Metabolic Response to Injury

Objectives

- Factors mediating the metabolic response
- Consequences of the metabolic response
- The differences between metabolic responses to starvation and trauma
- The effect of trauma on metabolic rate and substrate utilization
- Modifying the metabolic response

Mediating the Response

- **The Acute Inflammatory Response**
  - **Cellular activation**
  - **Inflammatory mediators (TNF, IL1, etc)**
  - **Paracrine Vs endocrine effects**

Mediating the Response

- **The Endothelium**
  - **Selectins, Integrins, and ICAMs**
  - **Nitric Oxide**
  - **Tissue Factor**

Mediating the Response

- **Afferent Nerve Stimulation**
  - **Sympathetic Nervous System**
  - **Adrenal Gland Medulla**

Mediating the Response

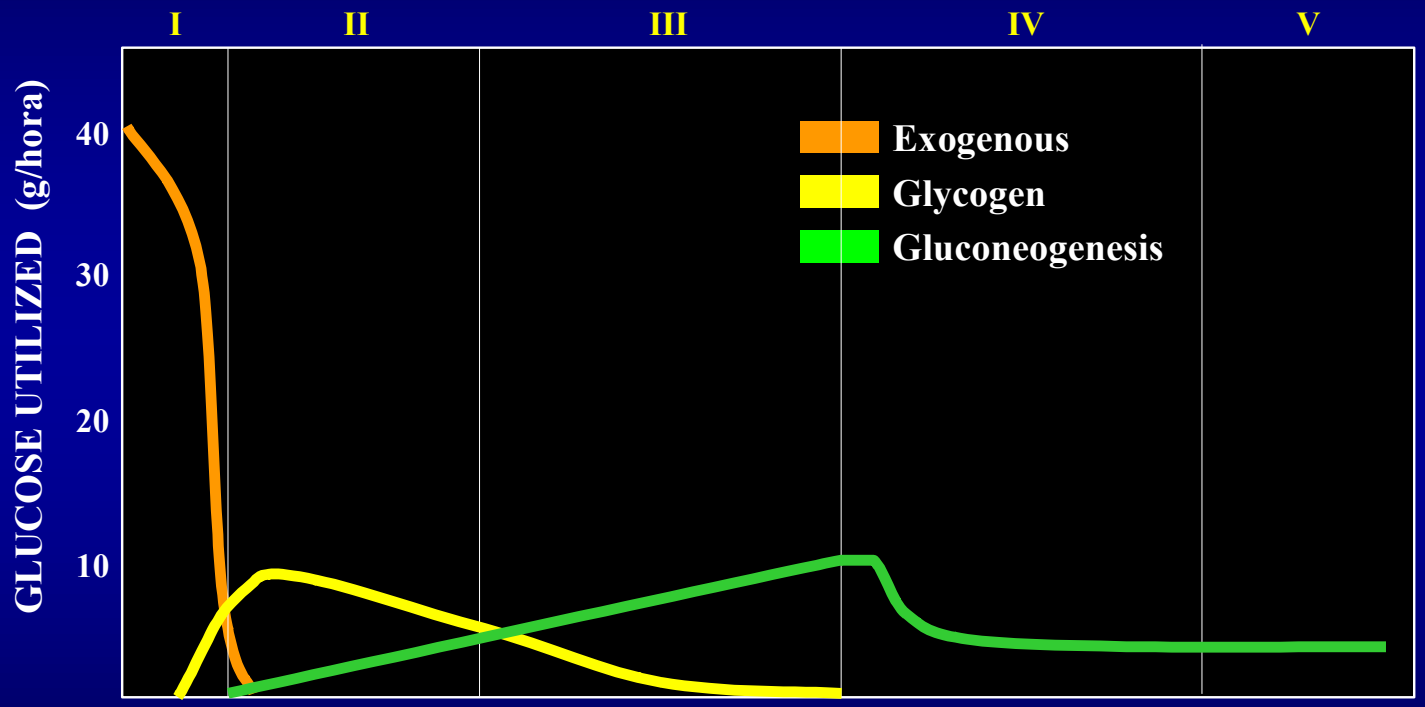
- **The Endocrine System**
  - **Pituitary Gland** (GH, ACTH, ADP)
  - **Adrenal Gland** (Cortisol, Aldosterone)
  - **Pancreatic** (Glucagon, ↓ Insulin)
  - **Others** (Renin, Angiotensin, ↓ Sex hormones, ↓ T4)

