

# The Biology of Stress

*Exploring the causes, types, and effects...*

Mini Med School

30 January, 2022

Nicole Cameron



a place of mind  
THE UNIVERSITY OF BRITISH COLUMBIA  
Faculty of Medicine



University  
of Victoria

let's talk  science

# Territorial Acknowledgement

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We acknowledge with respect the Lekwungen peoples on whose traditional territory the university stands and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

# Introductions and Disclosures

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- About the optional survey
- This talk will be recorded

# Introductions and Disclosures

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- I am a second year medical student
- This talk is intended for your entertainment and education, and is not meant to replace advice from your physician or another health care professional
- All pictures used are free stock photos or photos available under a Creative Commons license unless otherwise noted
- Thank you for joining us!

# Agenda

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- What is stress?
- Epidemiology of stress
- Types of stress
- Stress response pathway
- Effects of stress - acute
- *Intermission / Q&A*
- Effects of stress - chronic
- When to seek help
- Preview: stress management
- Suggested Resources
- Q&A

# What is stress?

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- A feeling of emotional or physical tension
  - Physiologic stressors
    - Put a strain on our body (e.g., injury, extreme temperatures, etc.)
  - Psychological stressors
    - Anything we interpret as negative or threatening (e.g., events, situations, people, comments, etc.)



# What is stress?

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- Common elements to all stressful situations...NUTS
  - Novelty
  - Unpredictability
  - Threat to the ego
  - Sense of control



# Epidemiology of stress

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- Statistics Canada survey 2020: Perceived life stress
  - 20.4% of people reported “most days are quite or extremely stressful”
    - Highest among those aged 35-49 (27.5%)
    - Lowest among those aged 65+ (10.3%)





# Poll

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What is the most common source of stress in people's day-to-day lives?

- Financial concerns
- Family
- Work
- Time pressures/not enough time

# Epidemiology of stress

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- Statistics Canada survey 2020: Main source of stress in day-to-day life

1. Work
2. Financial concerns
3. Family
4. Time pressures / not enough time



# Epidemiology of stress

STRESS IN AMERICA 2020: A NATIONAL MENTAL HEALTH CRISIS

## COVID-19 Is a Significant Stressor for Most Americans



Stress in America  
2020 study: COVID-19



Nearly 8 in 10 (**78%**) say the coronavirus pandemic is a significant source of stress in their life



Nearly 7 in 10 (**67%**) say they have experienced increased stress over the course of the pandemic

# Epidemiology of stress

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- Stress in America 2021 study: COVID-19 and decision making
- 63% of adults agreed that uncertainty about what the next few months will be like causes them stress



# Epidemiology of stress

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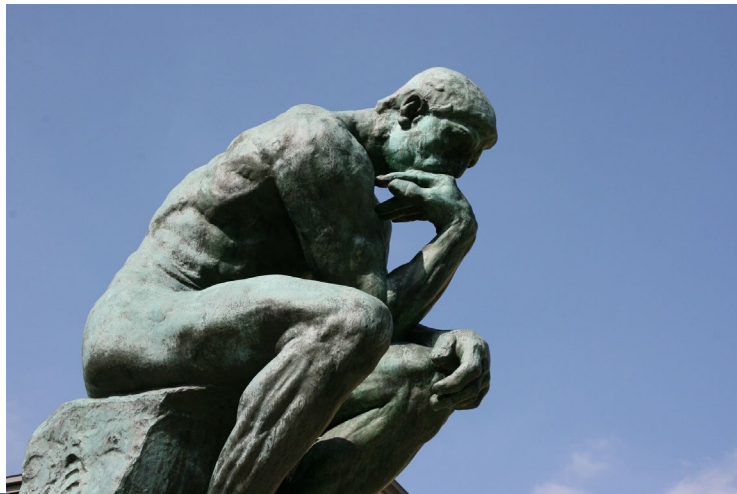
- Stress in America 2021 study: COVID-19 and decision making
  - 49% of adults said the pandemic makes planning for the future feel impossible
    - Younger adults, especially millennials feel this way



# Epidemiology of stress

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- Stress in America 2021 study: COVID-19 and decision making
- 61% of adults agreed the pandemic has made them re-think how they were living their life





# Poll

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## True or false?

- All stress is bad

# Types of stress

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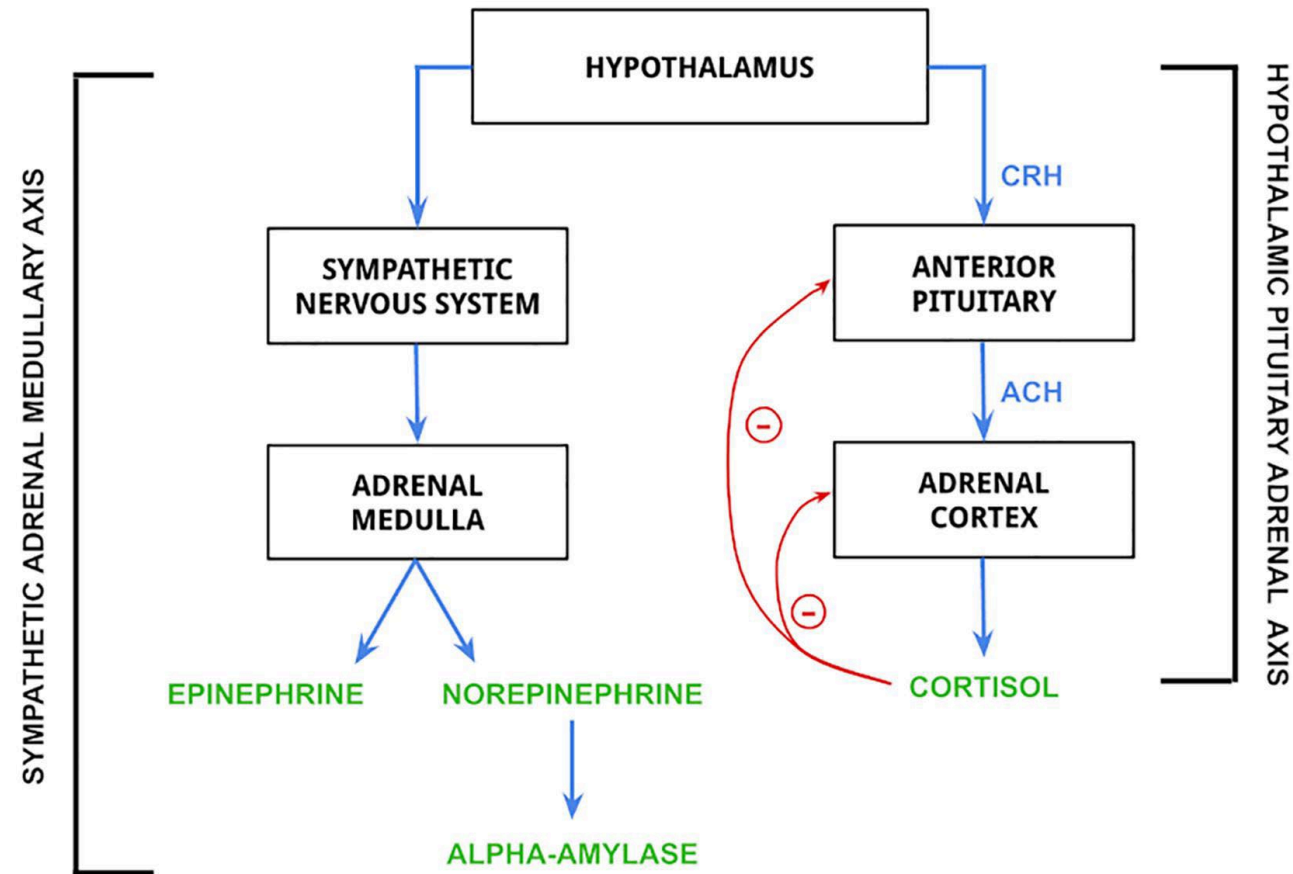
- Eustress (positive stress)
  - E.g., before performing in front of people
- Distress (negative stress)
  - Acute/episodic
    - E.g., Loss of a loved one
  - Chronic/toxic
    - E.g., abuse



