



National Enzyme Company

January 20, 2004

**Do Digestive Enzymes increase the
absorption of proteins and carbohydrates?**



NEC – TNO Studies

Efficacy of supplemental enzymes on the digestibility of proteins and carbohydrates during transit through a dynamic gastrointestinal model (TIM) simulating gastric and small intestinal conditions



TNO: Background

- TNO Nutrition and Food Research
- Independent research organization in the Netherlands
- Link between fundamental research and its application to food and drugs
- NEC – TNO collaboration



TNO: What is TIM?

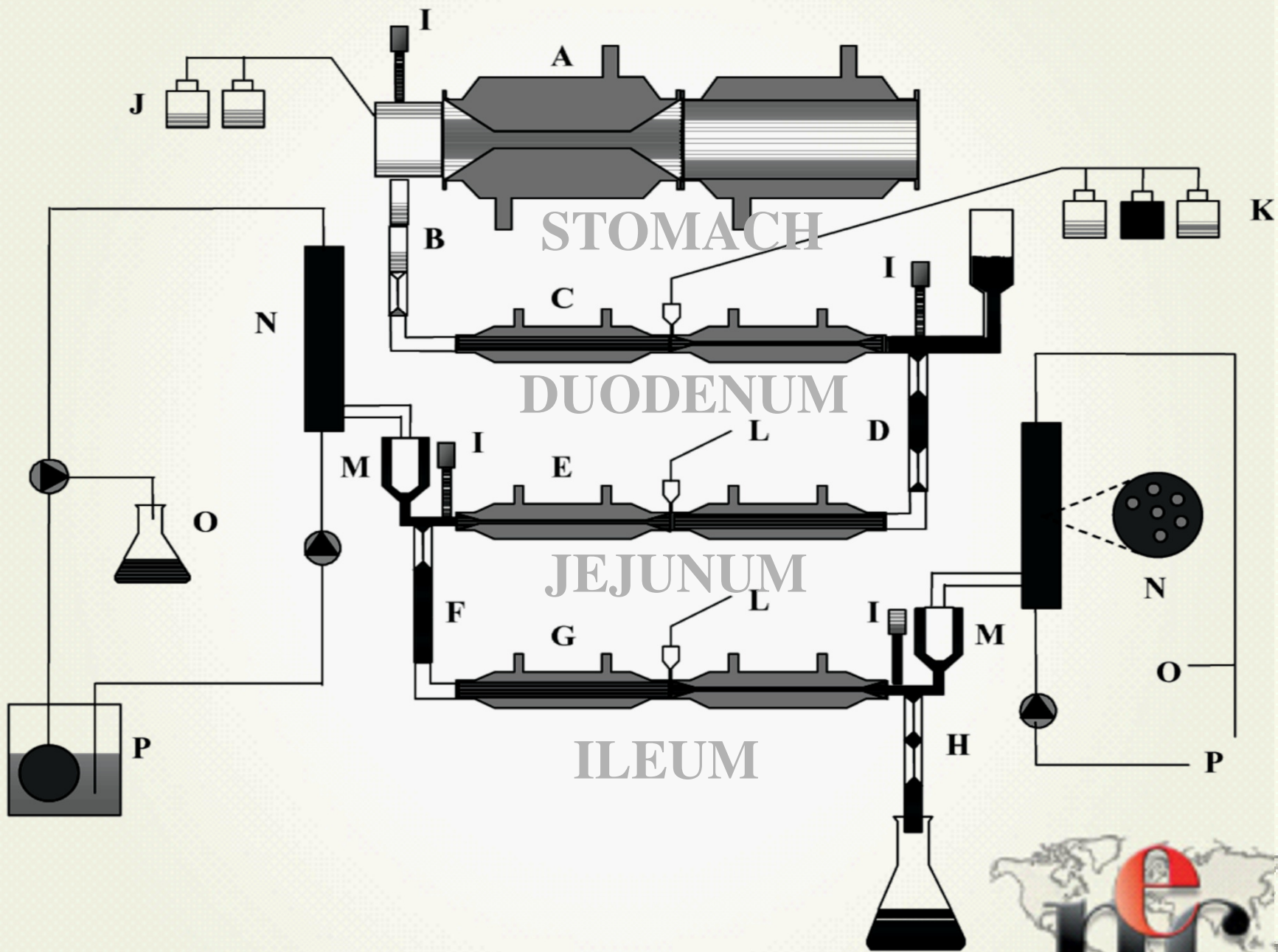
- *in vitro* Dynamic gastrointestinal model
- Simulate stomach, small intestine and large intestine conditions
- Sampling during digestion
- Specific protocol development and validation