Consequences of the Response

- Limiting injury
- Initiation of repair processes
- Mobilization of substrates
- Prevention of infection
- Distant organ damage

Starvation & Injury

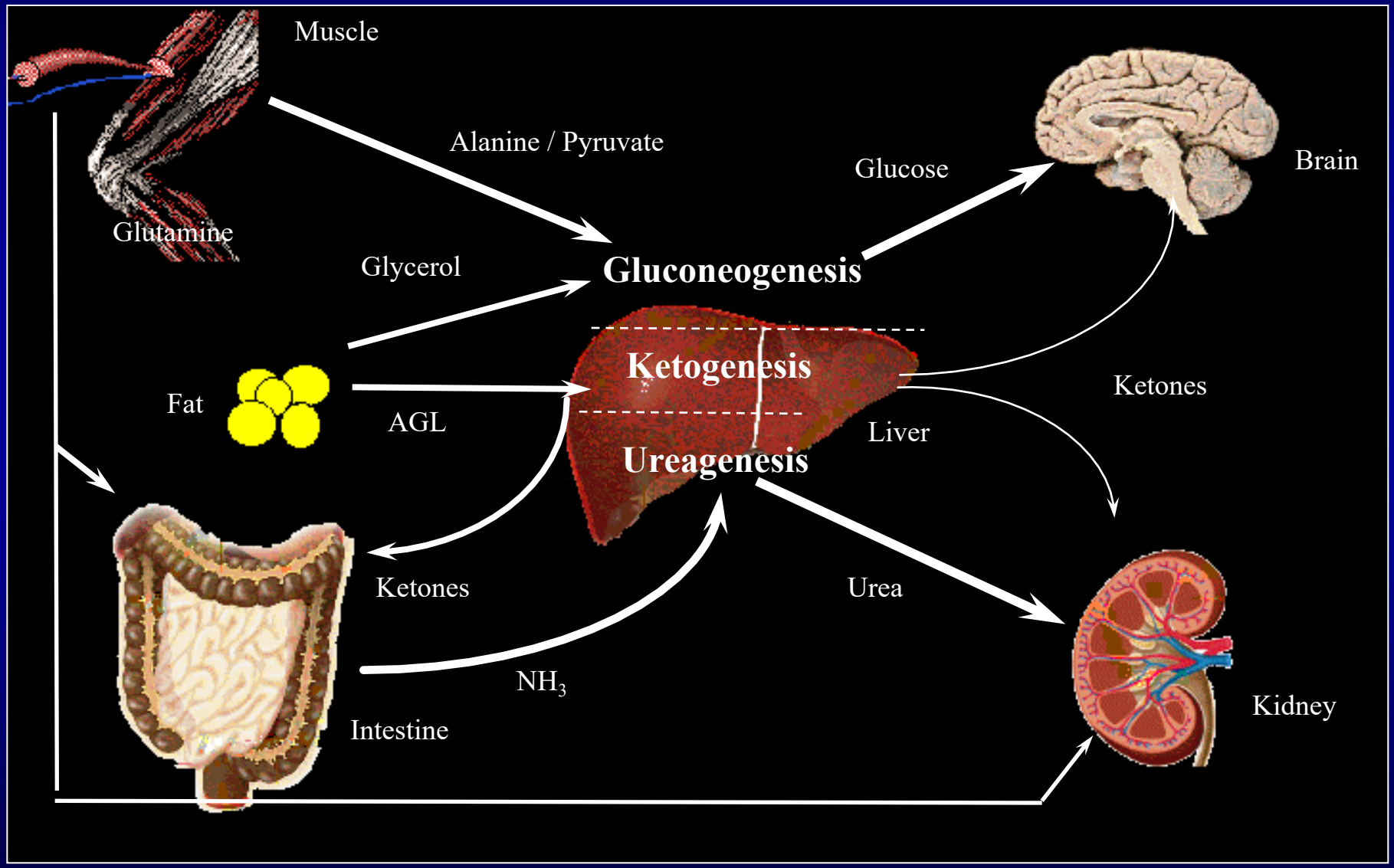
Metabolic Response to Fasting



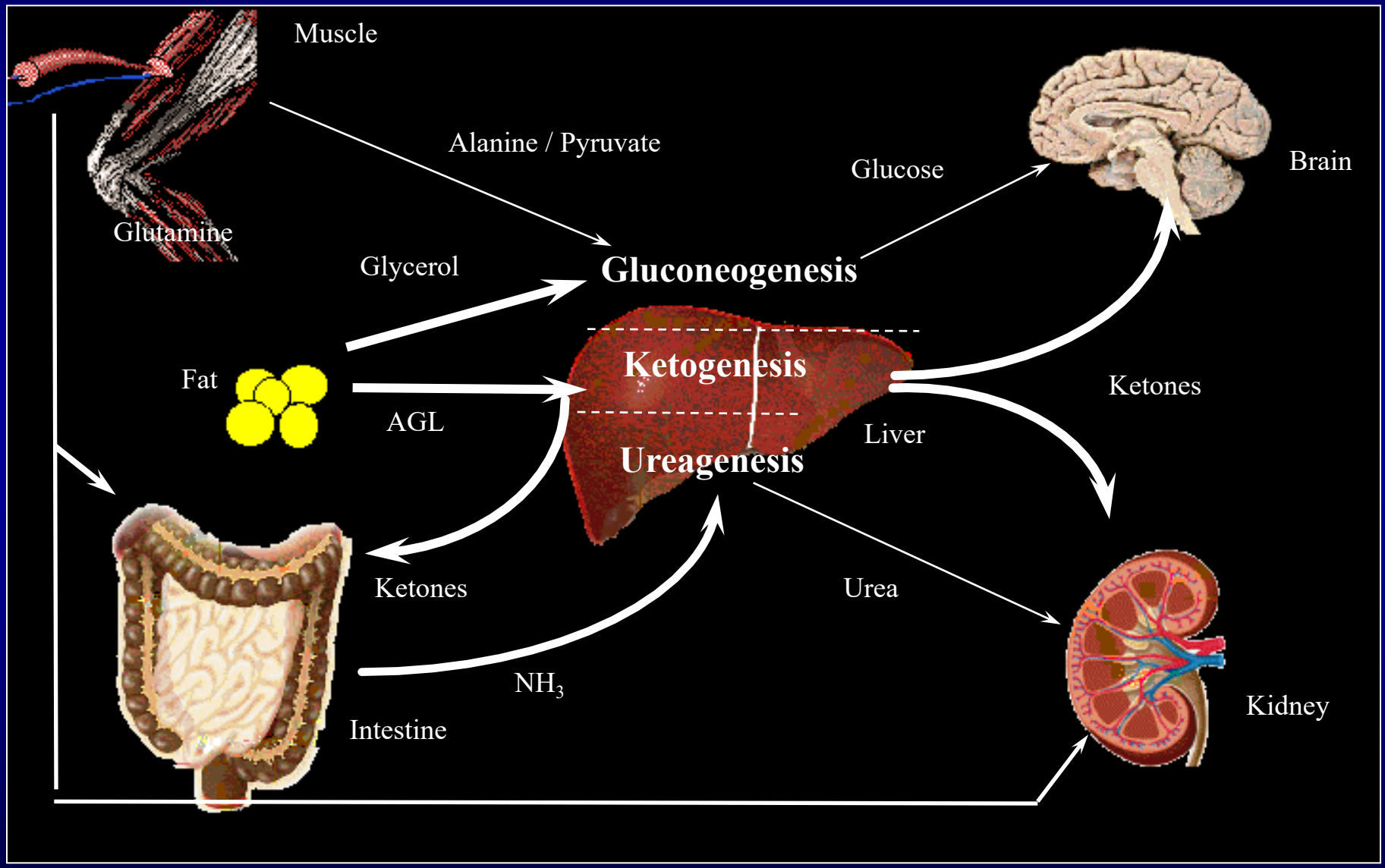
LEGEND	I	II	III	IV	V
FUEL FOR BRAIN	GLUCOSE	GLUCOSE	GLUCOSE	GLUCOSE, KETONES	GLUCOSE, KETONES

