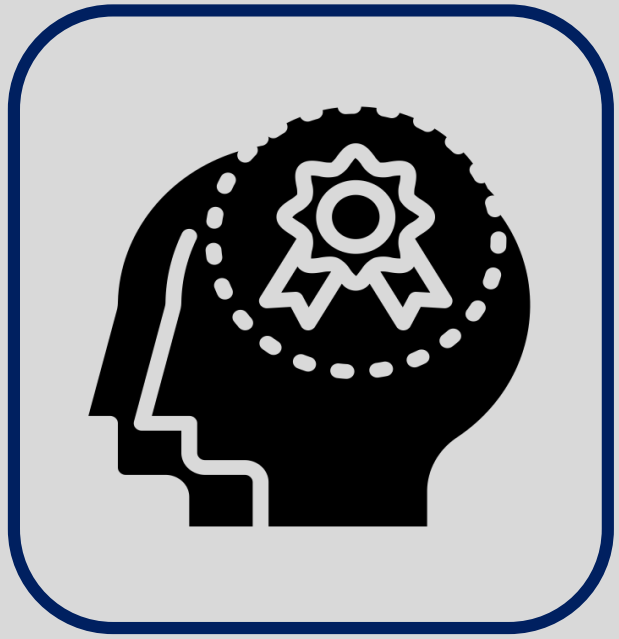
2. CLINICAL

3. INDIVIDUAL PREFERENCE

***Physiologically*, why do we eat?**

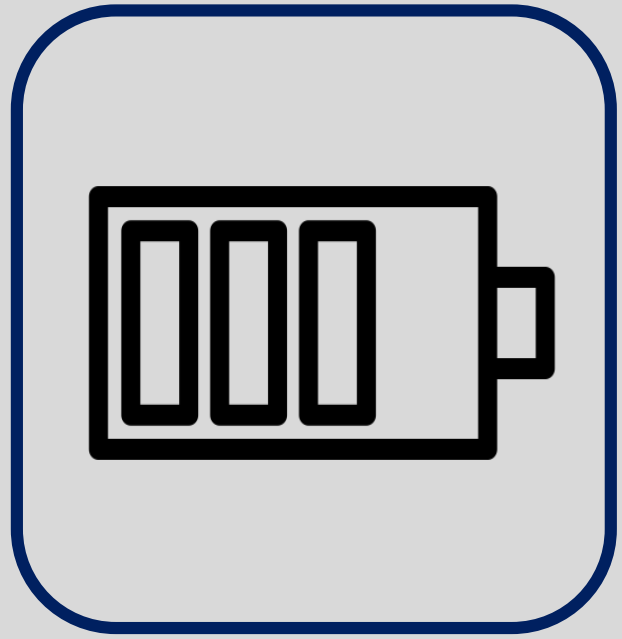
Domains of Eating

Eating as a



Eating as a hec

What we deriv



What if we can’t eat enough?

Homeostasis

~~Homeostatic~~ Regulatory Mechanisms

Homeostasis (noun):

Balance, equilibrium

A healthy state maintained by the constant adjustment of biochemical and physiological pathways.

Goal = maintain desired set points.

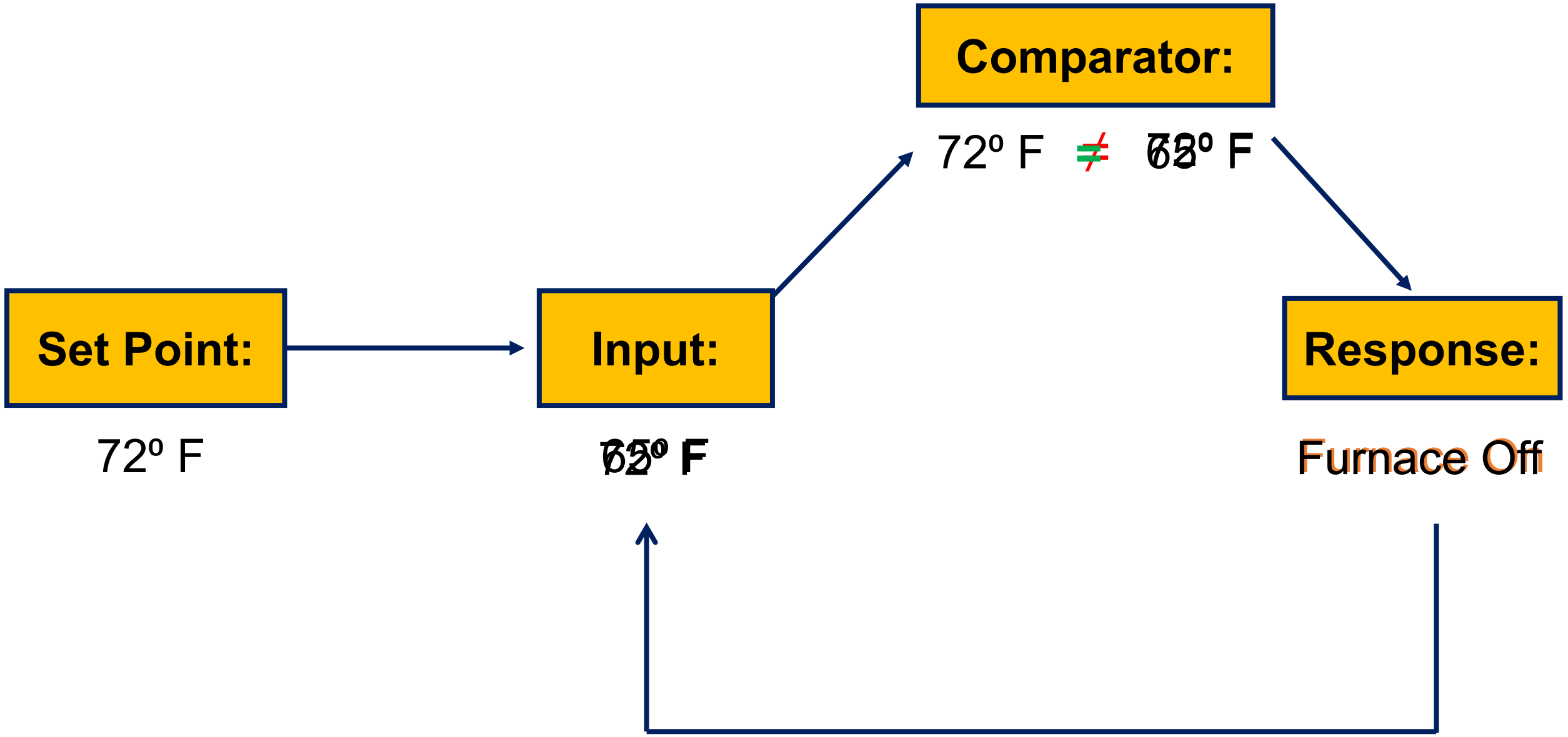
Homeostatic Regulation: Set Points

- Set point: physiologic value at which system is most comfortable.

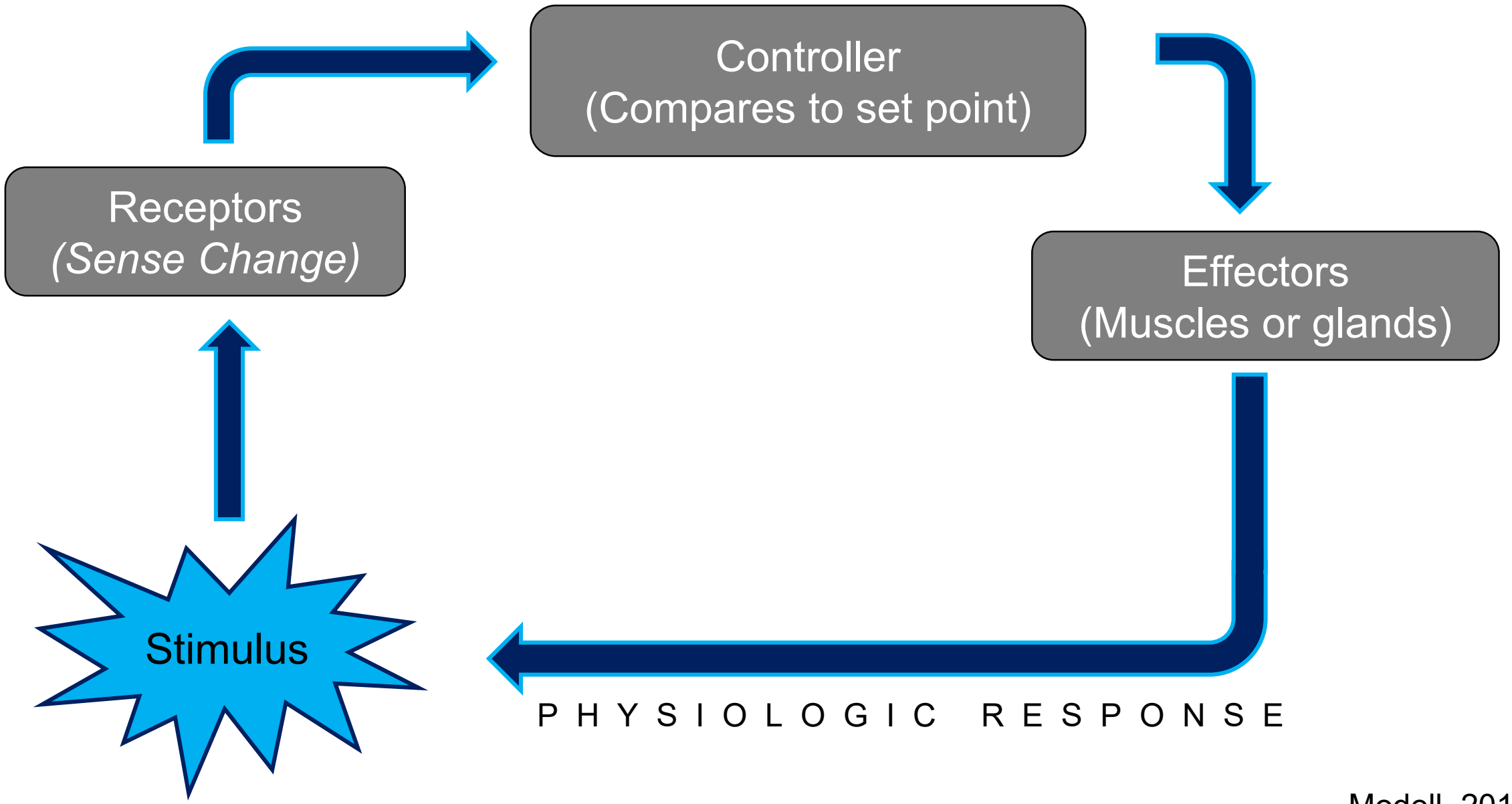
Physiologic Variable	Set Point
Core Body Temperature	98.6ºF
Systolic Blood Pressure	120mmHg
Diastolic Blood Pressure	80mmHg
Blood Glucose	70-110mg/dl
Blood Volume	5 Liters

- Homeostasis is not static, rather *dynamic.*

Rice University; Modell, 2015


Comparator:
72º F ≠ 68º F
Set Point:
72º F
Input:
68º F
Response:
Furnace Off

Homeostatic Regulatory Model



Modell, 2015

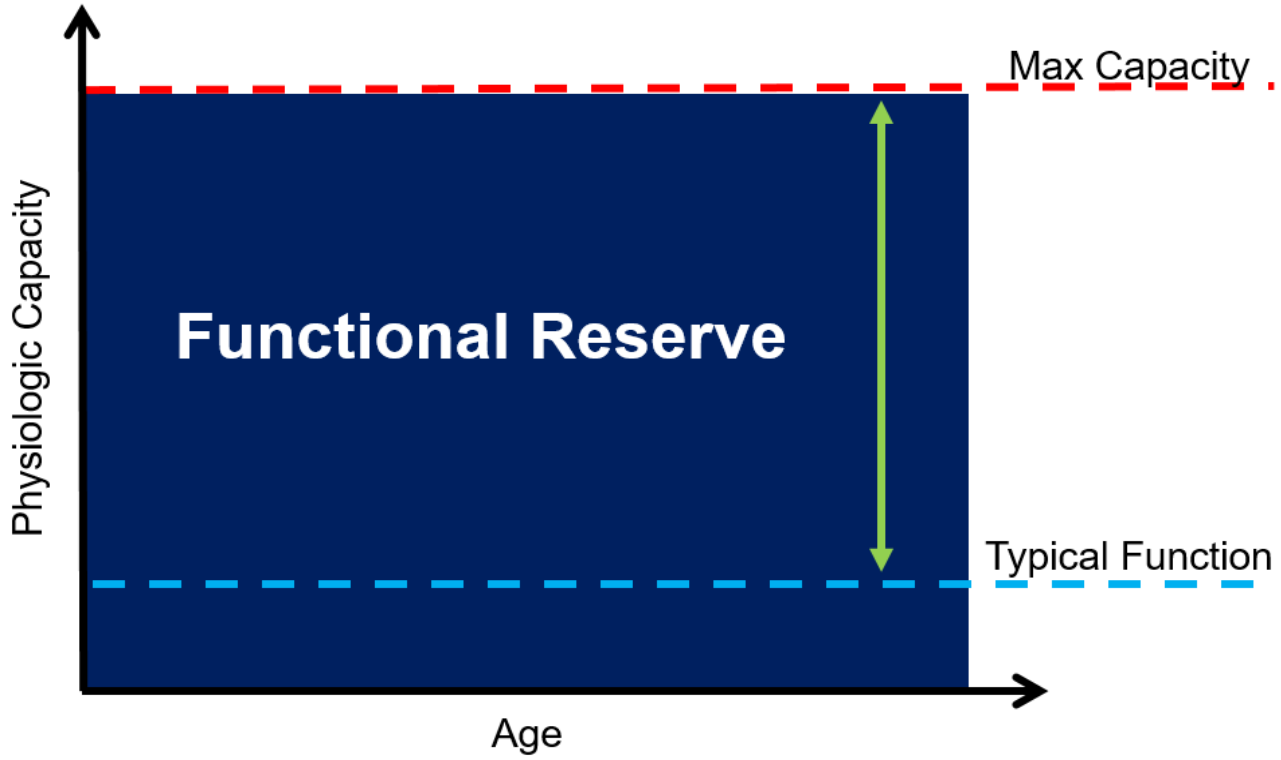
Majority of homeostatic functions operate via negative feedback.