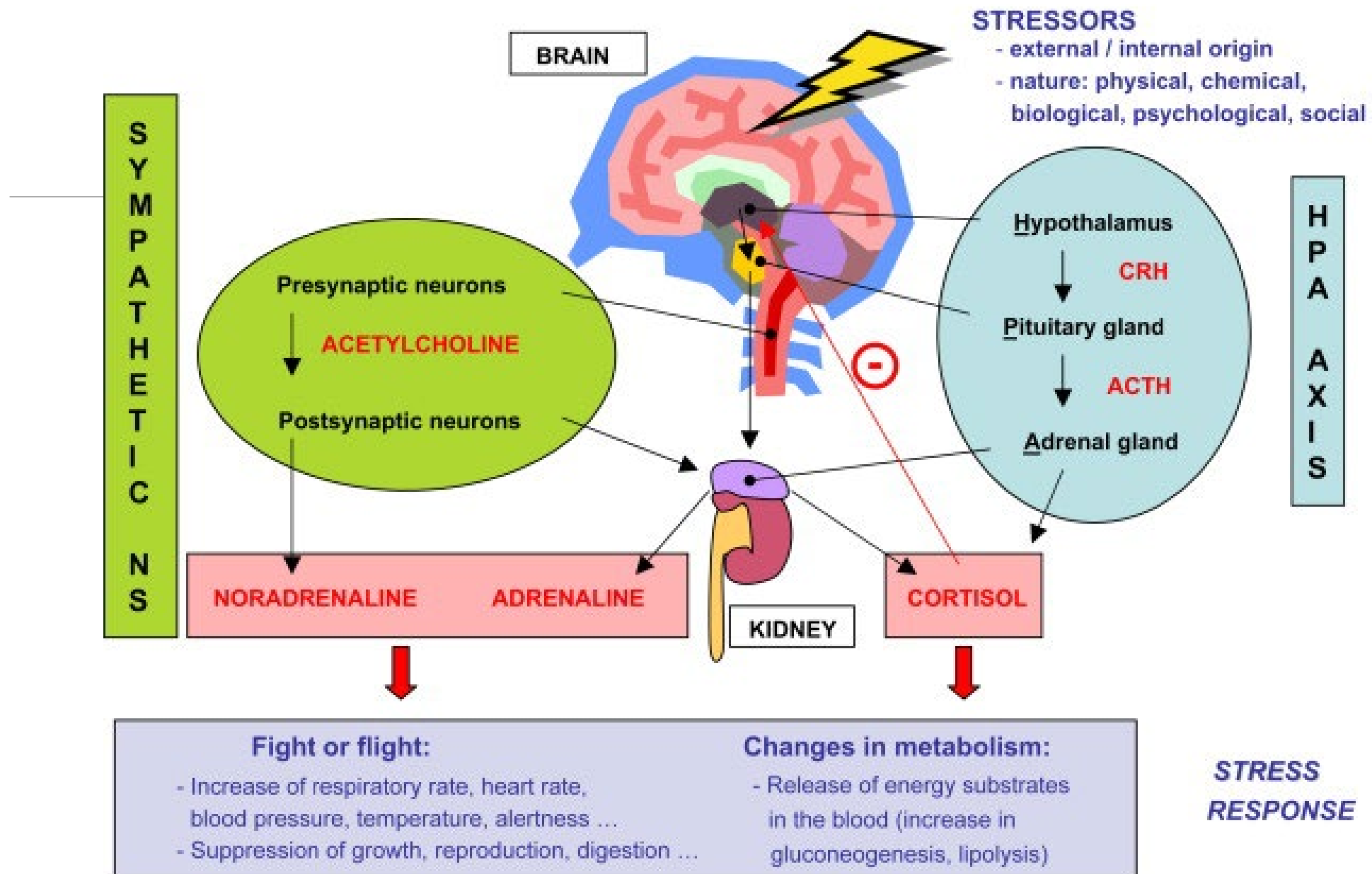


# Stress response system

- The stress response is mediated by two systems:
  - Fast response: Sympathetic Nervous System (SNS)
    - Epinephrine (Adrenaline)
  - Slow response: Hypothalamus-Pituitary-Adrenal (HPA) Axis
    - Cortisol



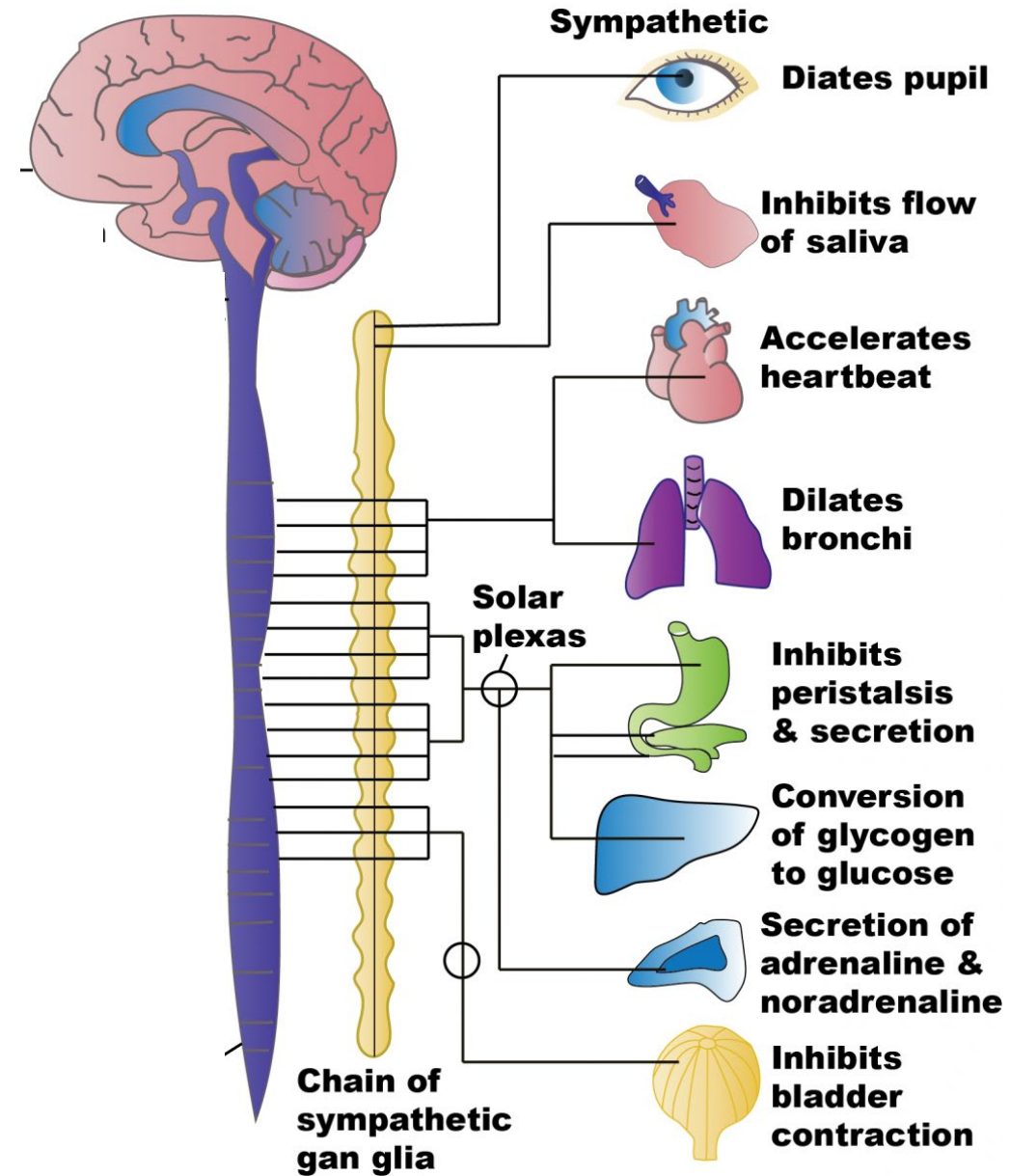
# The stress system



# Stress response system

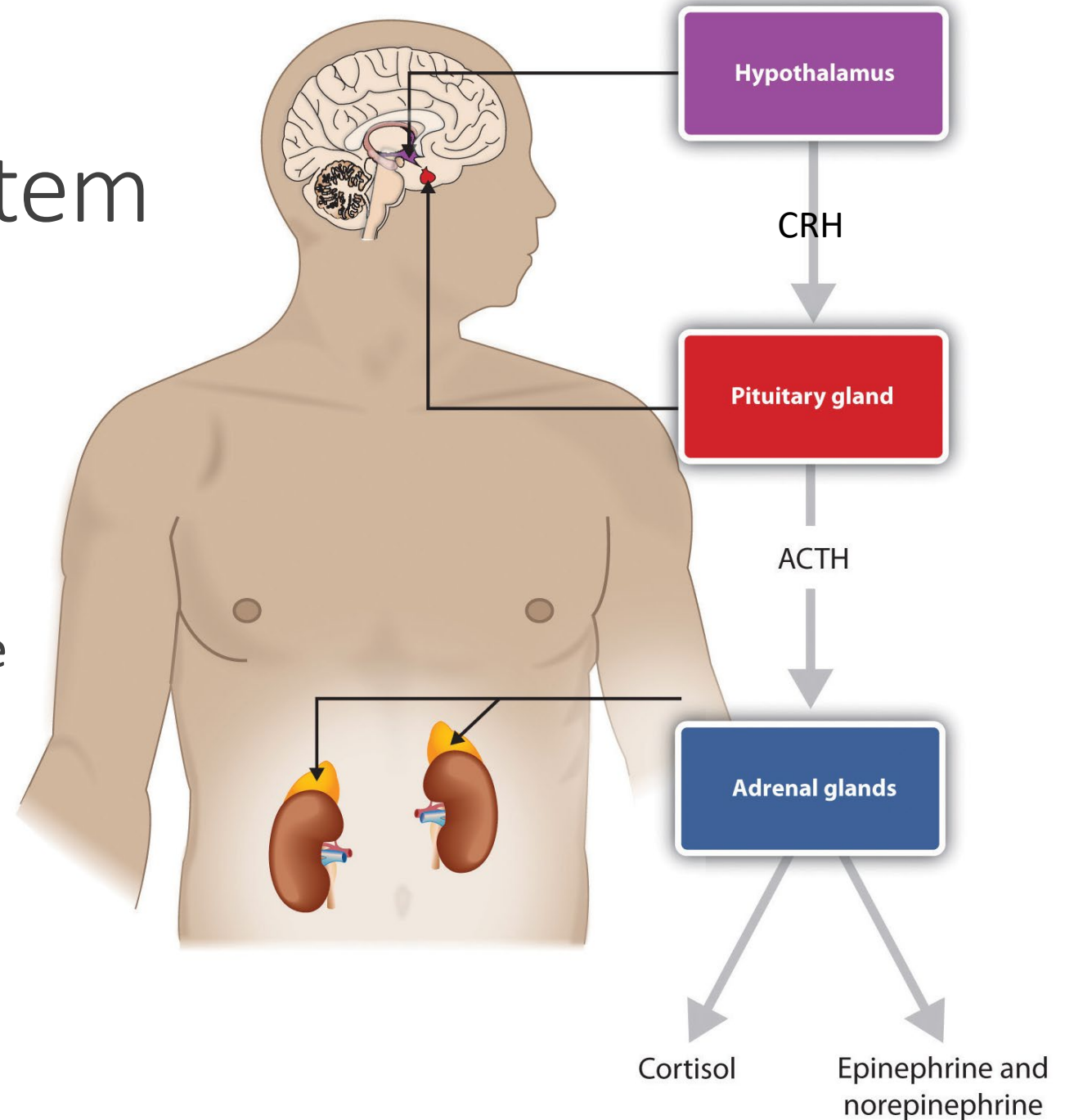
- Sympathetic Nervous System

- Increases heart rate
- Increases blood pressure
- Enhances arousal
- Reduces gut motility