Ruderman NB. *Annu Rev Med* 1975;26:248

Starvation – Early Stage



Starvation – Late Stage

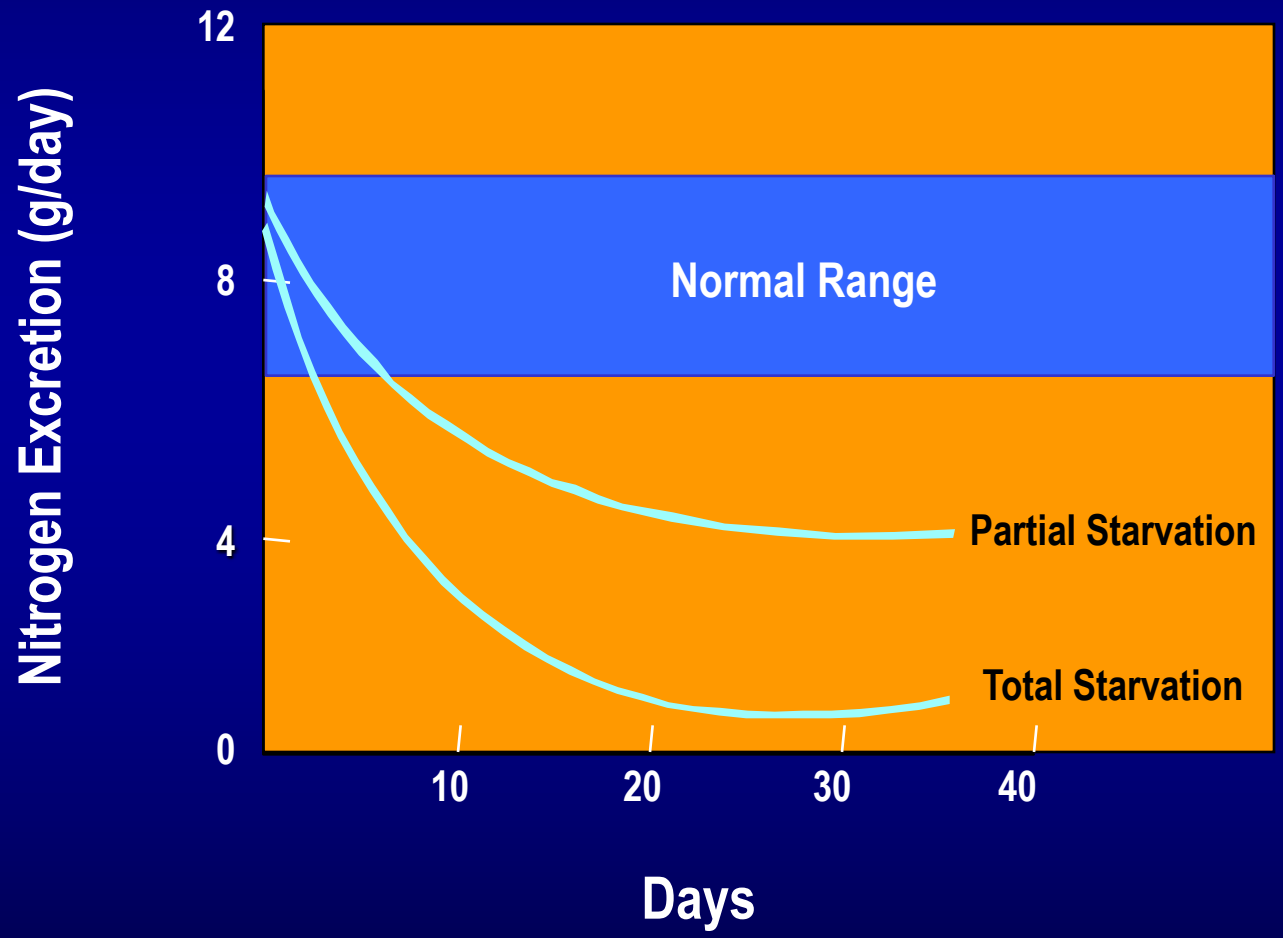


Metabolic Response to Starvation

Hormone	Source	Change in Secretion
Norepinephrine	Sympathetic Nervous System	↓↓↓
Norepinephrine	Adrenal Gland	↑
Epinephrine	Adrenal Gland	↑
Thyroid Hormone T4	Thyroid Gland (changes to T3 peripherally)	↓↓↓