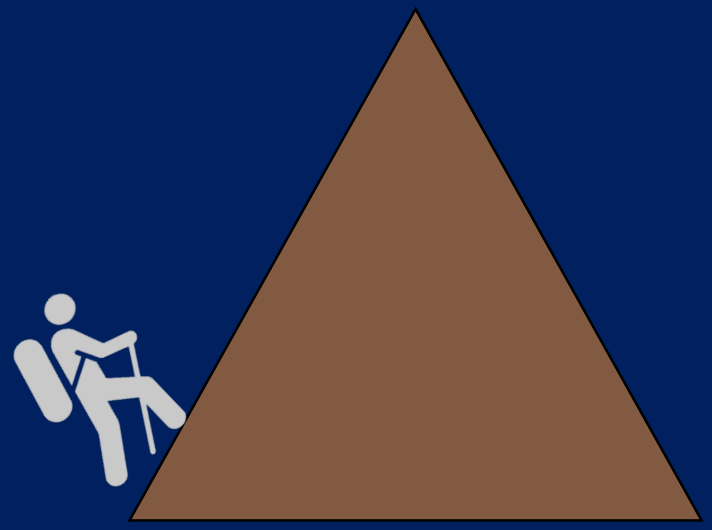
Negative feedback: response generated to reverse a change.

Is homeostasis ever challenged?

Functional Reserves: The “Savings Account"

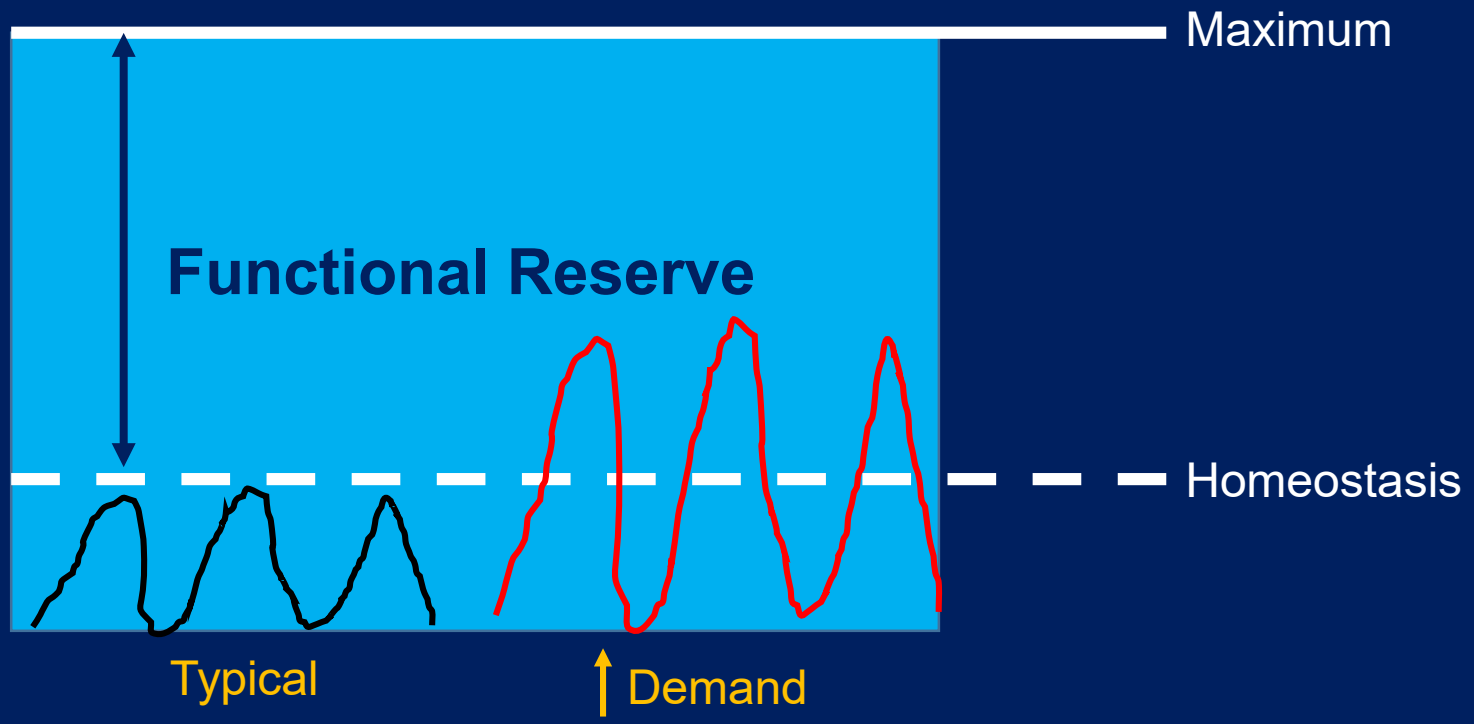
- External and internal disturbances to homeostasis = stressors
- Functional reserves = help counteract these stressors.
- Excess capacity of cells, organs, muscles not used typically.
- Used when stressors place increased demands on the system.





Environmental Stressor

Physiological Response



Protective Benefit of Reserve

- Amount of functional reserve considered a measure of health.
- Greater challenges = greater amounts of reserve needed.
- Increased reserve protects against appearance of clinical symptoms in some patient populations.

Stern 2002, 2009, 2012

Protective Benefit of Reserve

Brain Reserve = Physical Size of Brain

Cognitive Reserve = Intellectual Enrichment

- Greater amounts of brain and cognitive reserve = increased ability to tolerate age-related changes and pathology in the brain.

- 1997 study = Alzheimer's Disease pathology in those with increased brain reserve =clinical dementia not necessarily present.

Stern 2002, 2009, 2012; Mori 1997

Homeostatic regulation = Great!
Nothing can go wrong…right?