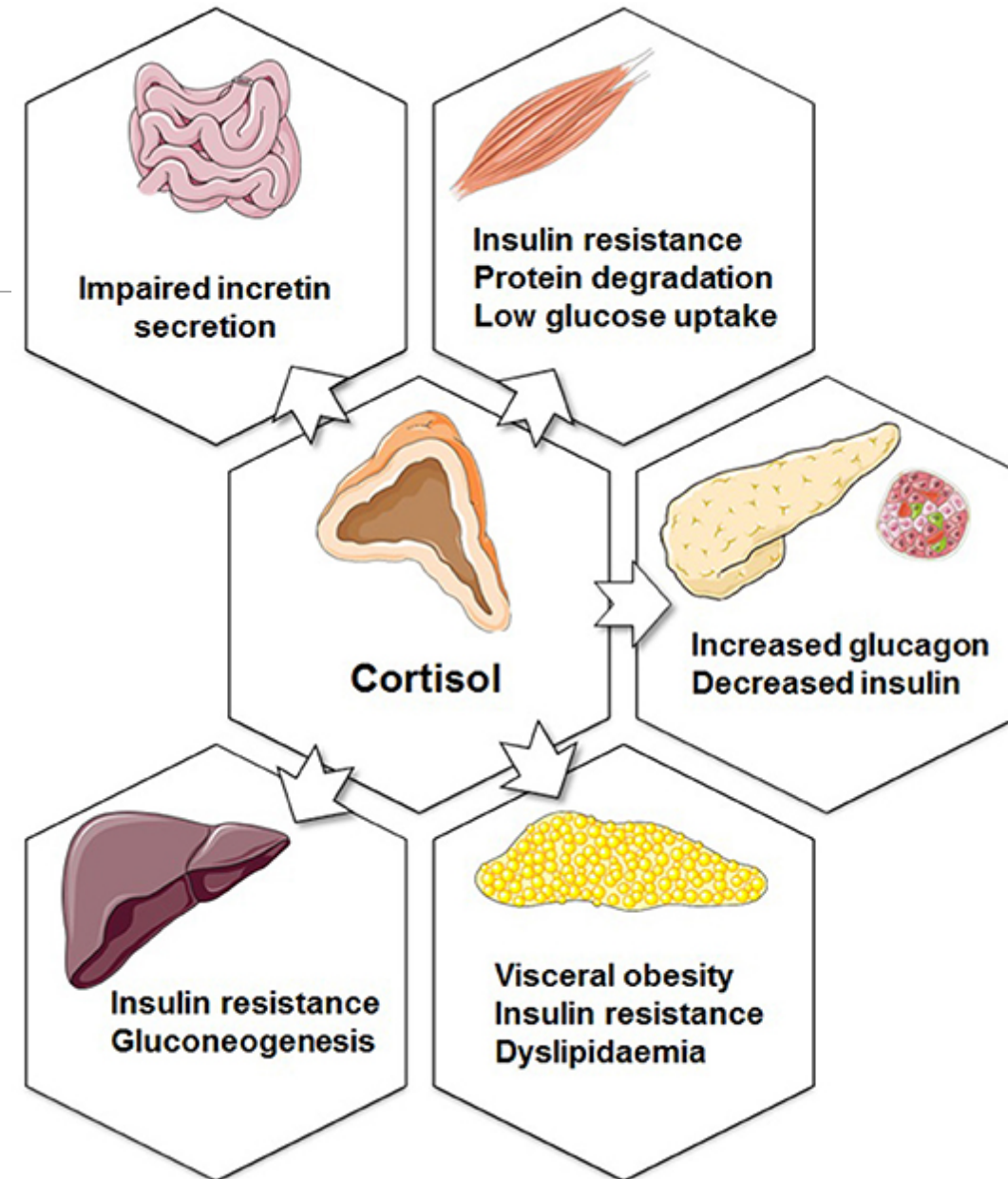
# Stress response system

- HPA Axis: Cortisol
  - Promotes release of epinephrine
  - Suppresses immune response
  - Mobilization of energy stores



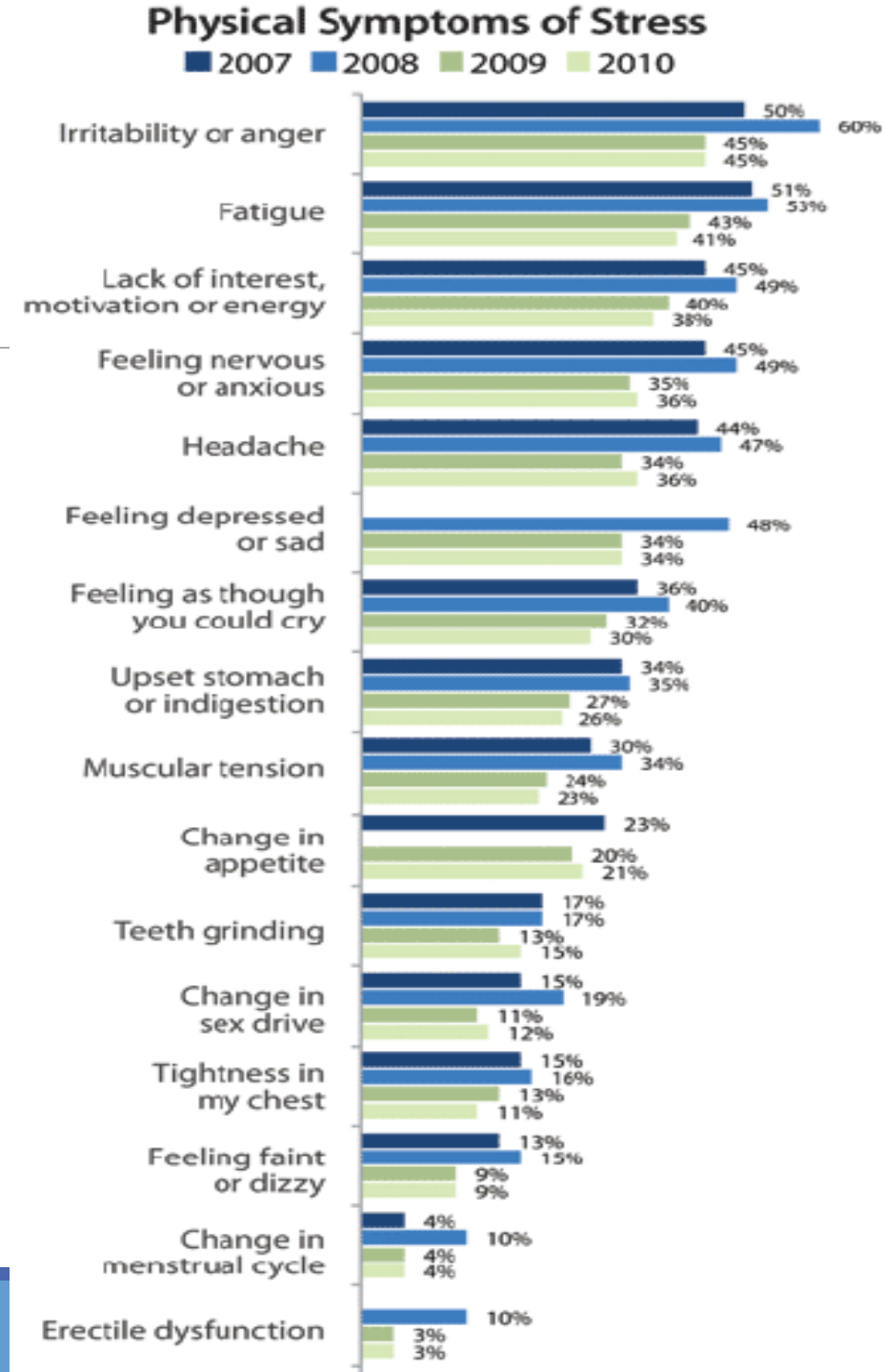
# Stress response system

- HPA Axis: Cortisol
  - Increases blood glucose
    - Promotes release of glucose from liver
    - Counteracts insulin
  - Promotes lipolysis (breakdown of fat)



# Stress response system

- What are the experienced effects of these systems?
  - Irritability or anger
  - Fatigue/lack of motivation
  - Feeling anxious
  - Headache
  - Upset stomach/indigestion