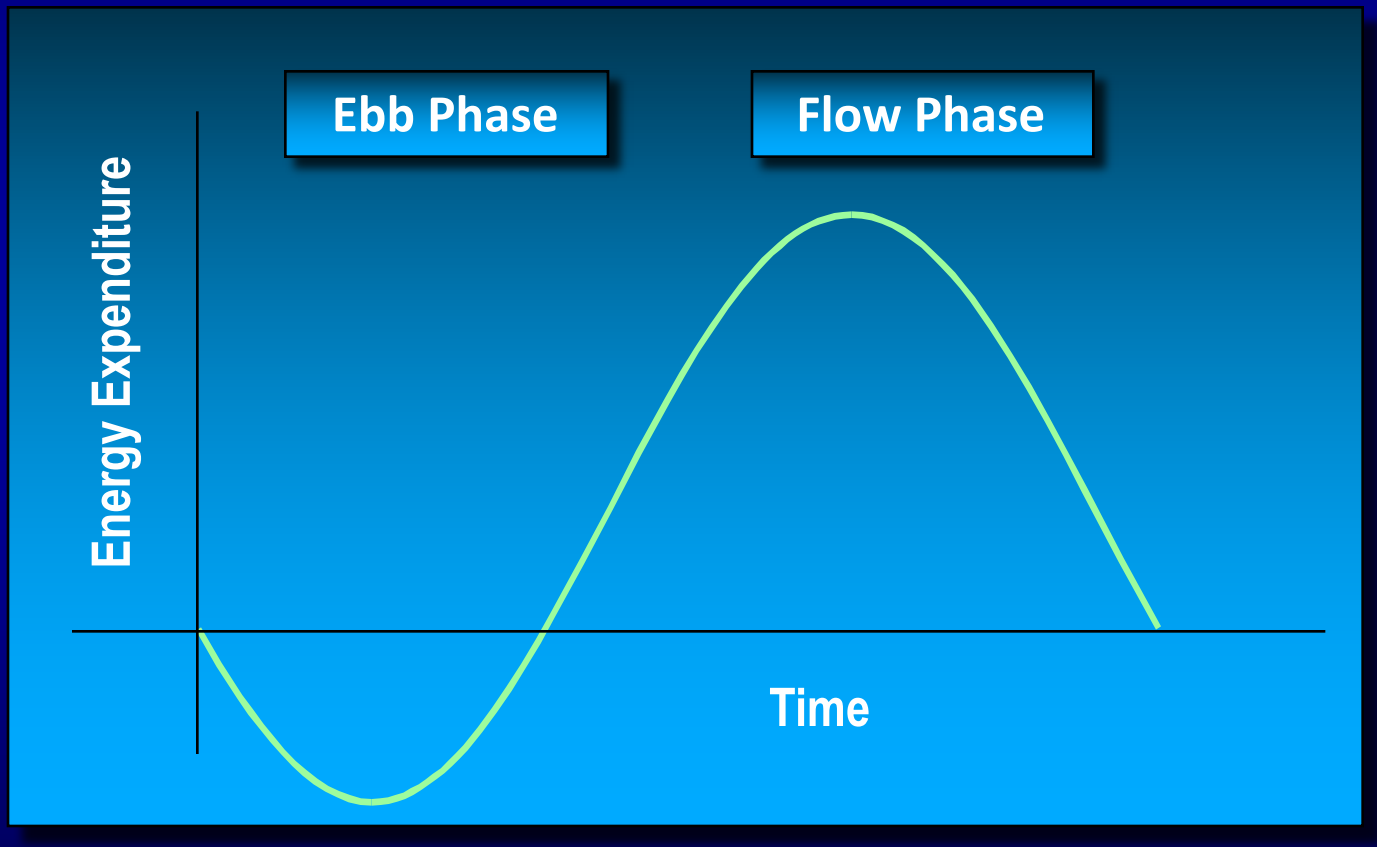
Landberg L, et al. *N Engl J Med* 1978;298:1295.

Energy Expenditure in Starvation



Long CL et al. *JPEN* 1979;3:452-456

Metabolic Response to Injury



Cutherbertson DP, et al. *Adv Clin Chem* 1969;12:1-55

Metabolic Response to Injury: Ebb Phase

- Characterized by hypovolemic shock
- Priority is to maintain life/homeostasis
  - **↓ Cardiac output**
  - **↓ Oxygen consumption**
  - **↓ Blood pressure**
  - **↓ Tissue perfusion**
  - **↓ Body temperature**
  - **↓ Metabolic rate**

Cuthbertson DP, et al. *Adv Clin Chem* 1969;12:1-55
Welborn MB. In: Rombeau JL, Rolandelli RH, eds. *Enteral and Tube Feeding.* 3rd ed. 1997