Illness

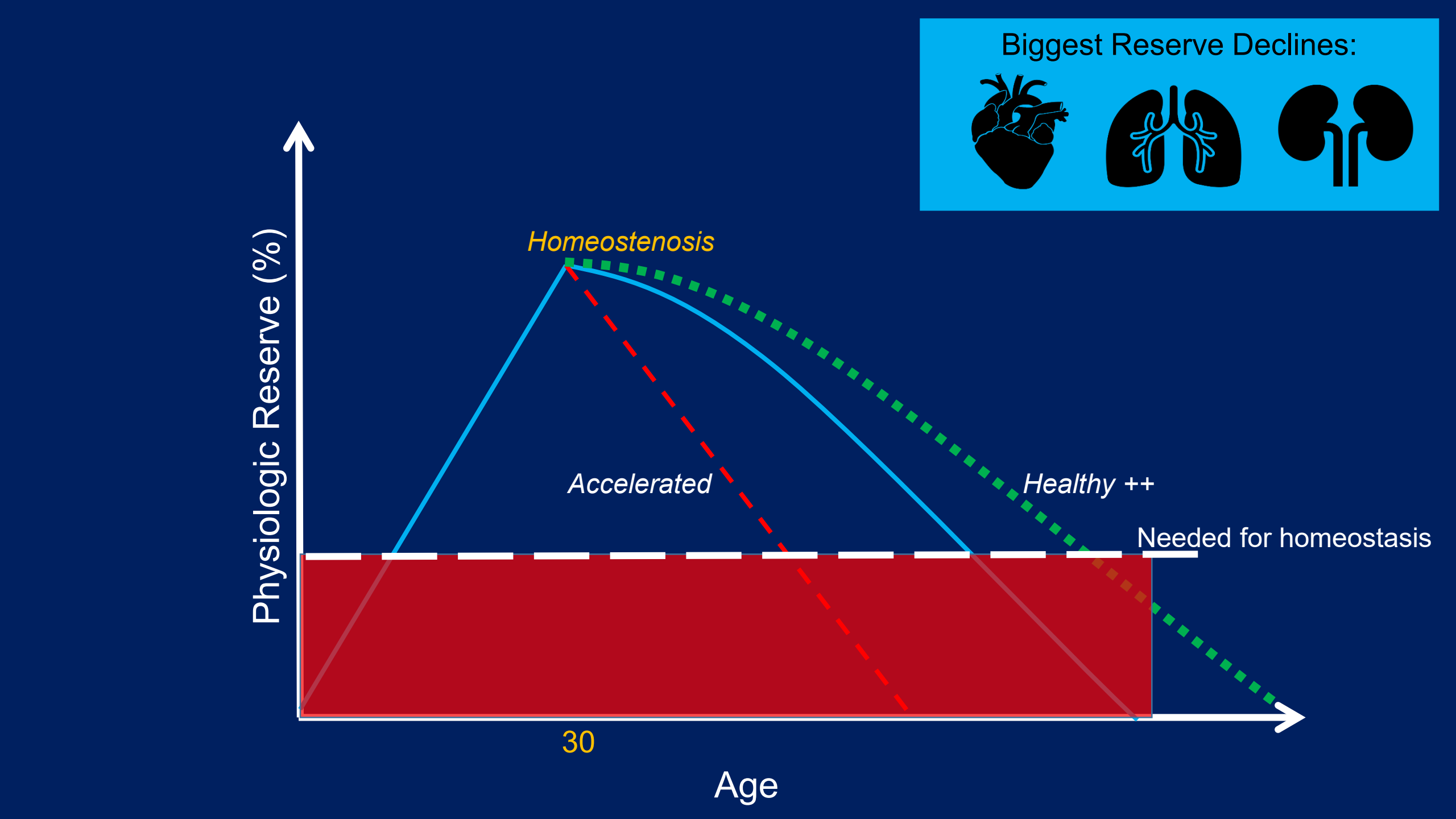
Disease

Aging

Reduced Reserve = Homeostenosis

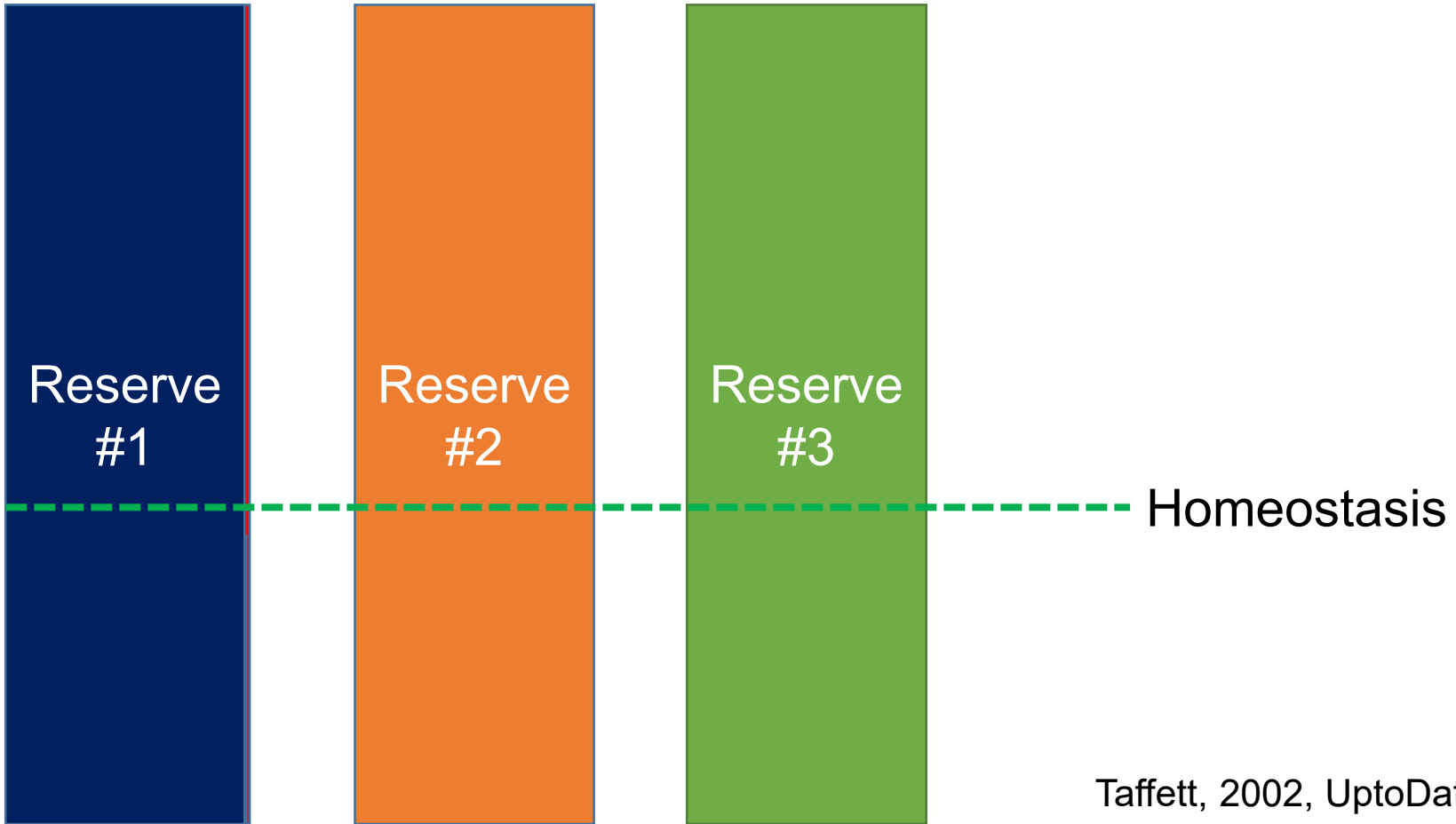
- Stenosis = “narrowing”
- Homeostenosis = narrowing of functional reserves due to age, illness, etc.
- Diminished reserve = difficult to maintain homeostasis / recover from stressors.
- Precipice = point at which negative health consequences are apparent.

Taffett, 2002


Biggest Reserve Declines:
Homeostenosis
Accelerated
Healthy ++
Needed for homeostasis
Physiologic Reserve (%)
30
Age

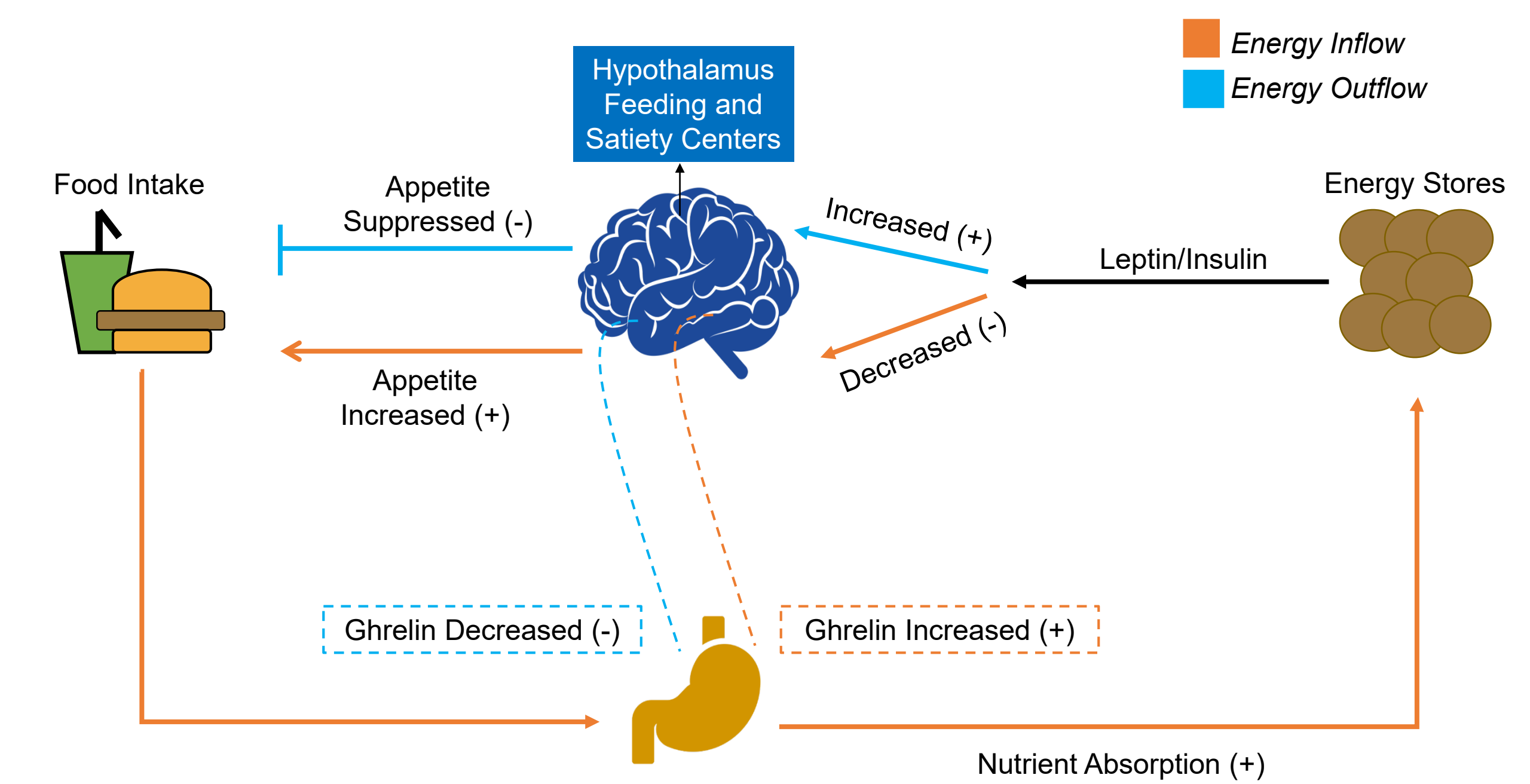
Compensations for Homeostenosis

Clinical Manifestation = Frailty



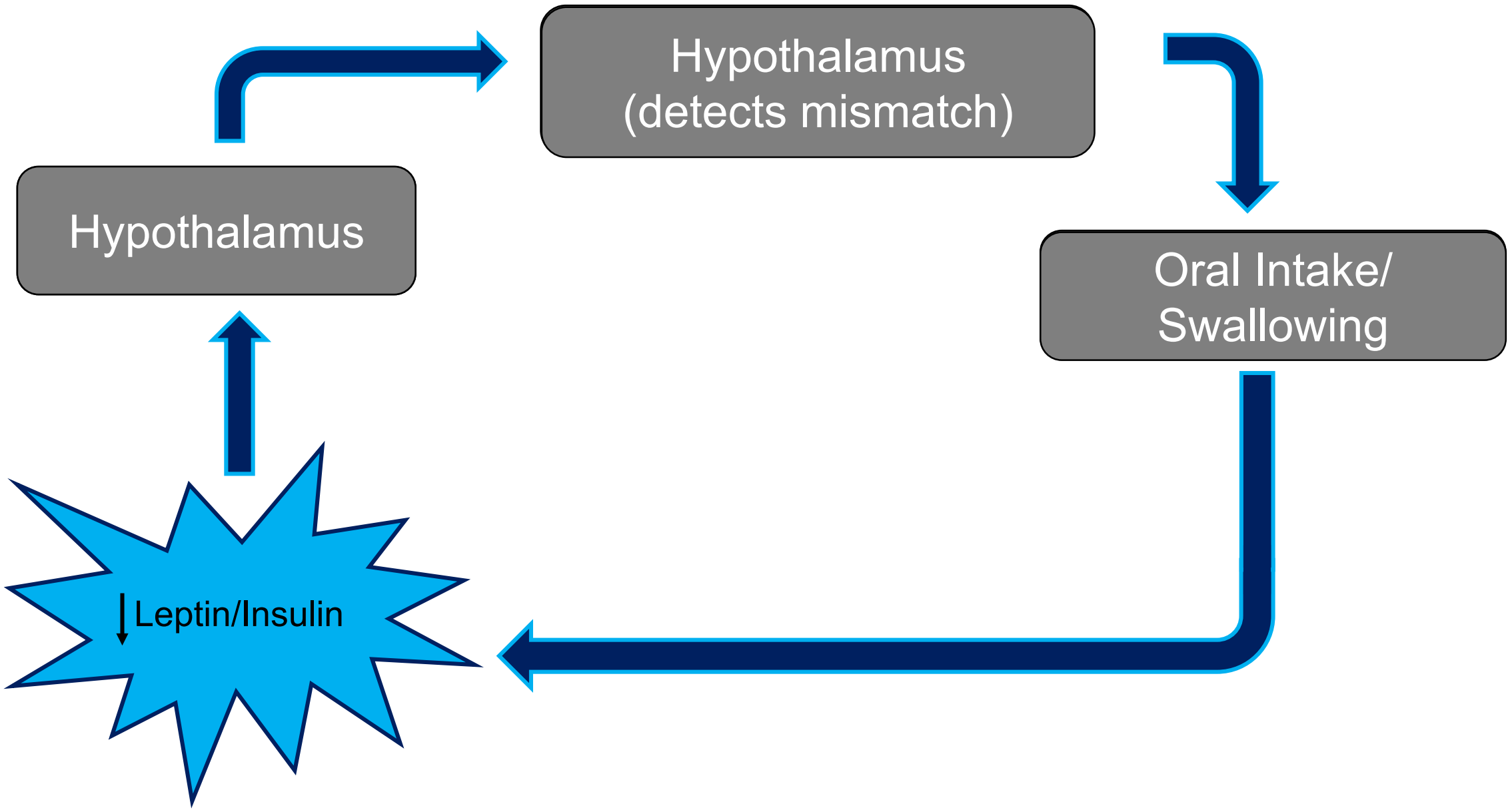
Taffett, 2002, UptoDate, 2011

*How does this relate to **swallowing**?*


Energy Inflow
Energy Outflow
Hypothalamus
Feeding and
Satiety Centers
Food Intake
Appetite
Suppressed (-)
Increased (+)
Leptin/Insulin
Energy Stores
Decreased (-)
Appetite
Increased (+)
Ghrelin Decreased (-)
Ghrelin Increased (+)
Nutrient Absorption (+)