# Effects of stress – acute

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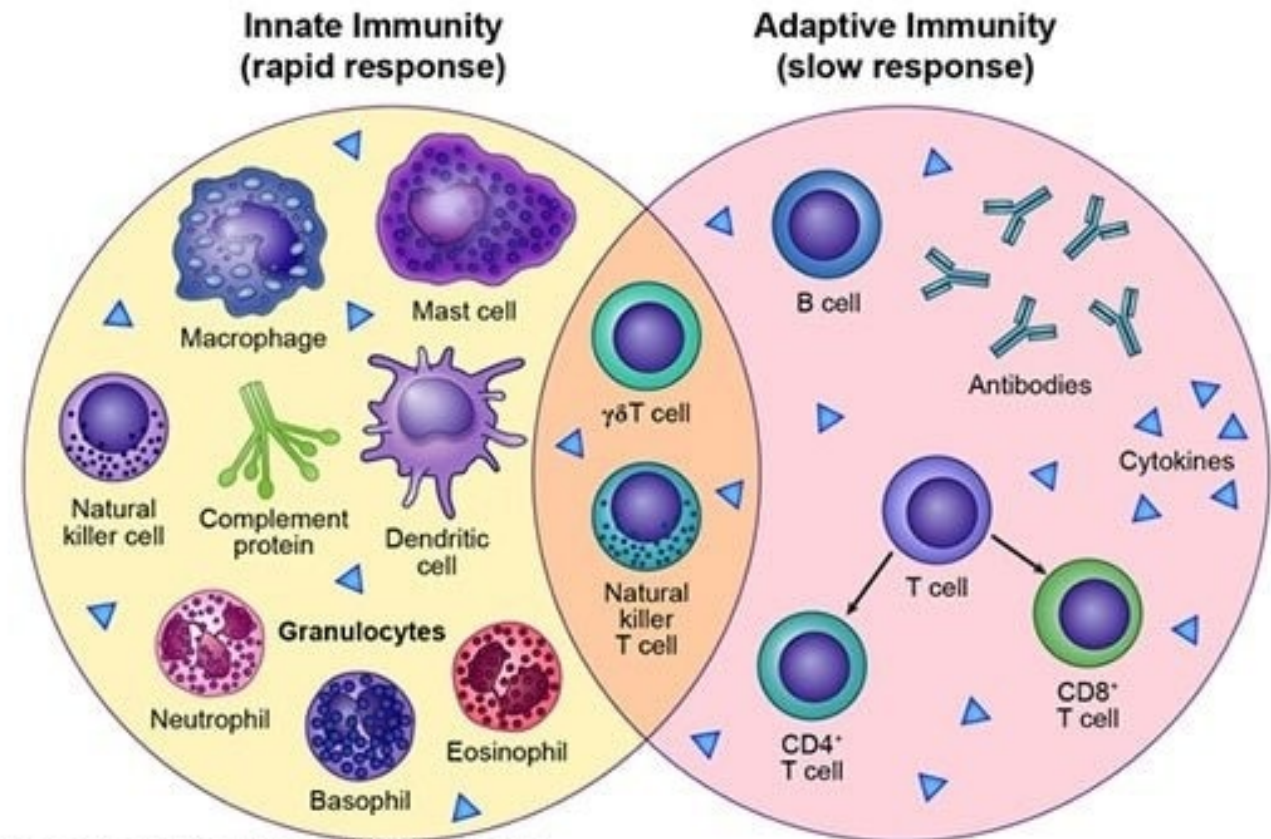
- These systems evolved to be adaptive/beneficial in times of stress
  - In the short-term, they are!
- Short-term stress can have positive impacts on functioning
  - Upregulation of part of the immune system
  - Improved performance and memory



# Effects of stress - acute

- Immune system
  - **Innate:** general protection that we are born with
    - E.g., skin as a barrier; mucus
  - **Adaptive:** immunity that develops throughout our lives with exposure
    - E.g., vaccines

## Innate vs Adaptive Immune Players





# Effects of stress - acute

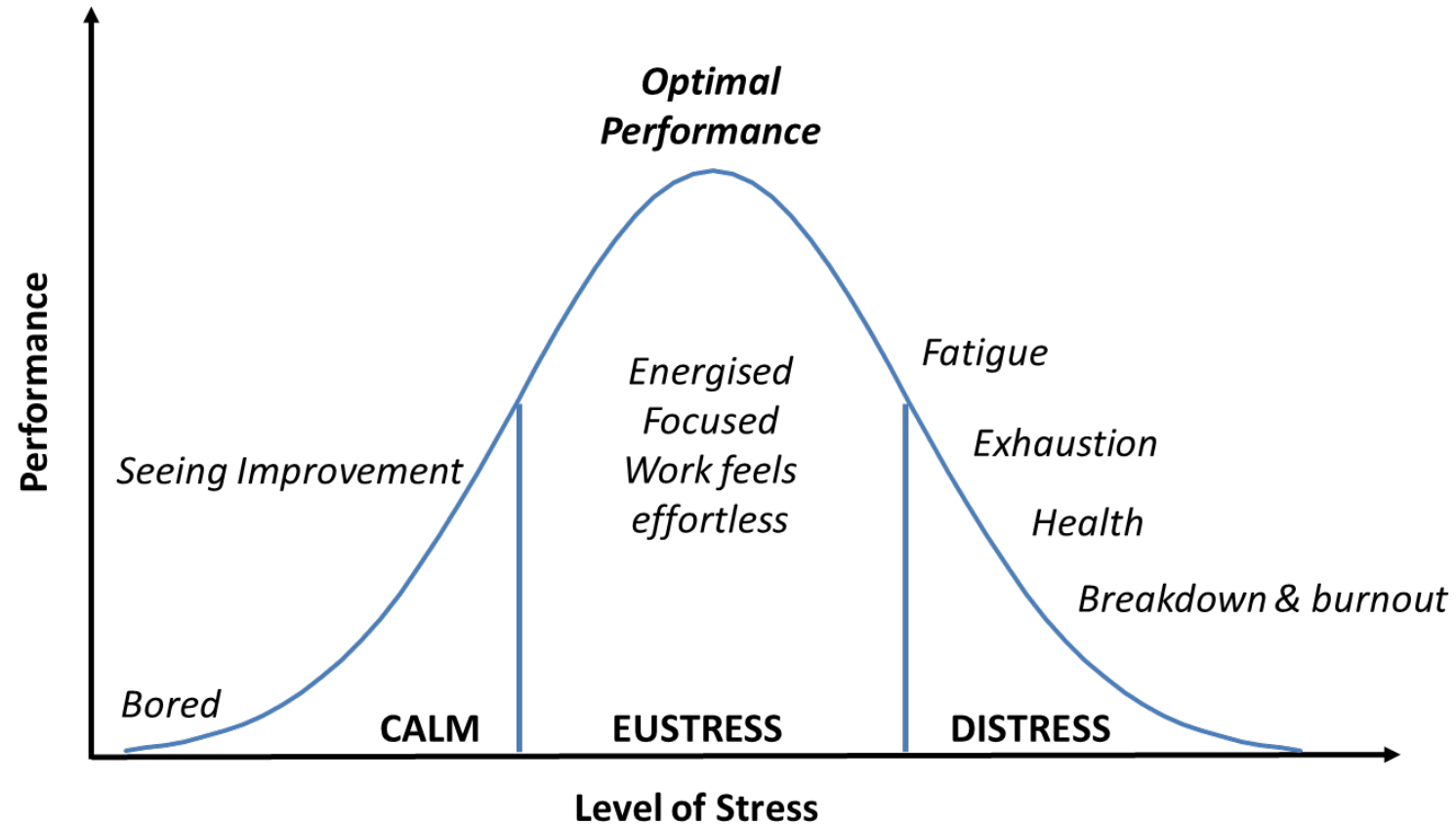
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- Immune system
  - Upregulates innate immunity = quick response, energy efficient
    - Prepares body for fighting infections from cuts, bite wounds, injury, etc.
  - Suppresses adaptive immunity = slow response, energy consuming

# Effects of stress - acute

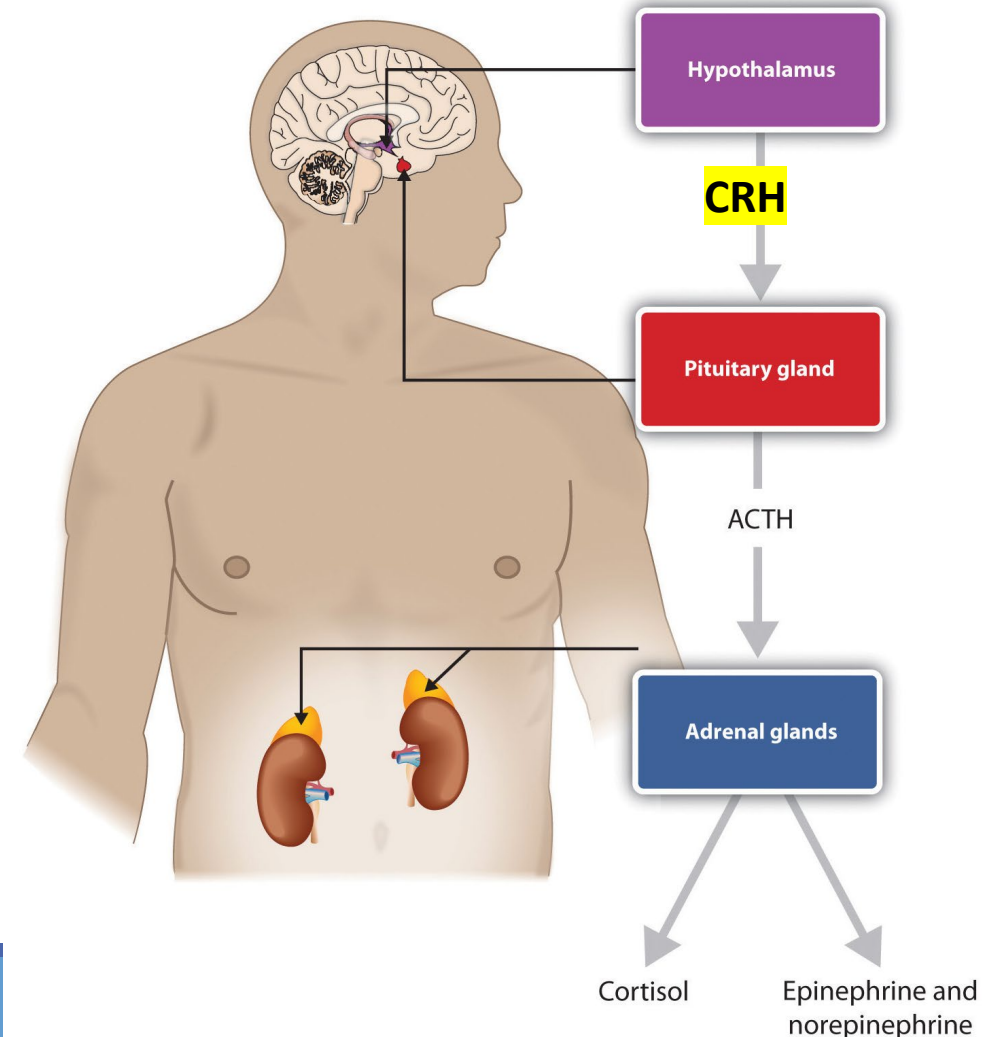
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- Performance
- Yerkes-Dawson Law
- Eustress (short-term, positive stress) can optimize performance