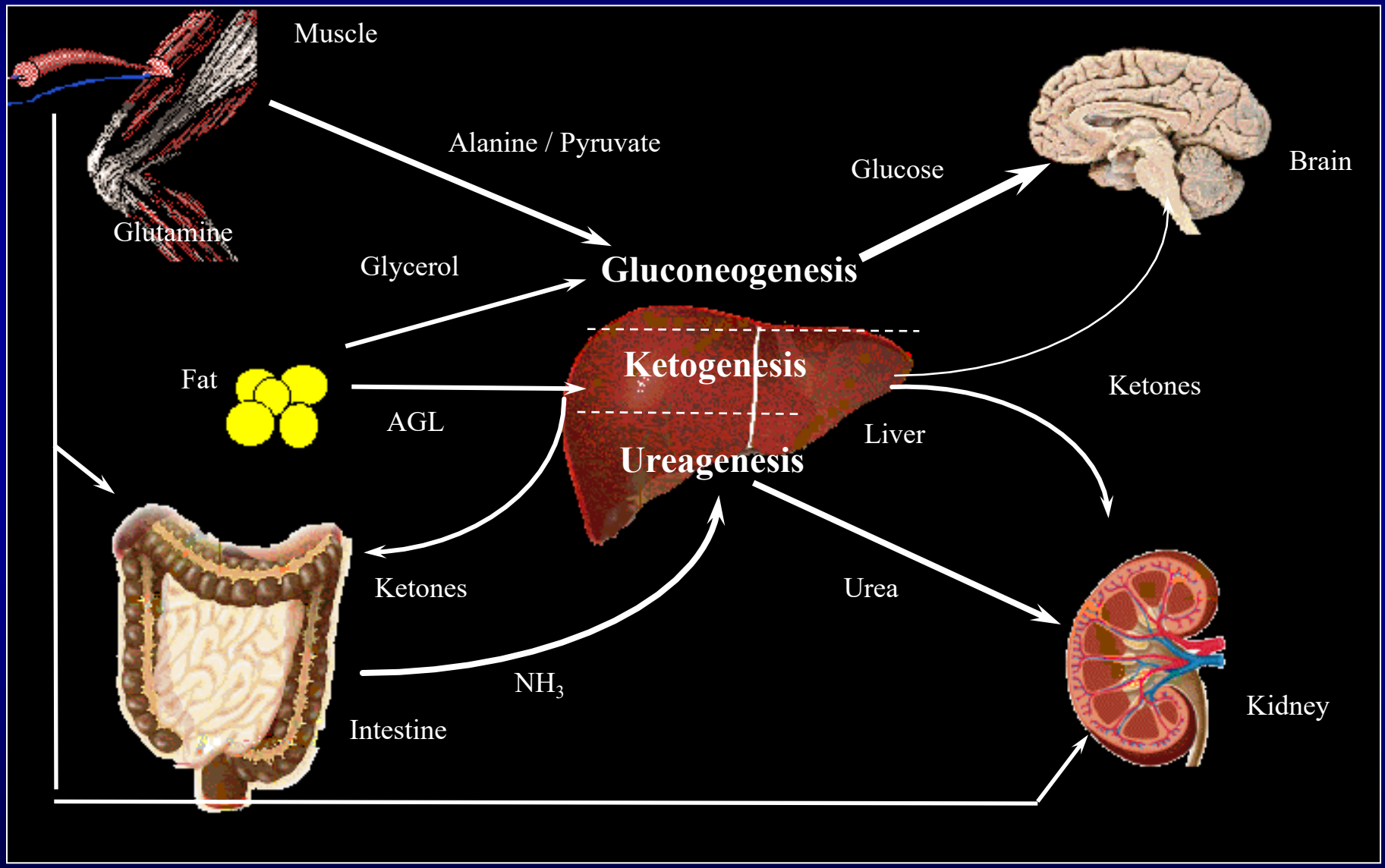
Metabolic Response to Injury: Flow Phase

- ↑ Catecholamines
- ↑ Glucocorticoids
- ↑ Glucagon
- Release of cytokines, lipid mediators
- Acute phase protein production