Kordon, 2003

Nutritional Homeostasis in Action



Nutritional Homeostasis

Effective Oral Intake

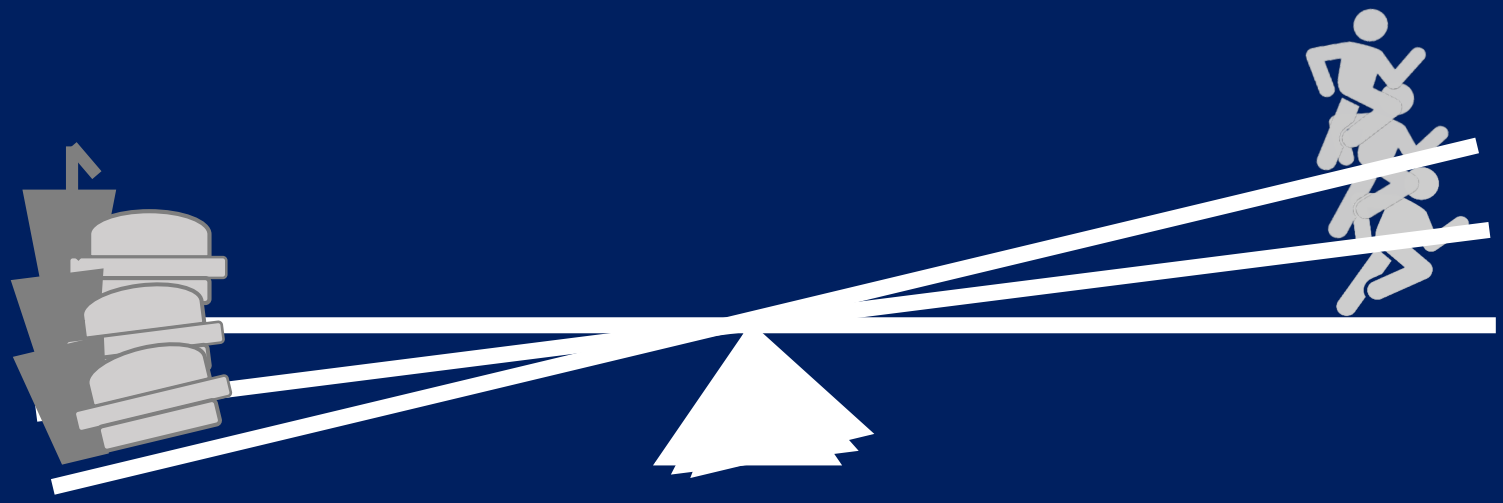
Swallowing Safety

Swallowing Efficiency

Unsafe Swallowing

Dysphagia

Inefficient Swallowing



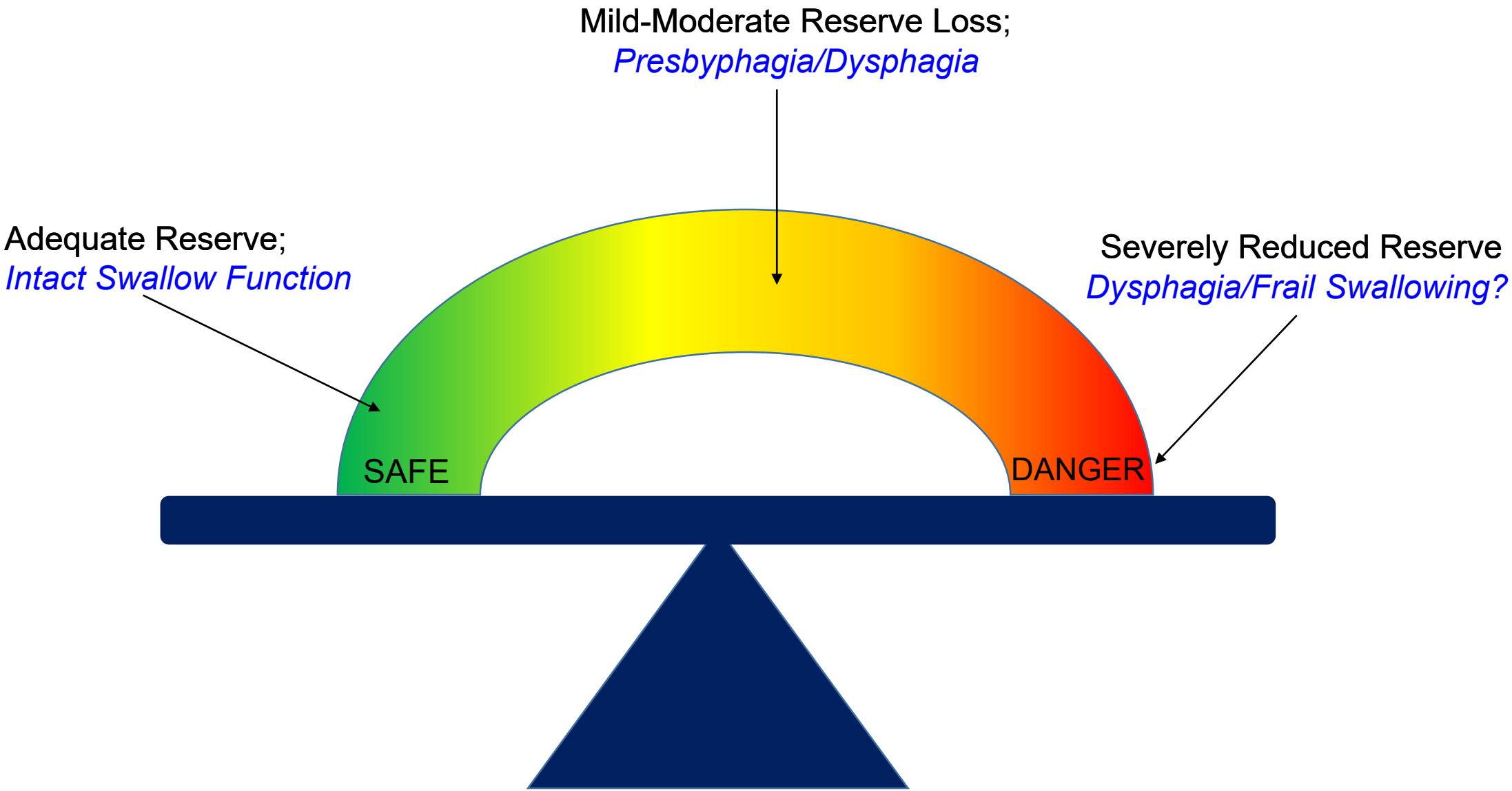
Dysregulated Nutritional Homeostasis

Swallowing and Reduced Functional Reserve

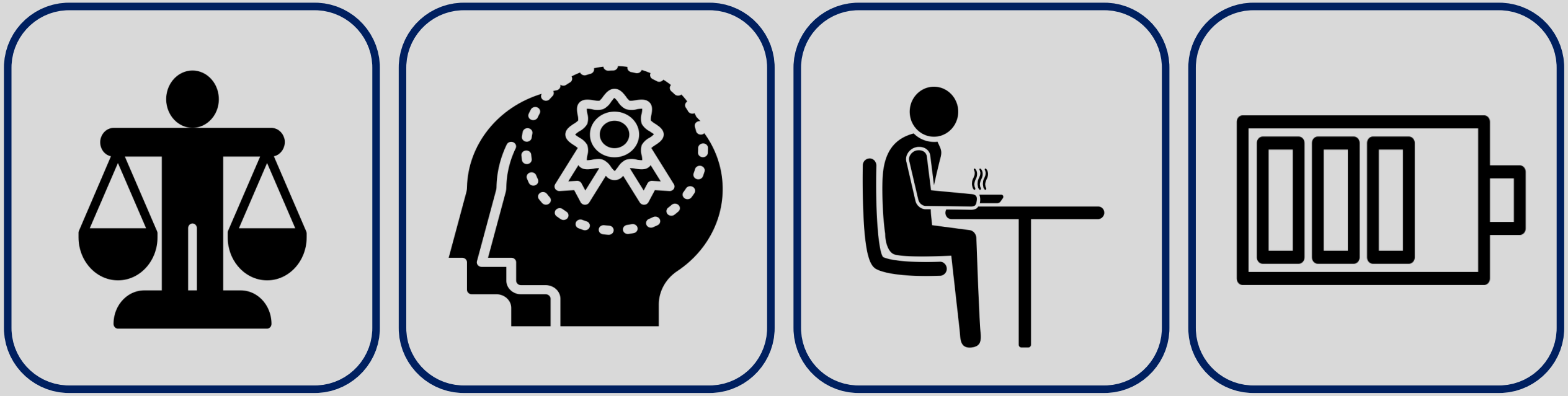
- Sarcopenia and declines in physiologic capacities that affect swallowing noted in aging and disease states.
  - Slower time to swallow
  - Delayed swallow initiation
  - Decreased sensory input
  - Less adaptable to perturbations
  - Reduced lingual pressure
- Reduced lingual reserve = presumed to increase dysphagia risk.

Steele 2013; Ney 2009; Humbert 2008; Easterling 2013

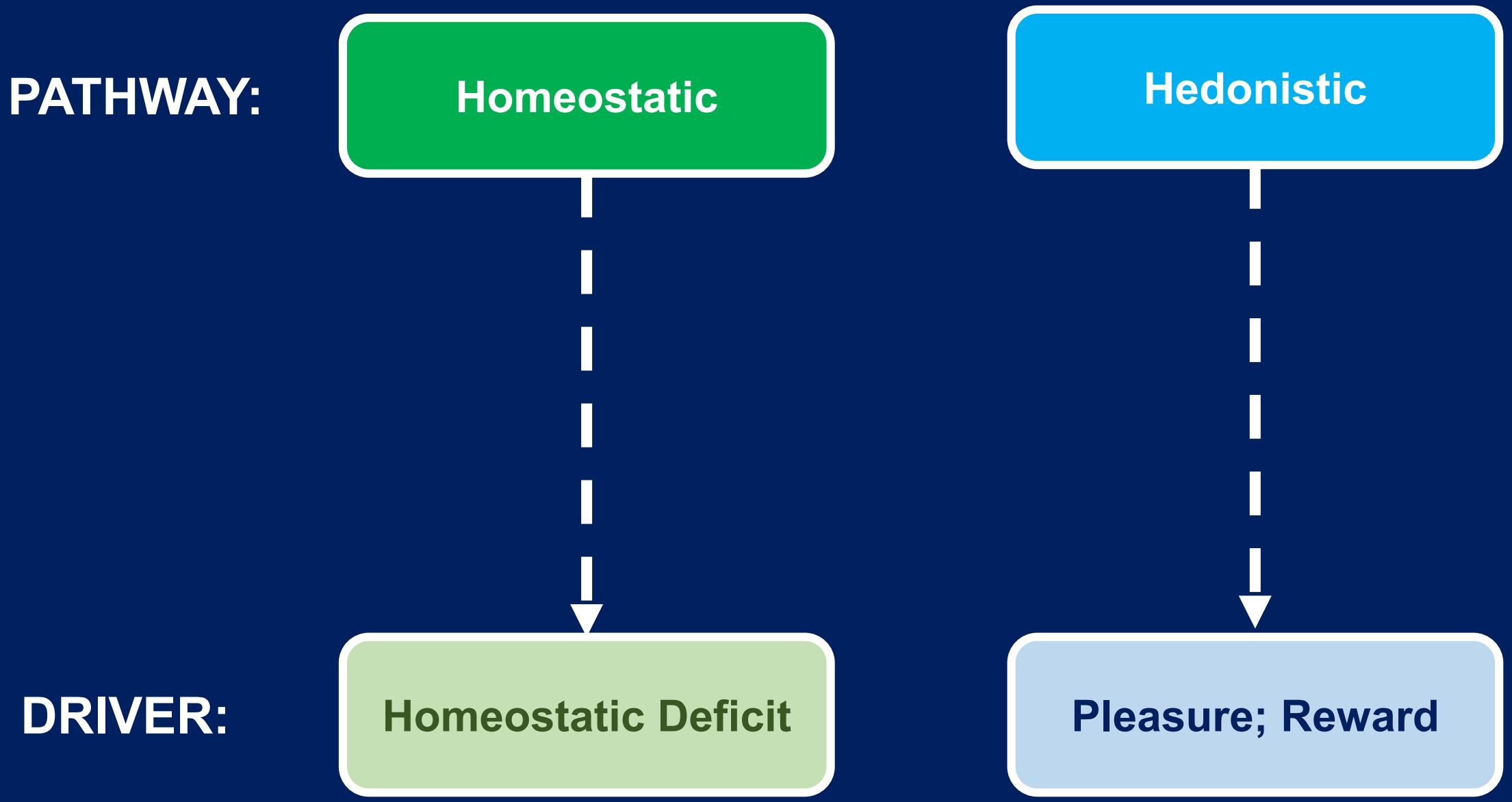
Theoretical Swallowing and Functional Reserve Continuum



Domains of Eating



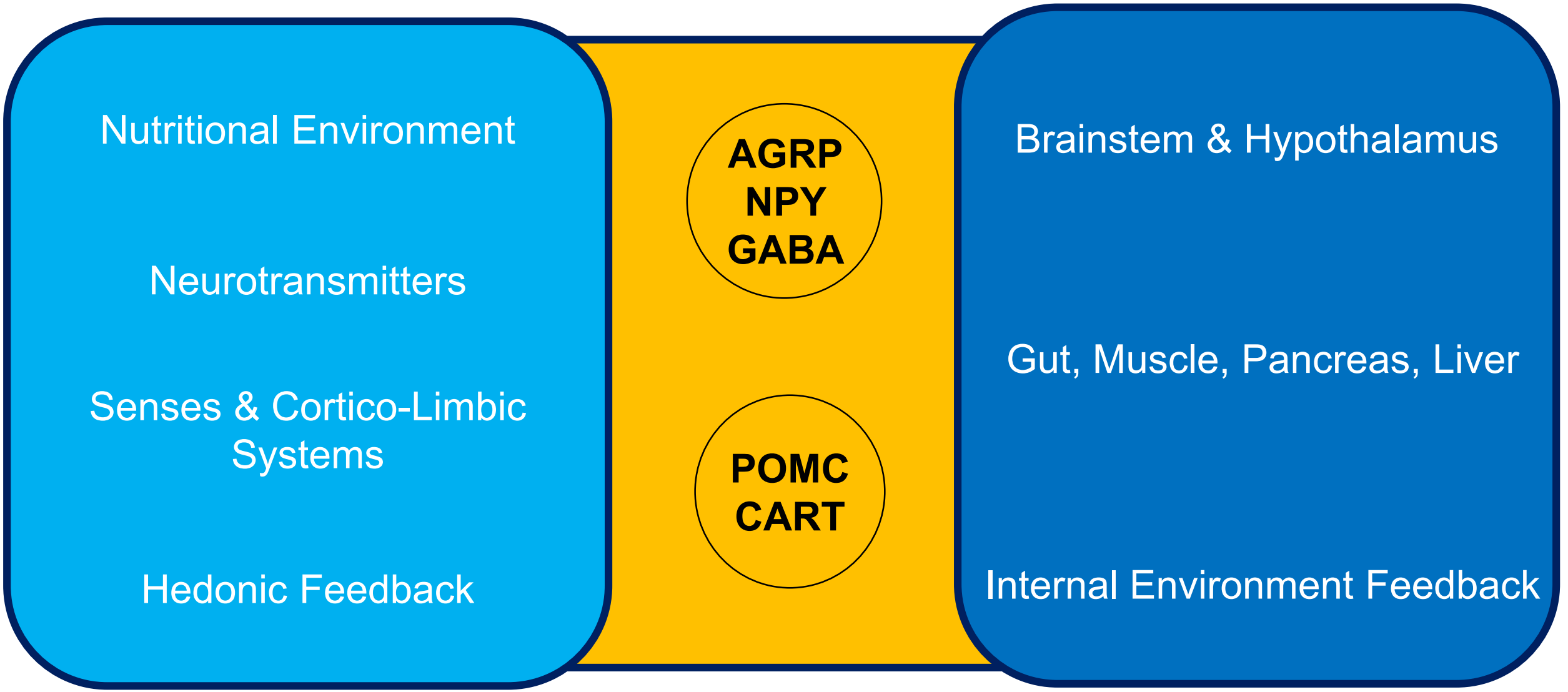
Eating as a hedonistic mechanism


PATHWAY:
Homeostatic
Hedonistic
DRIVER:
Homeostatic Deficit
Pleasure; Reward

"Liking" food: subjective pleasure of eating. Targets hedonic hot spots.