# Effects of stress - acute

- Memory
  - Limited levels of stress induce rapid memory formation
  - Potentially related to HPA axis signaling
    - CRH release from the hypothalamus acts not just on the pituitary, but other areas of the brain that are implicated in learning and memory



# Intermission

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- 10-minute break





# Poll

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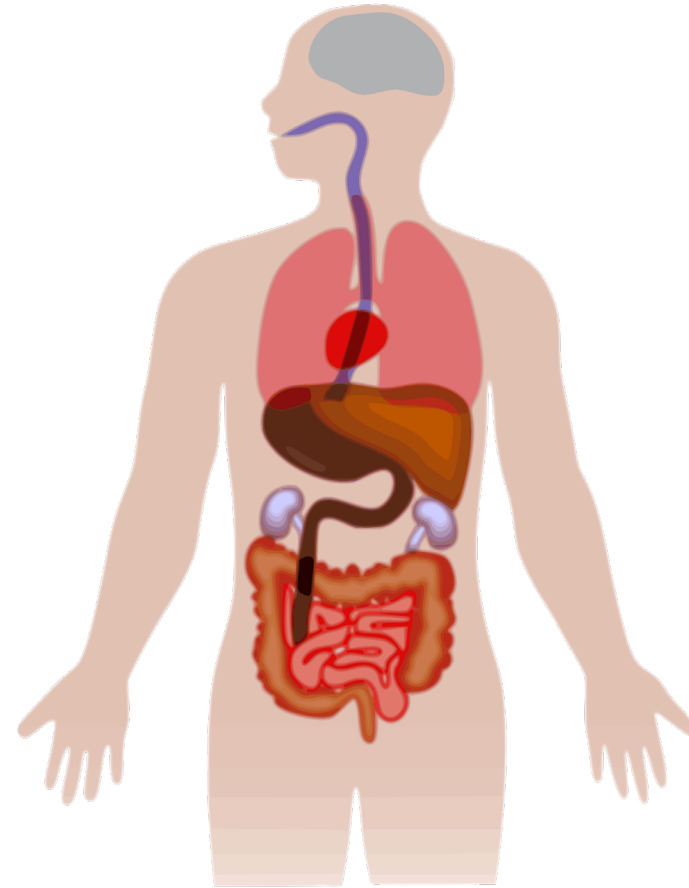
Which of the following body systems is/are impacted by chronic stress?

- Cardiovascular system
- Gastrointestinal system
- Immune system
- Nervous system
- All of the above

# Effects of stress - chronic

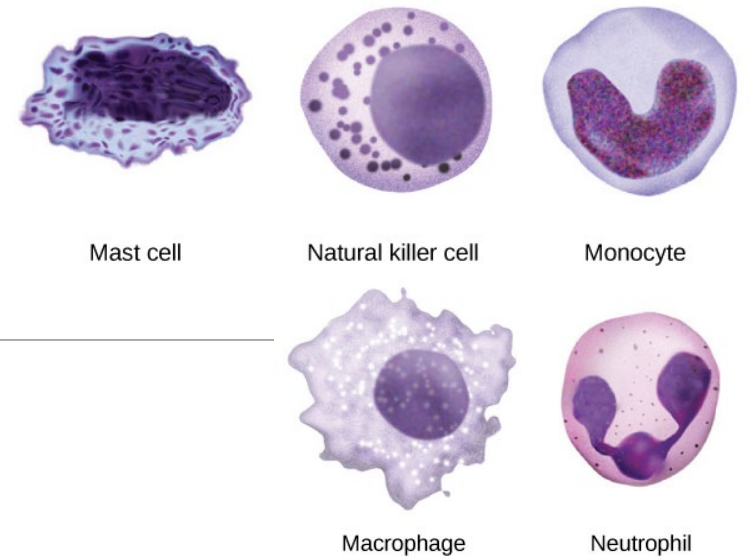
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- Immune system
- Memory/cognition
- Cardiovascular system
- Diabetes
- Obesity
- Gastrointestinal system
- Mental health



# Effects of stress - chronic

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## Immune system:

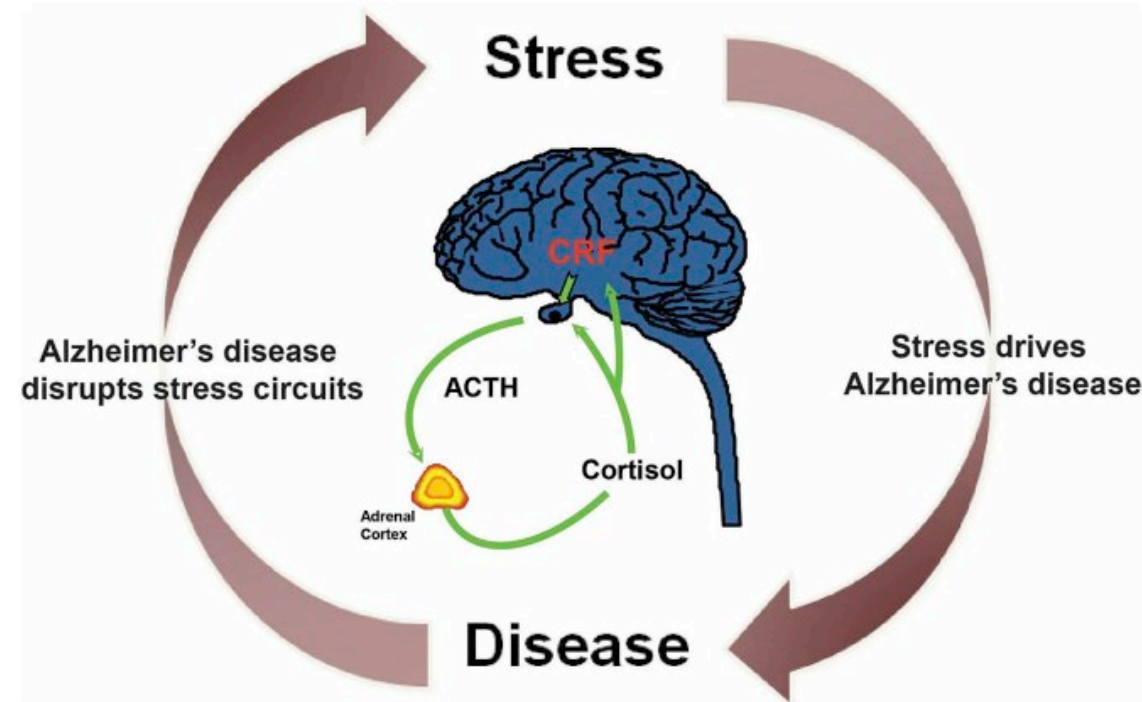
- In contrast to some beneficial effects during acute stress, chronic stress can lead to global immunosuppression and inflammation
  - Increasing stressor duration = shift from adaptive → detrimental
- Inflammation + suppression of important immune cells (T cells and Natural Killer cells) may increase susceptibility to some cancers

# Effects of stress - chronic

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Memory/cognition:

- Chronic psychological stress is a risk factor for Alzheimer's Disease
  - Potentially HPA axis-mediated





# Effects of stress - chronic

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## Cardiovascular system:

- Epinephrine (adrenaline) causes heart rate and blood pressure to increase
  - Hypertension damages blood vessel walls → atherosclerosis, aneurysm
  - Severe hypertension makes the heart work harder → heart walls can thicken/dilate → heart failure