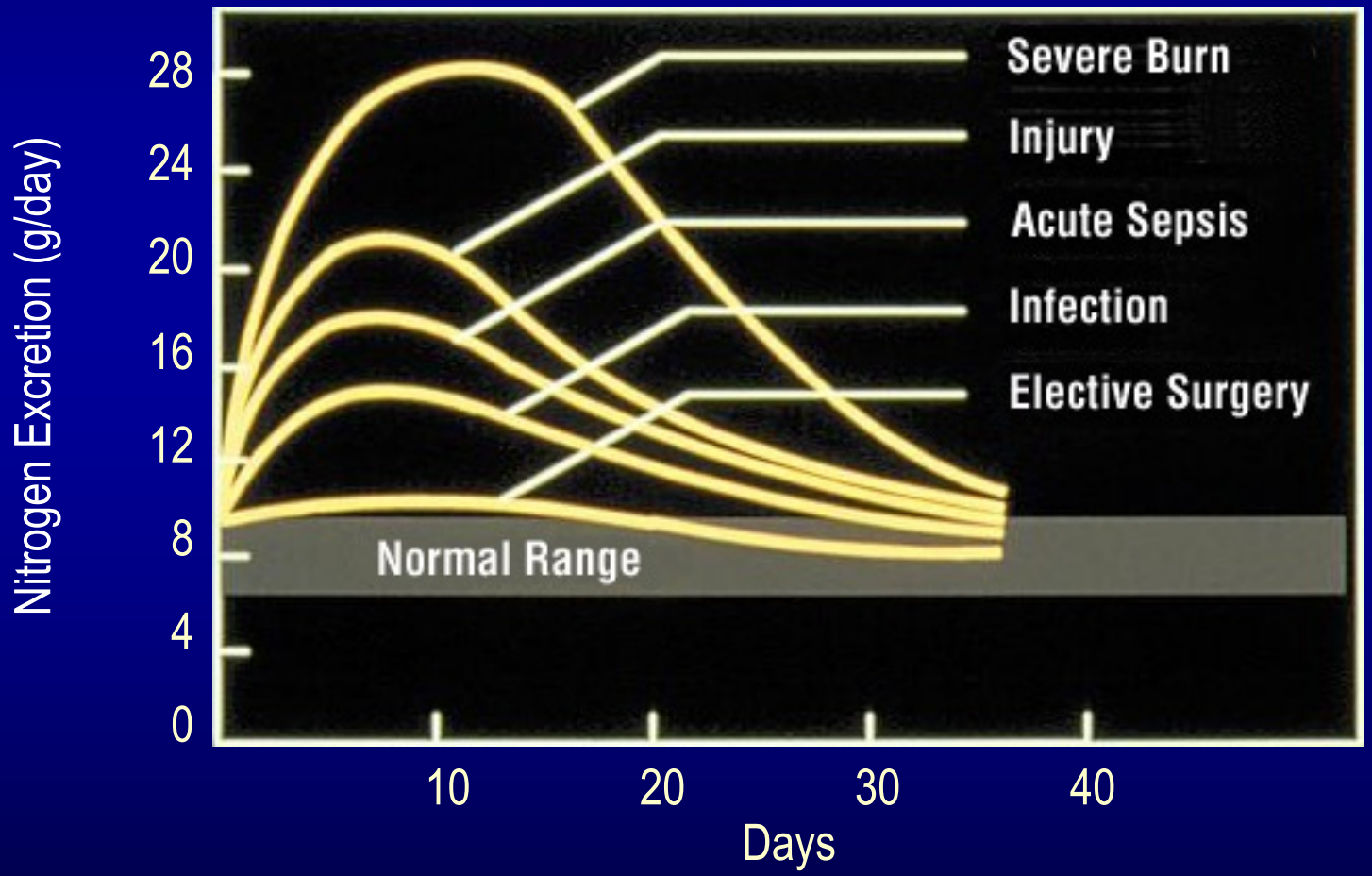
Cuthbertson DP, et al. *Adv Clin Chem* 1969;12:1-55
Welborn MB. In: Rombeau JL, Rolandelli RH, eds. *Enteral and Tube Feeding.* 3rd ed. 1997