"Wanting" food: can't be explained in concrete terms; just have to have it.

Gibbons, 2015



Berthoud et al, 2017

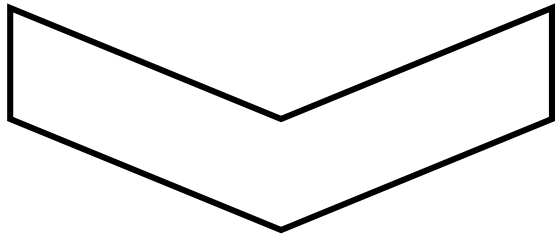
Hedonic Control of Eating

Triggers:

- Visual
- Olfactory
- Gustatory
- Mouthfeel
- Physico-Chemical

Neurotransmitters and Receptors:

- Dopamine
- Cannabinoids
- Opioids



Hedonic pathway will undermine and override the homeostatic system.

Creates bias towards highly-palatable and energy-dense foods.

Gibbons, 2015

HEDONIC CONTROL OF EATING

Hedonic control can impact homeostatic control to drive eating.

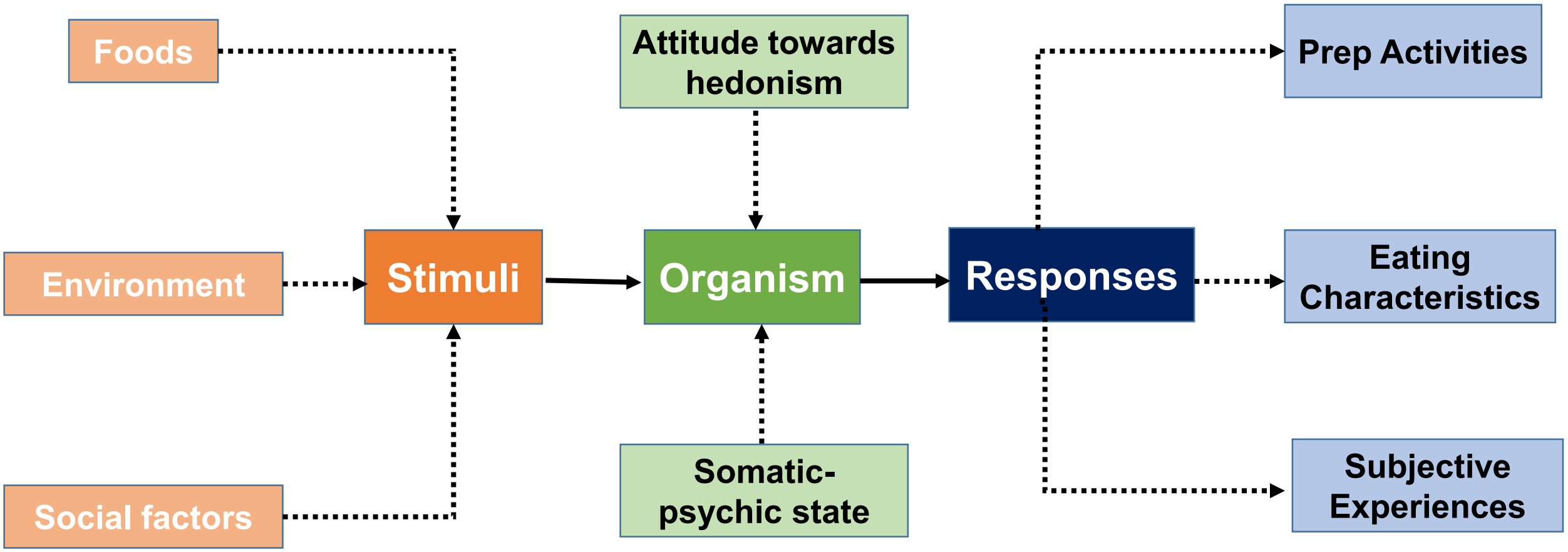
Hedonism as *positive influence*

Hedonic control can override homeostatic control; can lead to over-eating.

Hedonism as *negative influence*

Lutter 2009

Hedonic Factors in the Control of Eating

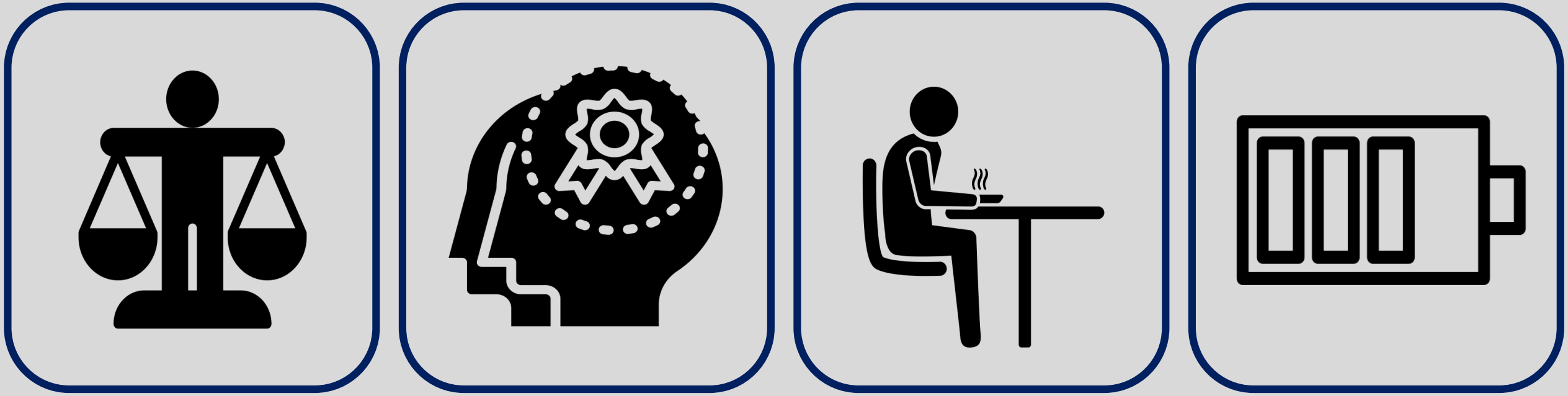


Macht et al, 2005

HEDONIC CONTROL OF EATING: THE CONUNDRUM

Flickr, Here We Buy, WikiHow, Pinterest, Go Dairy Free, Iwisr, Hopkins Medicine, Houzz

Domains of Eating



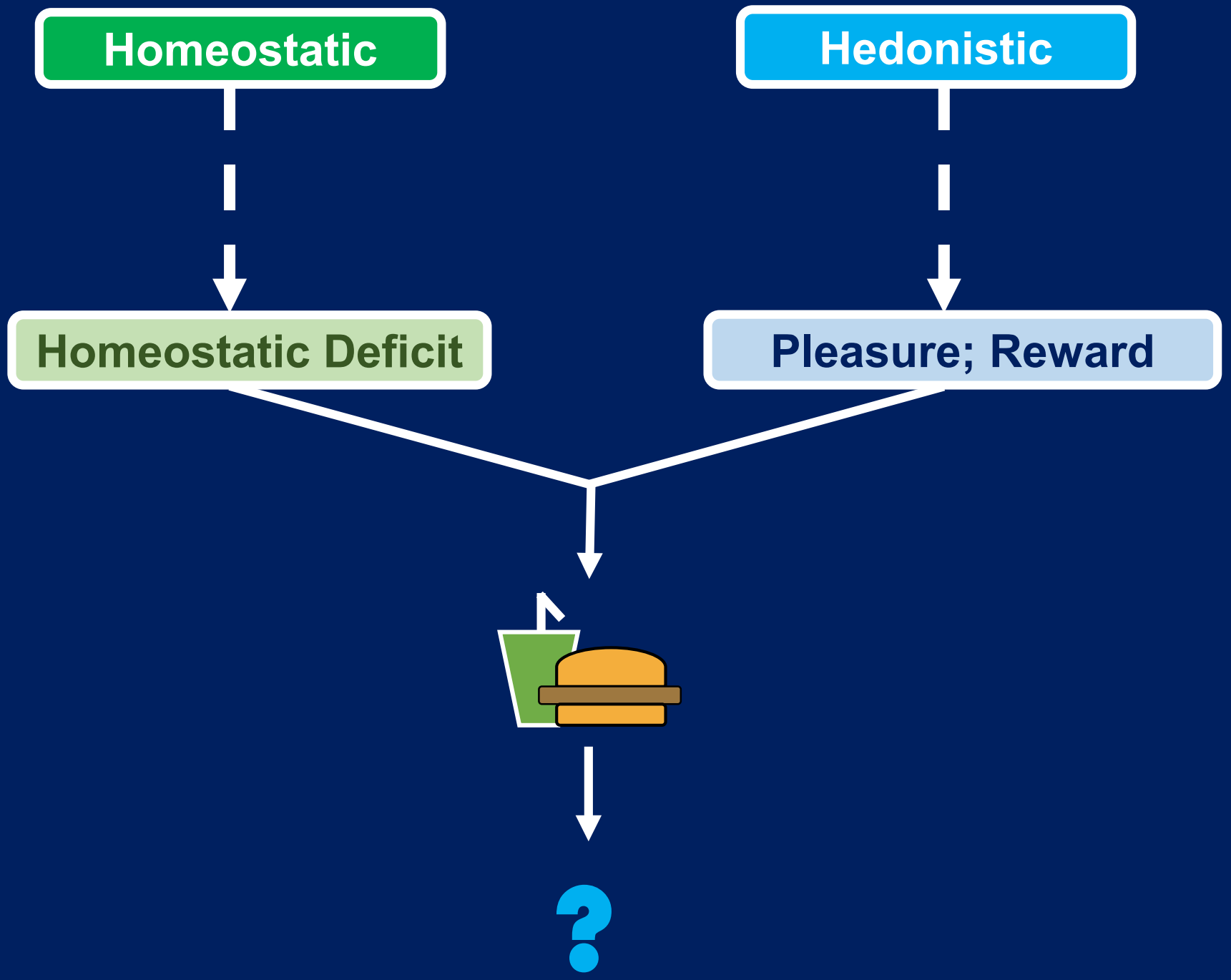
What we derive from eating

PATHWAY:

DRIVER:

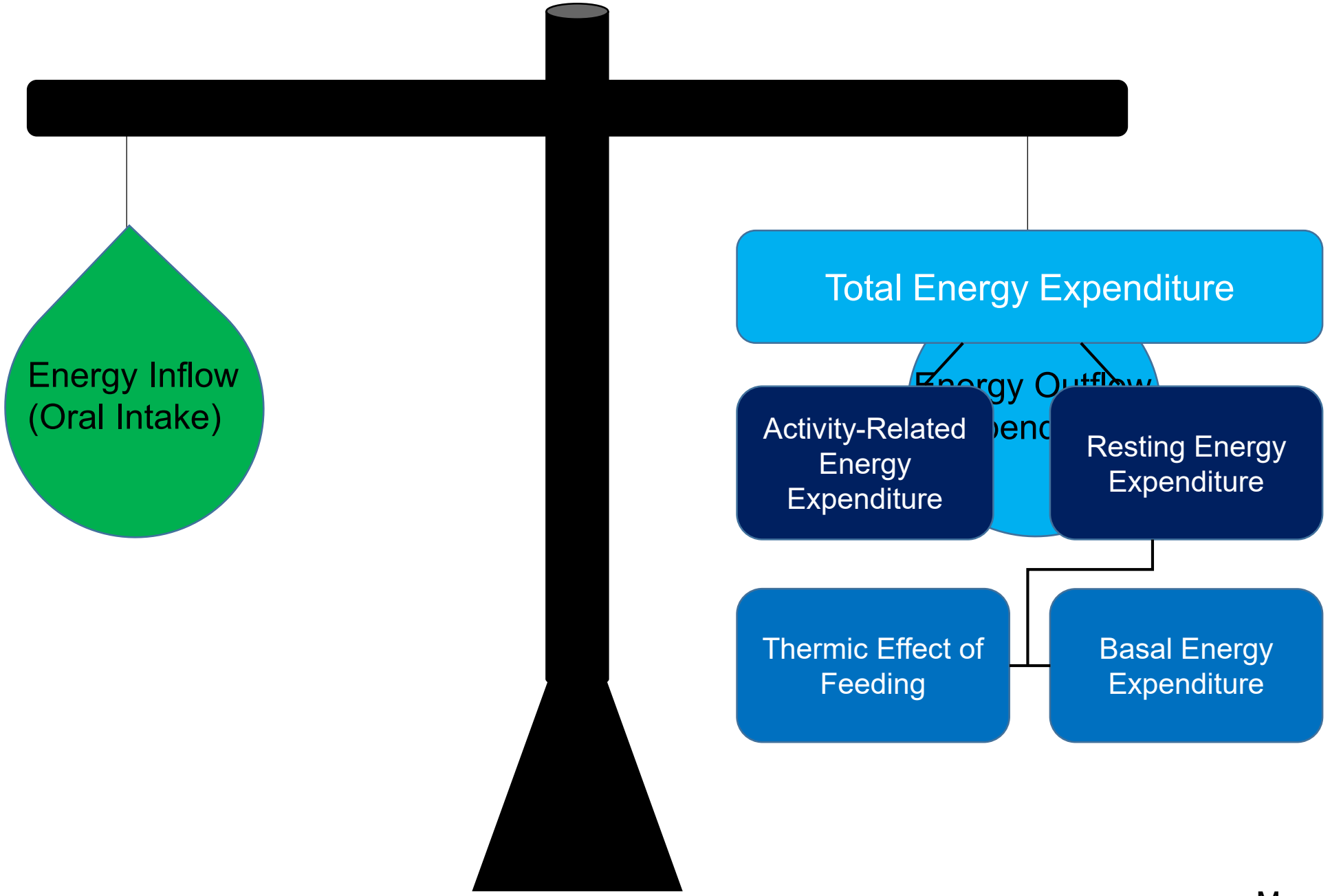
ACTION:

REACTION:



What happens with the energy (food) we consume?

Short and long answer: creates ***energy*** we can use and distribute.


Energy Inflow
(Oral Intake)
Total Energy Expenditure
Activity-Related
Energy
Expenditure
Resting Energy
Expenditure
Thermic Effect of
Feeding
Basal Energy
Expenditure

Moonen, 2021

BODY ENERGY REQUIREMENTS

- Energy needed for essential functions:
  - Cell growth and repair
  - Respiration
  - Blood transport
  - Maintaining immune system (fight fever, produce proteins and new immune cells to fight infection)
- Energy needed for activities of daily living:
  - Washing, dressing, etc
  - Eating
  - Walking
  - Exercise
- Energy Breakdown:
  - 60%: Resting metabolism/baseline function
  - 32%: Physical Activity
  - 8%: Thermic Effect

Essential we possess adequate energy stores and reserves to maintain adequate function.

Sciencelearn.org, Segerstorm, 2008, Health Engine 2009

Formula for Men:

Total Energy Expenditure (TEE) =
864 − 9.72 × age (years) + PA (Physical activity) ×
[(14.2 x weight (kg) + 503 × height (meters)]

Formula for Women:

TEE=
387 − 7.31 × age (years) + PA × [(10.9 x weight (kg) +
660.7 × height (meters)]

Men PA Values

- Sedentary: PA = 1.0, when 1.0 ≤ PAL* <1.4
- Low active: PA = 1.12, when 1.4 ≤ PAL <1.6
- Active: PA = 1.27, when 1.6 ≤ PAL <1.9
- Very active: PA = 1.54, when 1.9 ≤ PAL <2.5

*PAL = caloric cost of activity

Women PA Values

- Sedentary: PA = 1.0, when 1.0 ≤ PAL <1.4
- Low active: PA = 1.14, when 1.4 ≤ PAL <1.6
- Active: PA = 1.27, when 1.6 ≤ PAL <1.9
- Very active: PA = 1.45, when 1.9 ≤ PAL <2.5

Gerrior 2006

Estimated Energy Requirement (EER) Calculator available in:
"An Easy Approach to Calculating EER" by Gerrior

Table. Template for Calculation of Estimated Energy Requirements for an Active Man and Woman

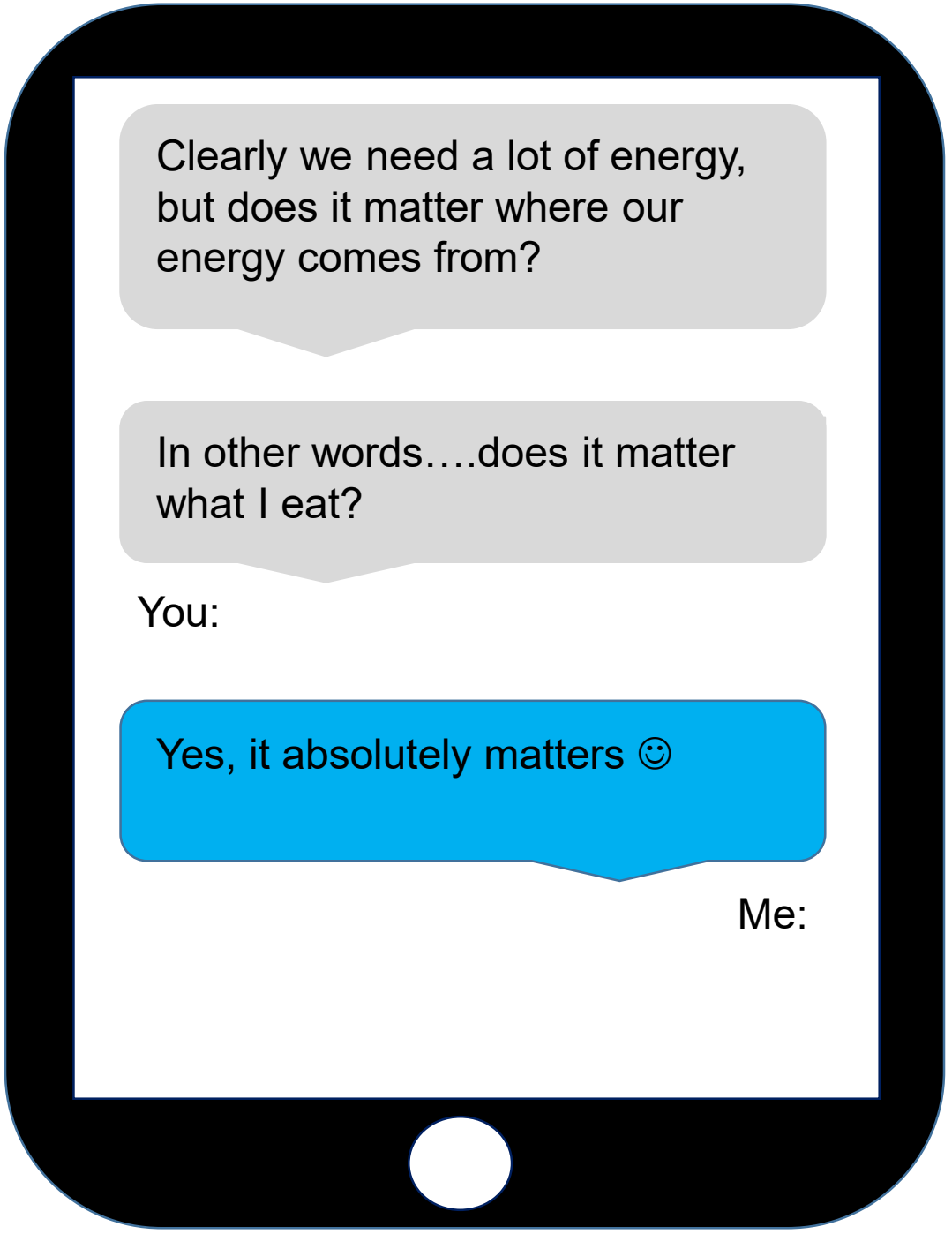
Man	Age (y)	Weight (kg)	Height (m)	BEE (kcal)	Activity[1]	Duration (min)[2]	METs	ΔPAL[3]	PAL	PA	TEE (kcal)
	30	70	1.77	1695.228	Household tasks, moderate effort	25	3.5	0.05770896959649			
					Light activity while sitting	120	1.5	0.05540061081263			
					Loading/unloading car	5	3	0.00923343513544			
					Mopping	10	3.5	0.02308358783859			
					Walking from house to car or bus	20	2.5	0.02770030540631			
					Watering the plants	12	2.5	0.01662018324379			
					Mowing lawn (power mower)	30	4.5	0.09695106892210			
					Cycling (moderately)	25	5.7	0.10849286284139			
					Tennis (doubles)	60	5	0.22160244325051	1.80	1.27	2965.4737
Woman	**Age (y)**	**Weight (kg)**	**Height (m)**	**BEE (kcal)**	**Activity[1]**	**Duration (min)[2]**	**METs**	**ΔPAL[3]**	**PAL**	**PA**	**TEE (kcal)**
	30	54	1.63	1285.745	Household tasks, moderate effort	25	3.5	0.05869651447215			
					Light activity while sitting	120	1.5	0.05634865389327			
					Loading/unloading car	5	3	0.00939144231554			
					Mopping	10	3.5	0.02347860578886			
					Mowing lawn (power mower)	30	4.5	0.09861014431322			
					Cycling (moderately)	25	5.7	0.11034944720765			
					Tennis (doubles)	60	5	0.22539461557307	1.82	1.27	2282.9371

BEE indicates basal energy expenditure; METs, metabolic equivalents; PAL, physical activity level; PA, physical activity coefficient; TEE, total energy expenditure.

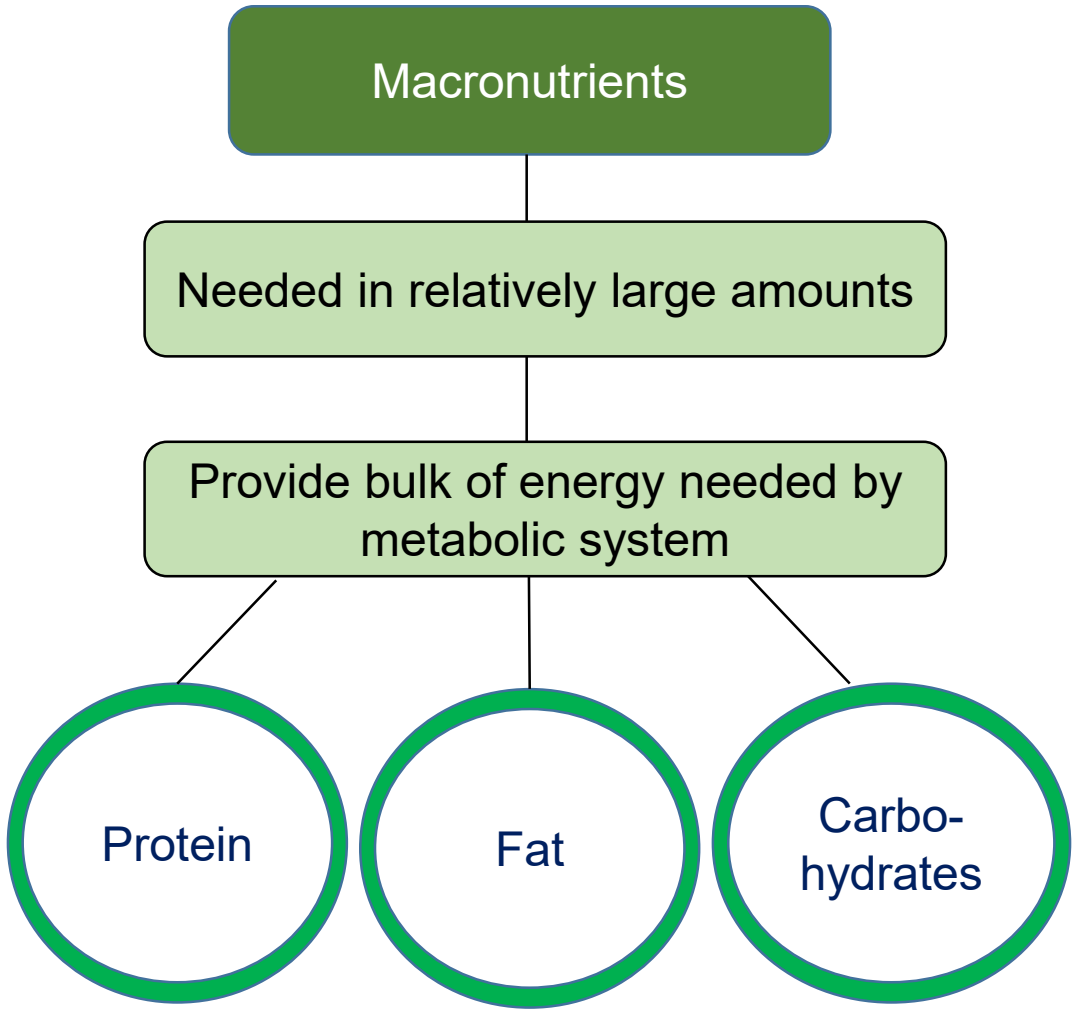
[1] Activity: activities performed in the past 24 hours