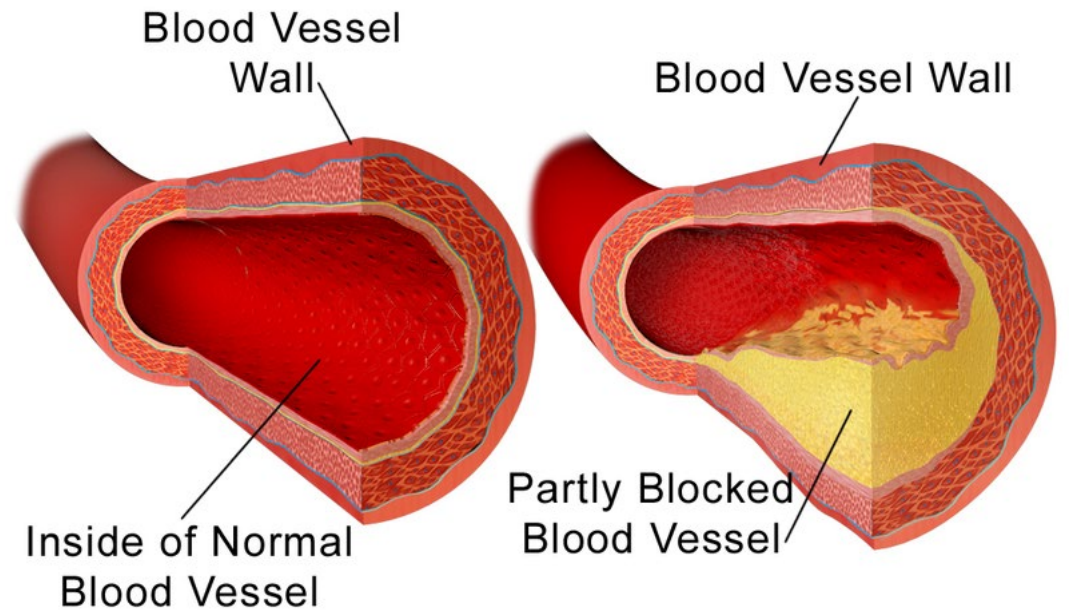


# Effects of stress - chronic

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Cardiovascular system:

- Cortisol and chronic low-grade inflammation contributes to development of atherosclerosis → coronary artery disease



# Effects of stress - chronic

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Cardiovascular system:

- Stress can lead to unhealthy coping mechanisms (poor diet, smoking, etc.) that can further contribute to heart disease



# Effects of stress

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## Cardiovascular system:

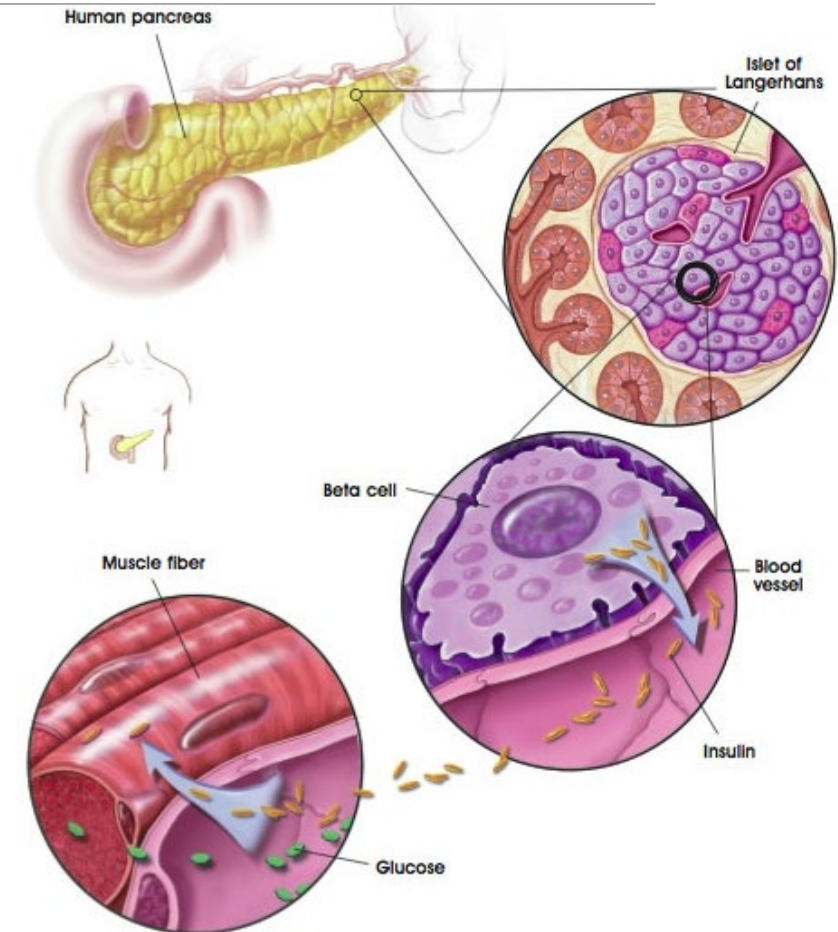
- Extreme stress can lead to “Broken Heart Syndrome” (Takotsubo cardiomyopathy)
  - Exact mechanism not known, but thought that high levels of stress hormones cause changes in heart muscle cells → weak heart walls and poor contraction of heart → 20% of people experience heart failure
  - Most people recover with no long-term damage



# Effects of stress - chronic

## Diabetes:

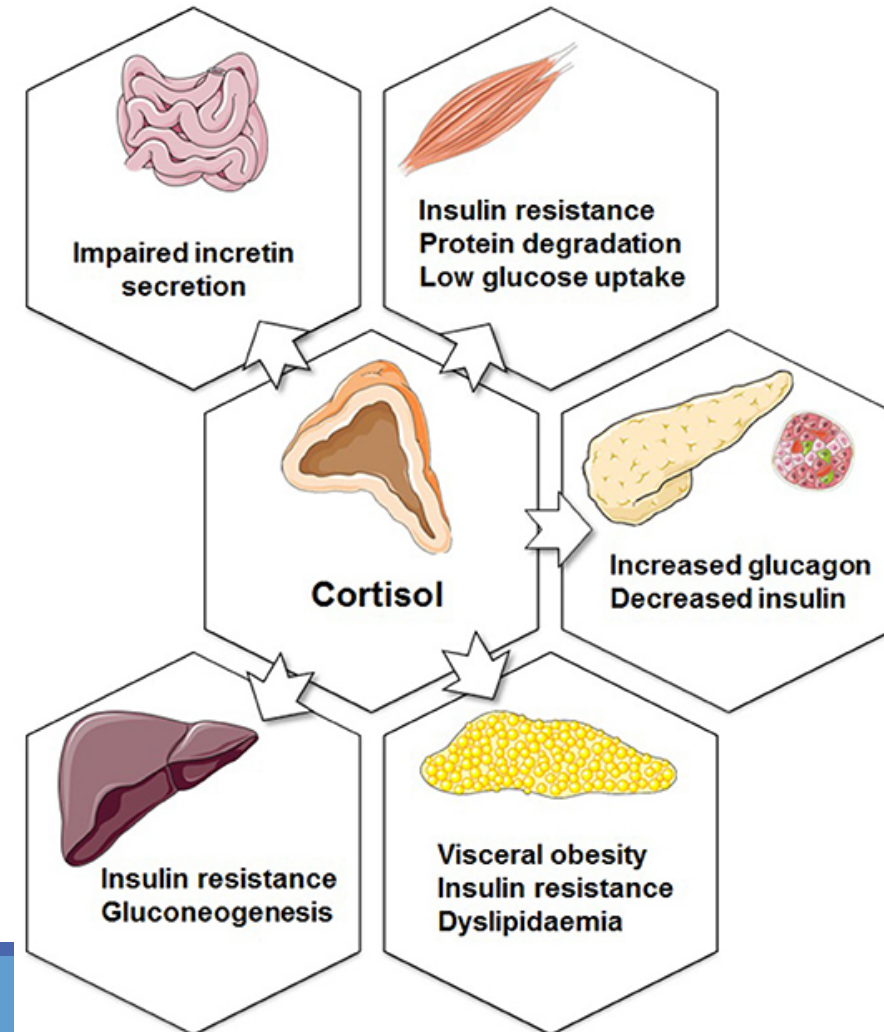
- Moderate/high levels of stress associated with 2.3-fold increase in the odds of diabetes three years later



# Effects of stress - chronic

## Diabetes:

- High levels of cortisol increase blood glucose and may prevent insulin-producing cells from working properly → Type 2 Diabetes
  - Cushing disease (too much cortisol produced) → Type 2 Diabetes

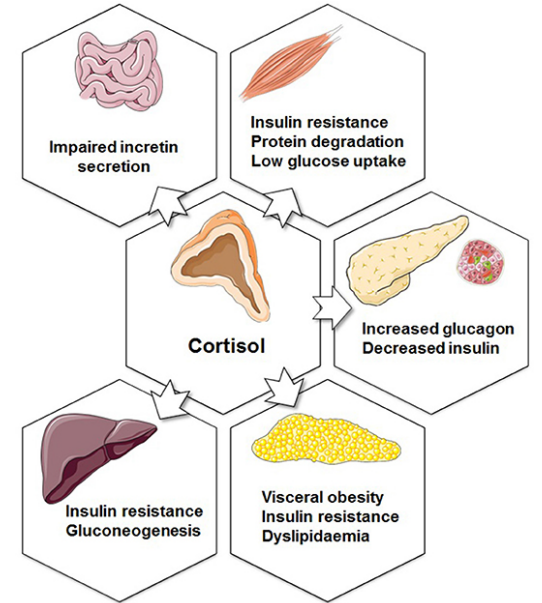




# Effects of stress - chronic

## Obesity:

- Behavioural and cellular mechanisms promote obesity and metabolic issues in chronically stressed people
  - Stress → unhealthy lifestyles/coping
  - Stress → cortisol, epinephrine, inflammation → central obesity, insulin resistance
  - Stress → poor sleep → obesity



# Effects of stress - chronic

- These effects are interlinked and driven through shared pathways → cardiovascular disease, diabetes, obesity