Metabolic Response to Injury

Metabolic Changes after Injury

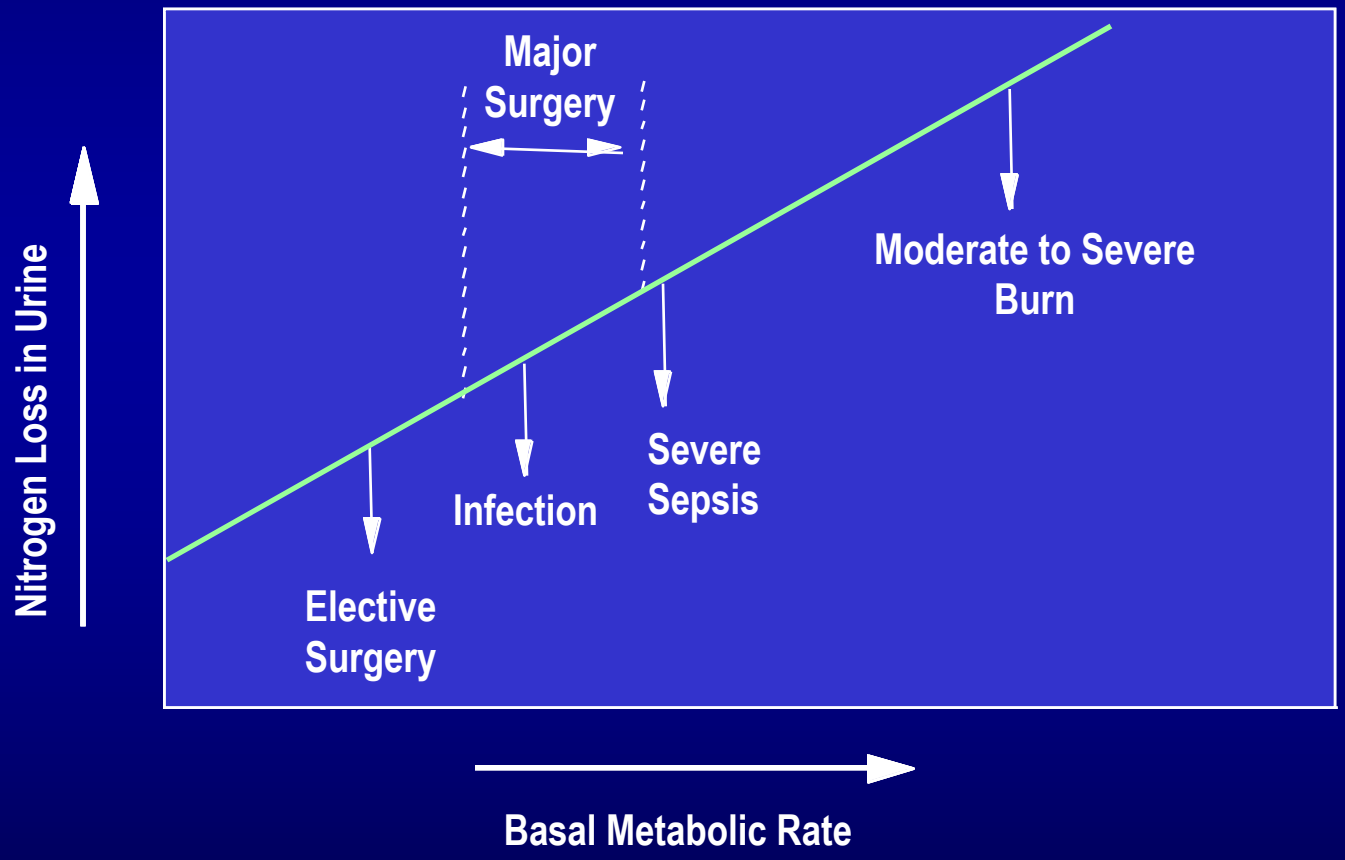


Metabolic Response to Injury



Long CL, et al. *JPEN* 1979;3:452-456

Severity of Injury: Effects on Nitrogen Losses and Metabolic Rate



Adapted from Long CL, et al. JPEN 1979;3:452-456

Comparing Starvation and Injury

	Starvation	Trauma or Disease
Metabolic rate	↓	↑ ↑
Body fuels	**conserved**	**wasted**
Body protein	**conserved**	**wasted**
Urinary nitrogen	↓	↑ ↑
Weight loss	**slow**	**rapid**

The body adapts to starvation, but not in the presence of critical injury or disease.

Popp MB, et al. In: Fischer JF, ed. *Surgical Nutrition*. 1983.

Modifying the Response

- Medication (before or after injury)
- Nutritional status
- Severity of injury
- Temperature
- Anesthetic technique

Summary

- Injury (Trauma or Surgery) leads to a metabolic response
- Metabolic response to injury is an adaptive response
- Metabolic response could overwhelm the body and lead to increased morbidity and mortality
- We can modify the metabolic response before and sometimes after injury

Metabolic Response to Injury

Questions