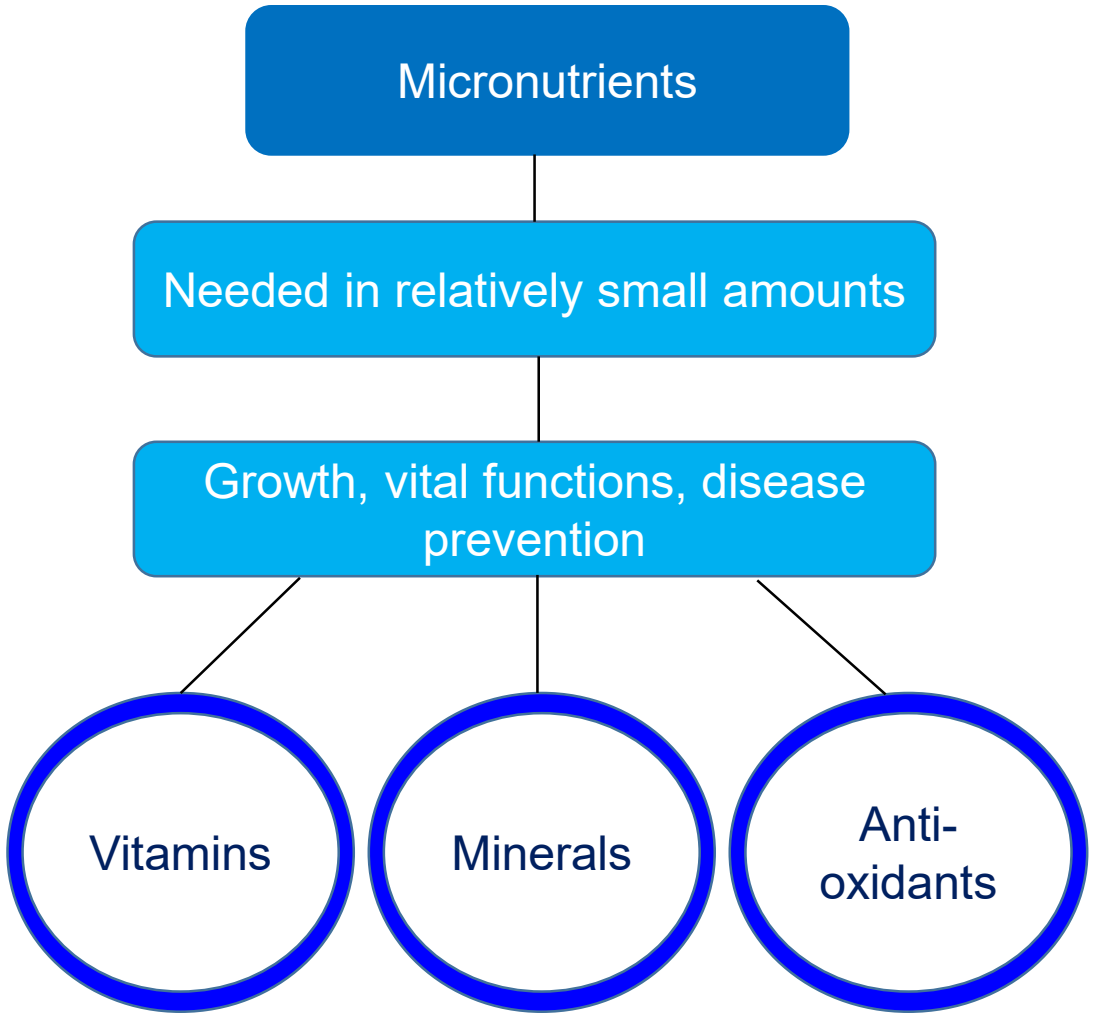
[2] Duration: length of each activity performed

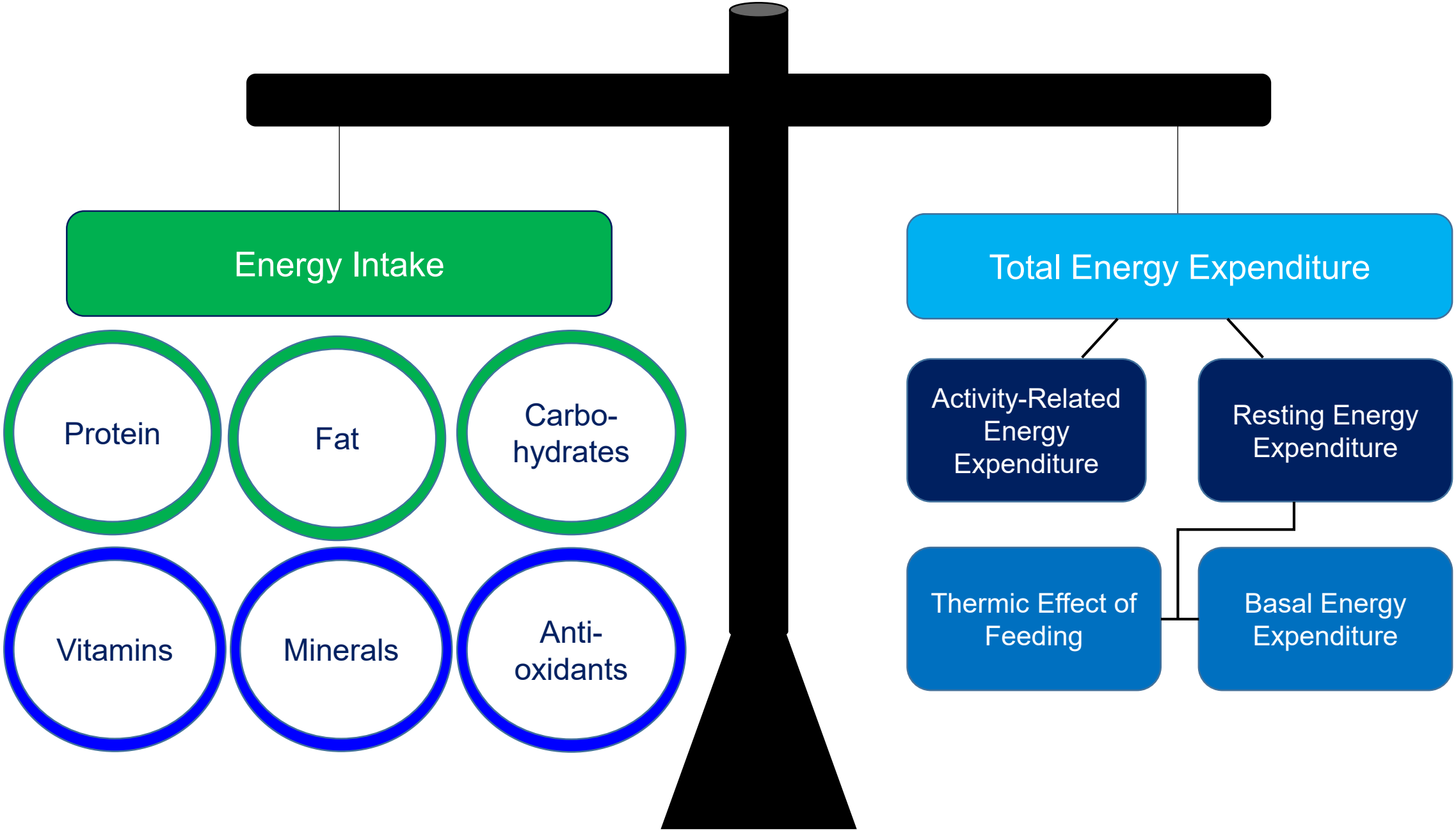
[3] ΔPAL: physical activity impacts on energy expenditure


Clearly we need a lot of energy, but does it matter where our energy comes from?
In other words….does it matter what I eat?
You:
Yes, it absolutely matters ☺
Me:

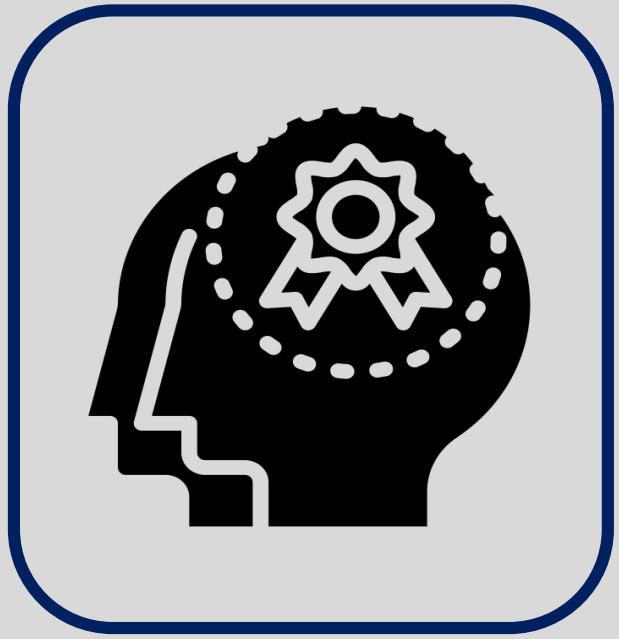
Types of Nutrients We Need

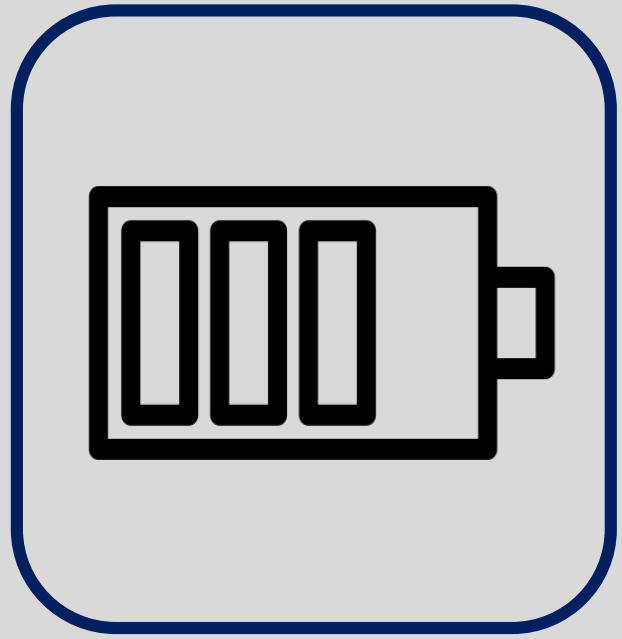





Energy Intake
Protein
Fat
Carbo-
hydrates
Vitamins
Minerals
Anti-
oxidants
Total Energy Expenditure
Activity-Related
Energy
Expenditure
Resting Energy
Expenditure
Thermic Effect of
Feeding
Basal Energy
Expenditure

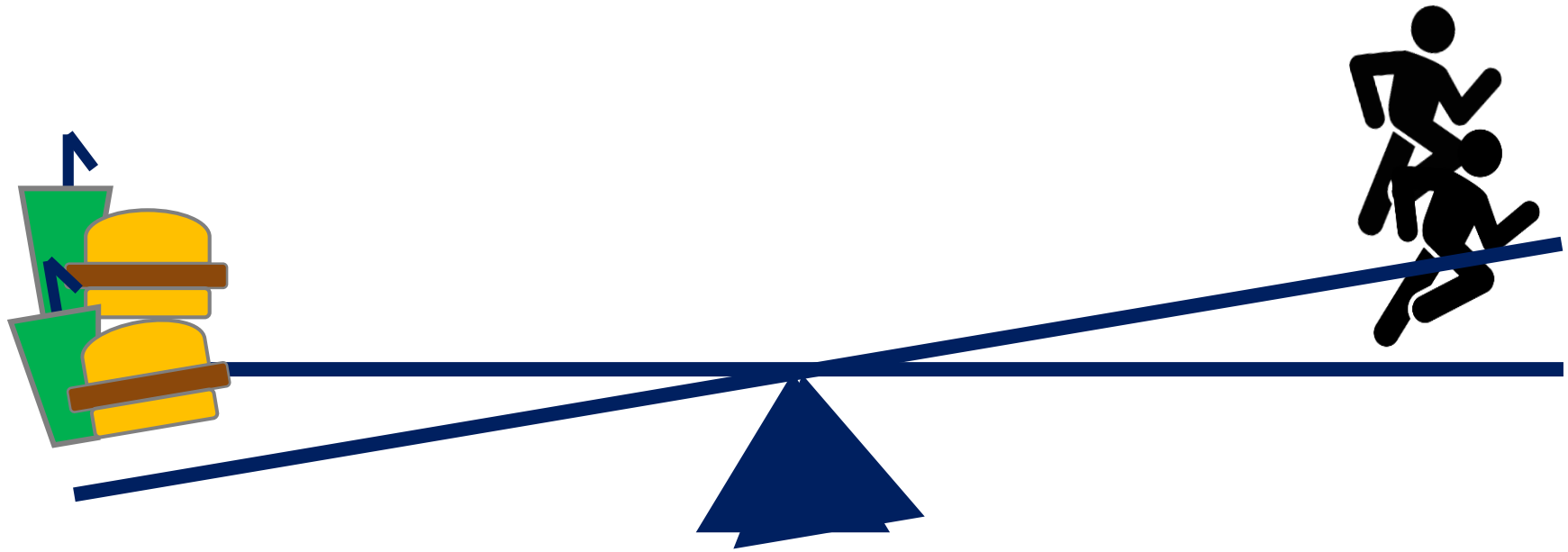
Domains of Eating





What if we can’t eat enough?