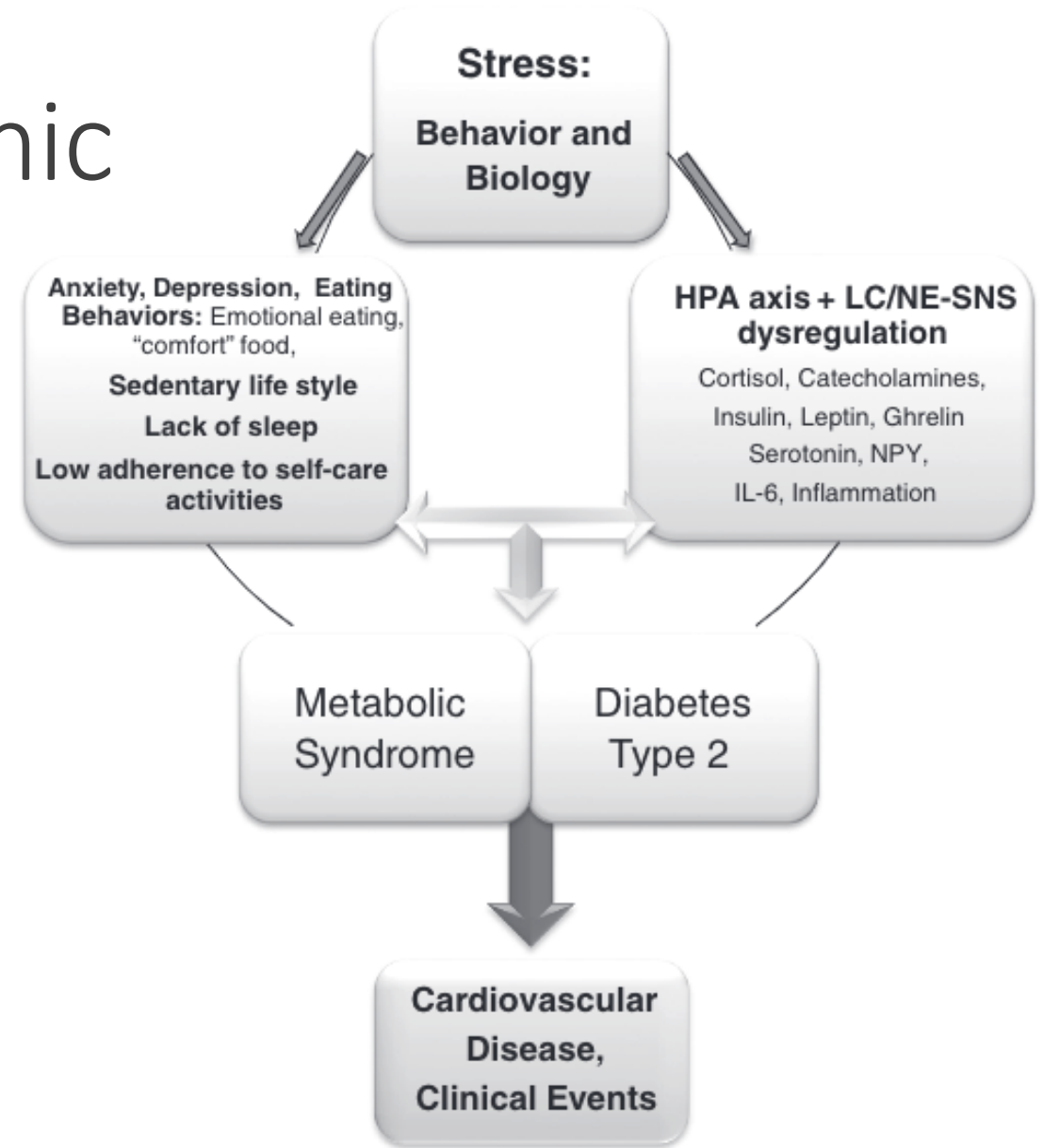


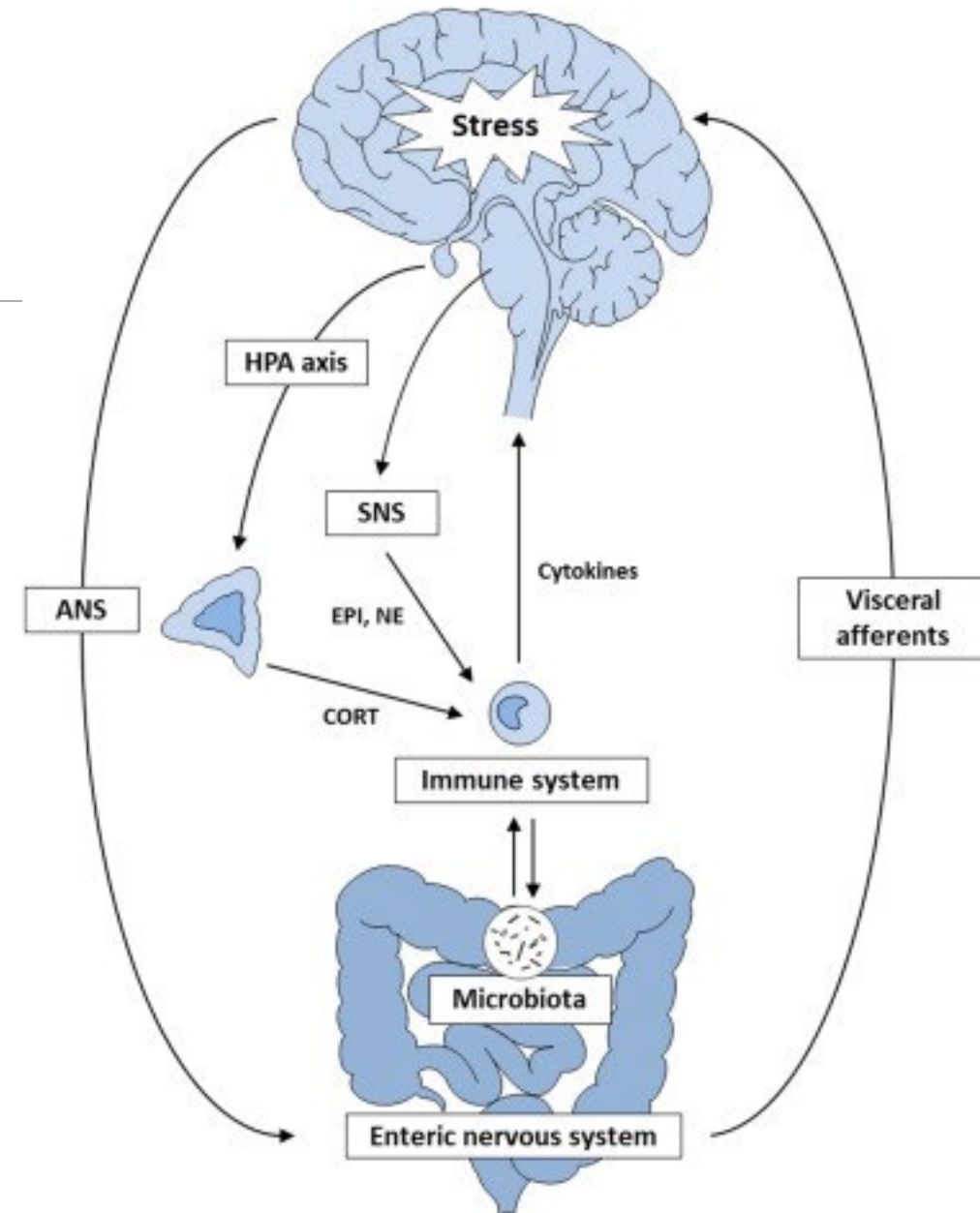
Fig. 2 – Biologic and behavioral pathways linking stress to obesity and the metabolic syndrome.



# Effects of stress - chronic

## Gastrointestinal system:

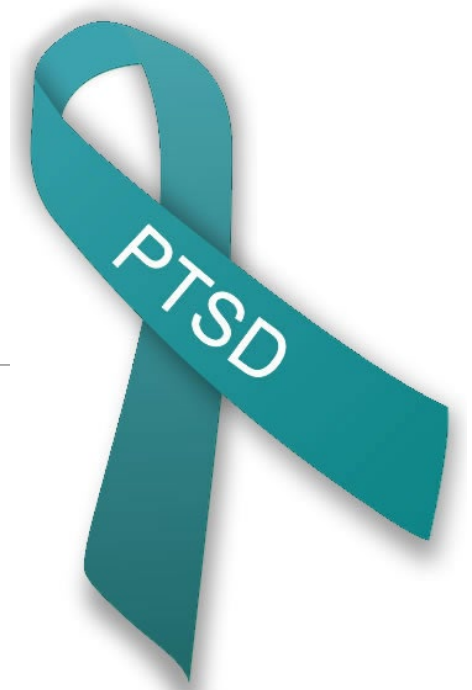
- Gut-brain axis
  - Interconnected bidirectional pathways between the brain and gut that are modulated by stress
    - Gut motility, immune function/microbiota
  - Functional gastrointestinal disorders (e.g., Irritable Bowel Syndrome) strongly linked to stress





# Effects of stress

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## Mental Health:

- Post-Traumatic Stress Disorder (PTSD)
  - Intrusive thoughts, nightmares/flashbacks of trauma, avoidance, hypervigilance, sleep disturbances
  - Occurs in 5-10% of people exposed to traumatic events
  - Underlying cause unclear but thought to relate to dysregulation of HPA axis

# Effects of stress - chronic

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## Mental Health:

- Depression
  - Strong links between chronic/toxic stress and depression
  - Behavioural and biological pathways involved
    - Stress → sedentary lifestyle, lack of sleep, poor self-care, relationship challenges
    - Stress → HPA axis dysregulation
    - = increased risk of depression



# Poll

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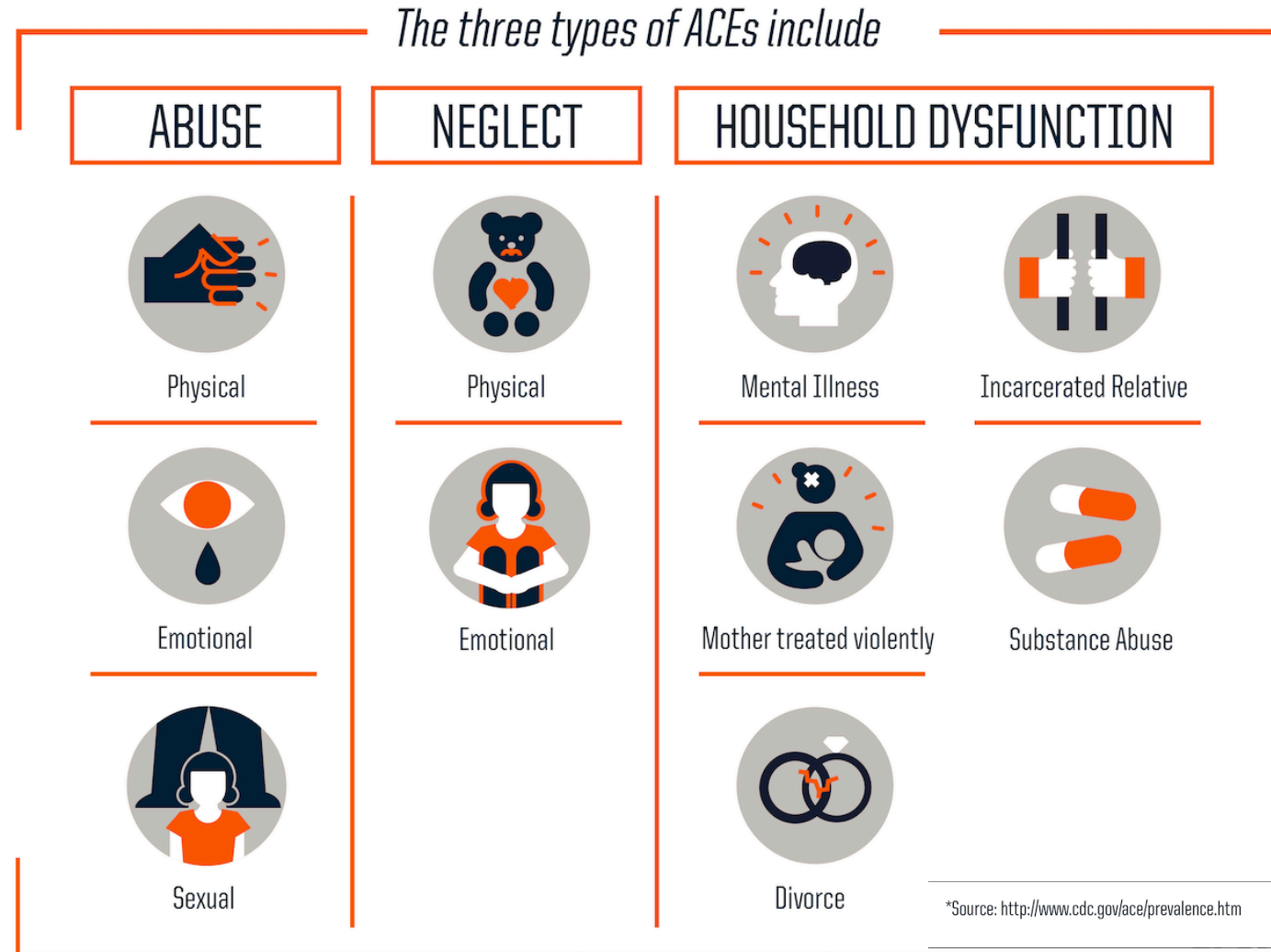


## True or False?

- Stressful/traumatic experiences in childhood can lead to long-term health consequences

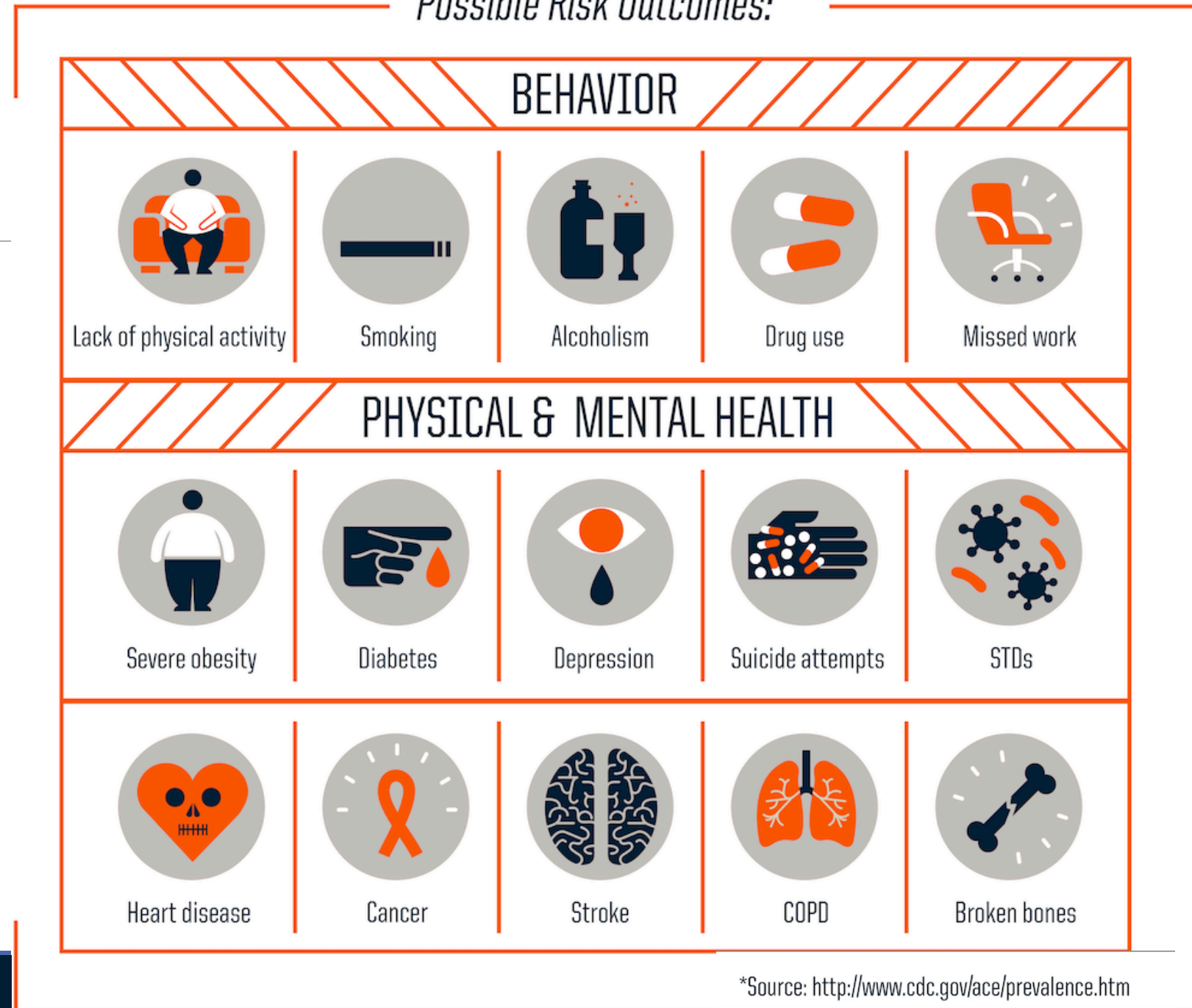
# Effects of stress - chronic

- Adverse Childhood Experiences (ACEs)
  - Abuse
  - Neglect
  - Household dysfunction
- Higher number of ACEs = higher risk of health problems\*



- Adverse Childhood Experiences (ACEs)
  - Lead to toxic stress
  - Increase risk of negative behaviours and chronic health conditions

*Possible Risk Outcomes:*



\*Source: <http://www.cdc.gov/ace/prevalence.htm>



# When to seek help

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- Feeling overwhelmed
  - Feeling worried about your level of stress and/or its impacts
  - Using drugs or alcohol to cope
  - Thoughts of hurting yourself
- 
- Reach out to your primary care provider, mental health provider (counsellor, therapist, etc.), or crisis line



# Preview: stress management

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- Relaxation activities - meditation, yoga, breathing exercises
- Exercise, eating well, sleep
- Positive attitude and gratitude
- Acceptance/reframing
- Social connection and talking



# Suggested Resources

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- Centre for Studies on Human Stress: <https://humanstress.ca/stress/>
- Canadian Mental Health Association: <https://cmha.ca/>
- Crisis Line Association of BC: <https://www.crisislines.bc.ca/>
  - 310Mental Health Support: **310-6789** (no area code needed)
- HealthLinkBC: Stress Management <https://www.healthlinkbc.ca/health-topics/stress-management>
- Telephone 8-1-1 (7-1-1 for the hearing impaired)
  - Speak to a Registered Nurse, Registered Dietician, exercise professional, or Pharmacist
- Dr. Gair book recommendation: Burnout, the Secret to Unlocking the Stress Cycle - Nagoski

# Q&A

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- Questions or comments about the talk?

# Closing Remarks

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- Thank you to Dr. Jane Gair, our supervisor for this activity, and to my classmates, Julia De Pieri and Drew Smith, who will be delivering several of the talks in this series

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- Thank you to Dr. Jane Gair, our supervisor for this activity, and to my classmates, Julia De Pieri and Drew Smith, who will be delivering several of the talks in this series
- Thank you for attending today!