The Balance Between Eating and Energy



Difficulty swallowing (dysphagia) can make it harder to get adequate energy inflow.

Dysphagia can contribute to energy imbalance in patients/individuals.

Body energy responses to disease, trauma, illness.

Cuthbertson (1942) Ebb and Flow Trauma Theory:

Ebb Phase (short-term): Declines in body temperature + oxygen consumption. Reduce posttraumatic energy depletion.

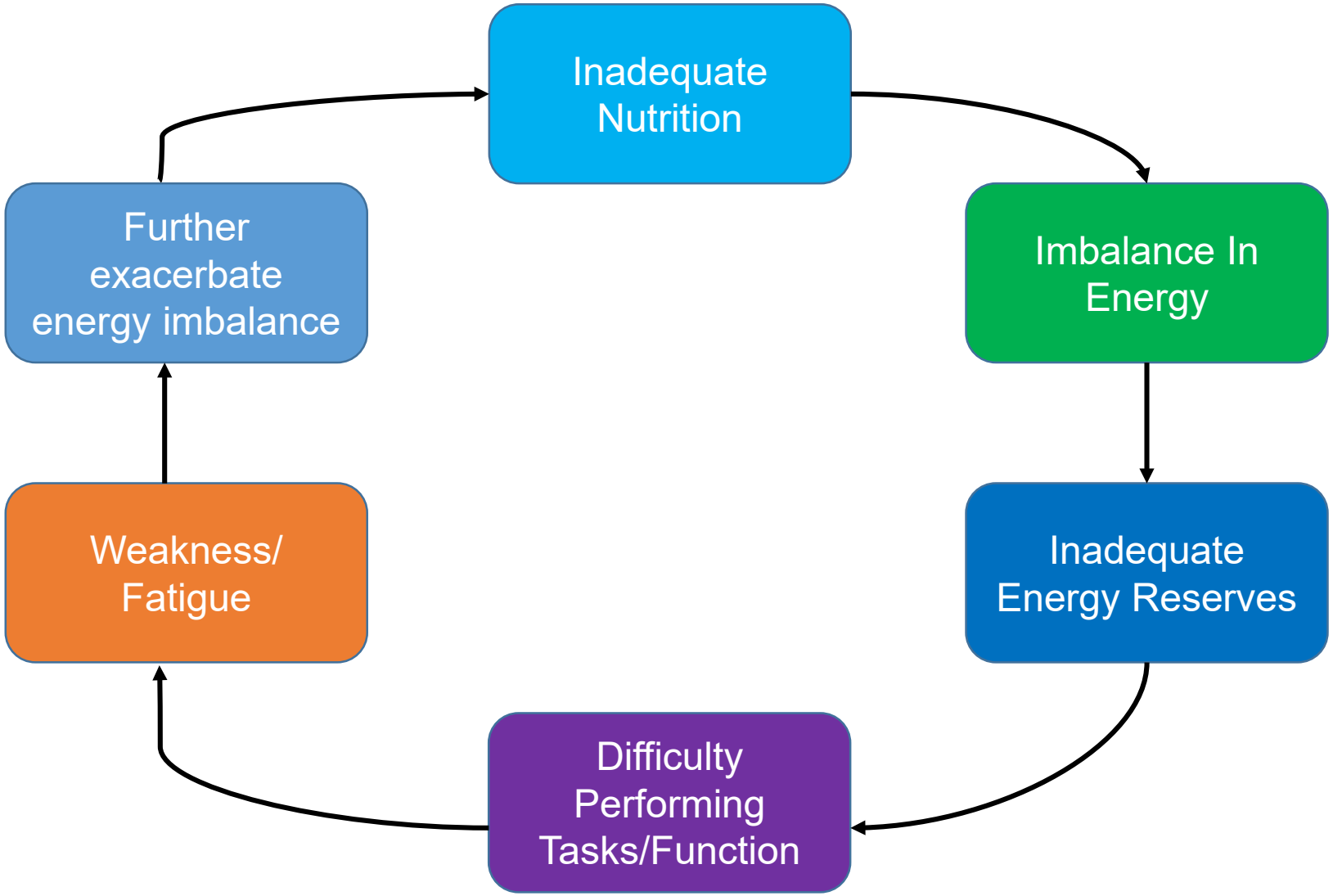
Flow Phase (long-term): Increased metabolic turnover, immune system activation, hepatic acute-phase response. Causes increased oxygen consumption and energy expenditure.

Selfish Brain Theory:

Brain will prioritize its' own energy requirements when faced with stress and fluctuations in energy throughout the body.

Moore 2010

A Vicious Cycle



Are Patients Aware of this Energy Imbalance?

Money Analogy

The Spoon Theory

The Spoon Theory

DYSAUTONOMIA INTERNATIONAL

AWARENESS ADVOCACY ADVANCEMENT

The Spoon Theory is a creative way to explain to healthy friends and family what it's like living with a chronic illness. Dysautonomia patients often have limited energy, represented by spoons. Doing too much in one day can leave you short on spoons the next day.

If you only had 12 spoons per day, how would you use them? Take away 1 spoon if you didn't sleep well last night, forgot to take your meds, or skipped a meal. Take away 4 spoons if you have a cold.

The Spoon Theory was written by Christine Miserando,
which you can check out on her website www.butyoudontlooksick.com.

www.dysautonomiainternational.org

INDIVIDUAL AND CLINICAN-DECISION MAKING

- If patients have inadequate nutrition and energy, they will have to make decisions about how to use their energy or body may make decision for them.

- How can this impact treatment and assessment? How do we ensure best performance?

Nutritional Determinants

QUANTITY of food

QUALITY of food

Lorenzo-López *et al. BMC Geriatrics* (2017) 17:108
DOI 10.1186/s12877-017-0496-2

BMC Geriatrics

RESEARCH ARTICLE Open Access

Nutritional determinants of frailty in older adults: A systematic review

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- Low intakes of specific micronutrients associated with increased frailty risk.
- Macronutrients and frailty: higher protein intake = lower risk of frailty
- Inverse relationship between diet quality and frailty risk.
- Increased dietary antioxidant capacity = lower risk of frailty.
- Association between malnutrition and frailty.

Role of the Speech-Language Pathologist (SLP)

- Considerations of patient energy levels, energy reserves, and diet considerations may go above the scope and training of SLPs.
- All of this information is needed when working with patients with swallowing disorders and implementing a treatment plan.

Role of the Dietitian

- Direct training in nutrition and dietary management. Can assess patient's nutritional needs and design plan.
- An opportunity for collaboration to prepare patient to swallow and eat the variety of foods necessary for function and survival.

“Your energy comes from what you eat. Eating enough + enough of the right things gives you more ‘bang for your buck’.”

~~“You are what you eat”~~

Eating and Energy: A Summary

Homeostasis is essential to our lives and gives rise to all our functions. Eating is one of the most important homeostatic functions.

Equally important to eating is the pleasure (hedonics) of eating and can be used to enhance the eating experience.

Eating and Energy: A Summary

Body uses energy in very specific ways. Important to use patient-centered, collaborative approach to tailor tx accordingly.

Inadequate nutrition creates energy imbalance. Individual and their body will have to prioritize most meaningful functions.

Not enough to eat a lot, must also *eat well.*

Acknowledgments

Aerodigestive Research Core:

- UG Students
- Masters Students
- Amber Anderson
- Lauren DiBiase
- Danny Nunn
- Residue Team
- Dr. Terrie Vasilopoulos

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- Dr. Nadine Connor
- Dr. Timothy McCulloch
- Dr. Kristen Pickett
- Dr. Nathaniel Chin
- Dr. Amy Kind
- Dr. Molly Carnes

Swallowing and Salivary Bioscience Laboratory

Funding:

NINDS Grant #1R01NS100859 (PI: Plowman)

NINDS Diversity Supplement #NS100859-01 (Trainee: Robison)

F99/K00 NINDS Blueprint D-Span #F99NS115339 (PI: Robison)

References

- Taffett GE. Physiology of Aging. Geriatr Med An Evidence-Based Approach [online]. New York, NY: Springer New York; 2003. p. 27–35.
- Humbert IA, Robbins J. Dysphagia in the elderly. Phys Med Rehabil Clin N Am. 2008 Nov;19(4):853-66, ix-x. doi: 10.1016/j.pmr.2008.06.002. PMID: 18940645; PMCID: PMC3182519.
- Kordon C, Robinson I, Hanoune J, Dantzer R, Christen Y. Brain Somatic Cross-Talk and the Central Control of Metabolism [online]. Springer; 2003.
- Steele CM. Optimal approaches for measuring tongue-pressure functional reserve. J Aging Res. Hindawi; 2013;2013.
- Ney DM, Weiss JM, Kind AJH, Robbins J. Senescent swallowing: impact, strategies, and interventions. Nutr Clin Pract [online serial]. 2009;24:395–413. Accessed at: https://www.ncbi.nlm.nih.gov/pubmed/19483069.
- Modell H, Cliff W, Michael J, McFarland J, Pat Wenderoth M, Wright A. A Personal View A physiologist's view of homeostasis. Adv Physiol Educ [online serial]. 2015;39:259–266. Accessed at: www.physiology.org/journal/advances.
- Easterling C, Antinoja J, Cashin S, Barkhaus PE. Changes in tongue pressure, pulmonary function, and salivary flow in patients with amyotrophic lateral sclerosis. Dysphagia [online serial]. 2012/12/18. 2013;28:217–225. Accessed at: http://www.ncbi.nlm.nih.gov/pubmed/23242462.

References

- Stern Y. What is cognitive reserve? Theory and research application of the reserve concept. J Int Neuropsychol Soc. 2002 Mar;8(3):448-60. PMID: 11939702.

- Stern Y. (2009). Cognitive reserve. *Neuropsychologia*, *47*(10), 2015–2028. https://doi.org/10.1016/j.neuropsychologia.2009.03.004

- Mori E, Hirono N, Yamashita H, Imamura T, Ikejiri Y, Ikeda M, Kitagaki H, Shimomura T, Yoneda Y. Premorbid brain size as a determinant of reserve capacity against intellectual decline in Alzheimer's disease. Am J Psychiatry. 1997 Jan;154(1):18-24. doi: 10.1176/ajp.154.1.18. PMID: 8988953.

- Berthoud HR, Münzberg H, Morrison CD. Blaming the Brain for Obesity: Integration of Hedonic and Homeostatic Mechanisms. Gastroenterology. 2017 May;152(7):1728-1738. doi: 10.1053/j.gastro.2016.12.050. Epub 2017 Feb 10. PMID: 28192106; PMCID: PMC5406238.

- Gibbons, C., & Blundell, J. (2015). Appetite regulation and physical activity–an energy balance perspective. Hamdan Medical Journal, 212(2137), 1-20

- Lutter, M., & Nestler, E. J. (2009). Homeostatic and hedonic signals interact in the regulation of food intake. The Journal of nutrition, 139(3), 629–632. https://doi.org/10.3945/jn.108.097618

- Macht, M., Meininger, J. & Roth, J. The Pleasures of Eating: A Qualitative Analysis. J Happiness Stud 6, 137–160 (2005). https://doi.org/10.1007/s10902-005-0287-x

References

- Moonen, H.P.F.X., Beckers, K.J.H. & van Zanten, A.R.H. Energy expenditure and indirect calorimetry in critical illness and convalescence: current evidence and practical considerations. *j intensive care* **9,** 8 (2021). https://doi.org/10.1186/s40560-021-00524-0

- Segerstrom S. C. (2007). Stress, Energy, and Immunity: An Ecological View. Current directions in psychological science, 16(6), 326–330. https://doi.org/10.1111/j.1467-8721.2007.00522.x

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