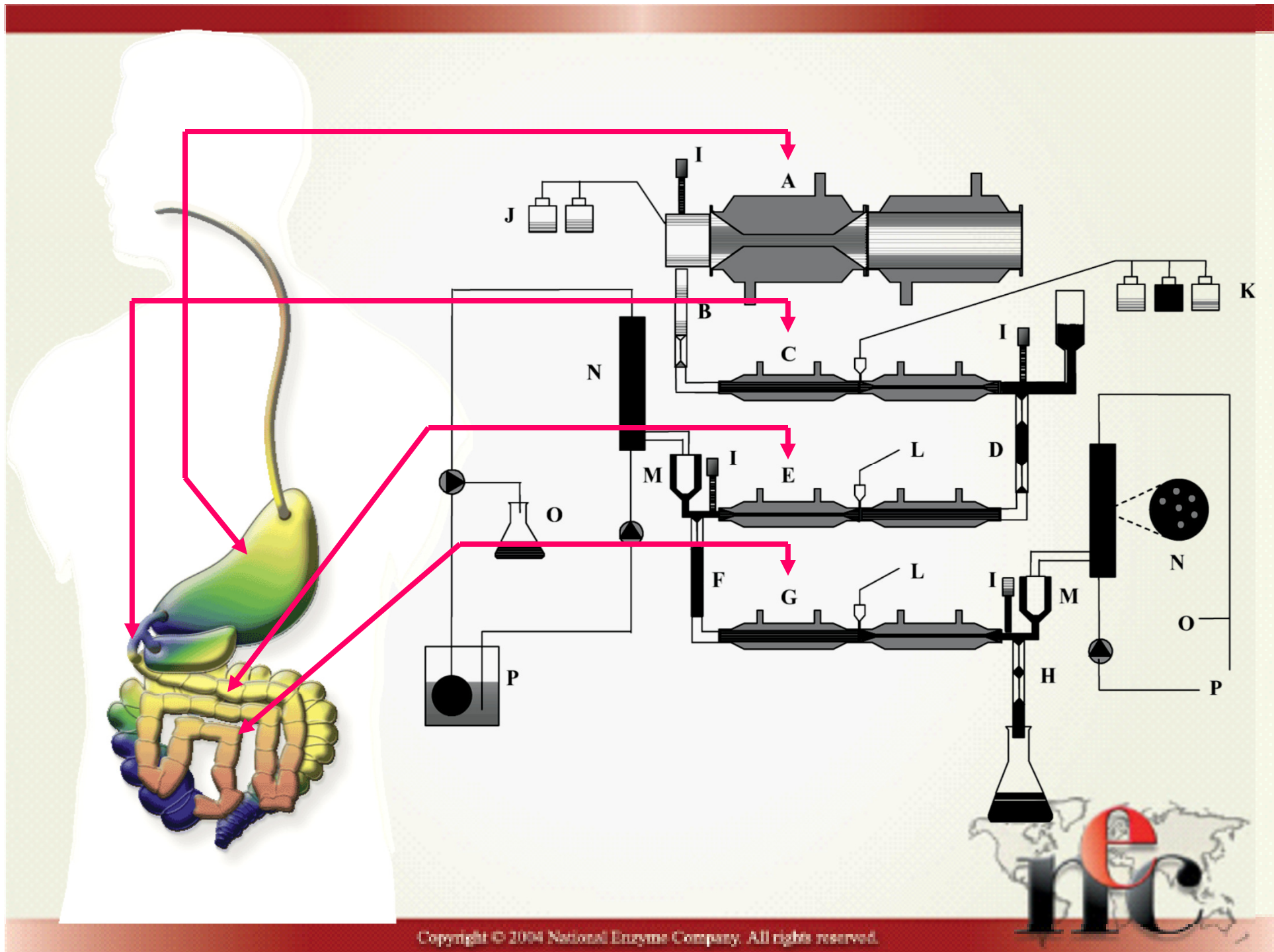




Copyright © 2004 National Enzyme Company. All rights reserved.







Study Protocol

- Aim: To determine the efficacy of exogenous NEC enzymes on the digestibility of proteins and carbohydrates
- Standard FDA-type test meal
- Proteins, carbohydrates and fat
- Mouth, stomach and small intestine conditions



Protocol: cont'd

- Meal mixed with artificial saliva and water
- Stomach secretions: acid and pepsin
- Duodenum: bicarbonate and pancreatin
- Small intestine
- Enzyme Blend: Proteases, Carbohydrases, Lipases



Protocol: cont'd

- Gastric emptying and intestinal passage mimicked for humans
- Temperature, peristalsis, pH, etc... controlled by computer
- Sampling spots: Jejunum and Ileum
- Small intestine: Semi-permeable membrane



Conditions Tested

1. Perfect digestion
2. Perfect digestion with NEC enzymes
3. Impaired digestion (30% of pancreatin)
4. Impaired digestion with NEC enzymes

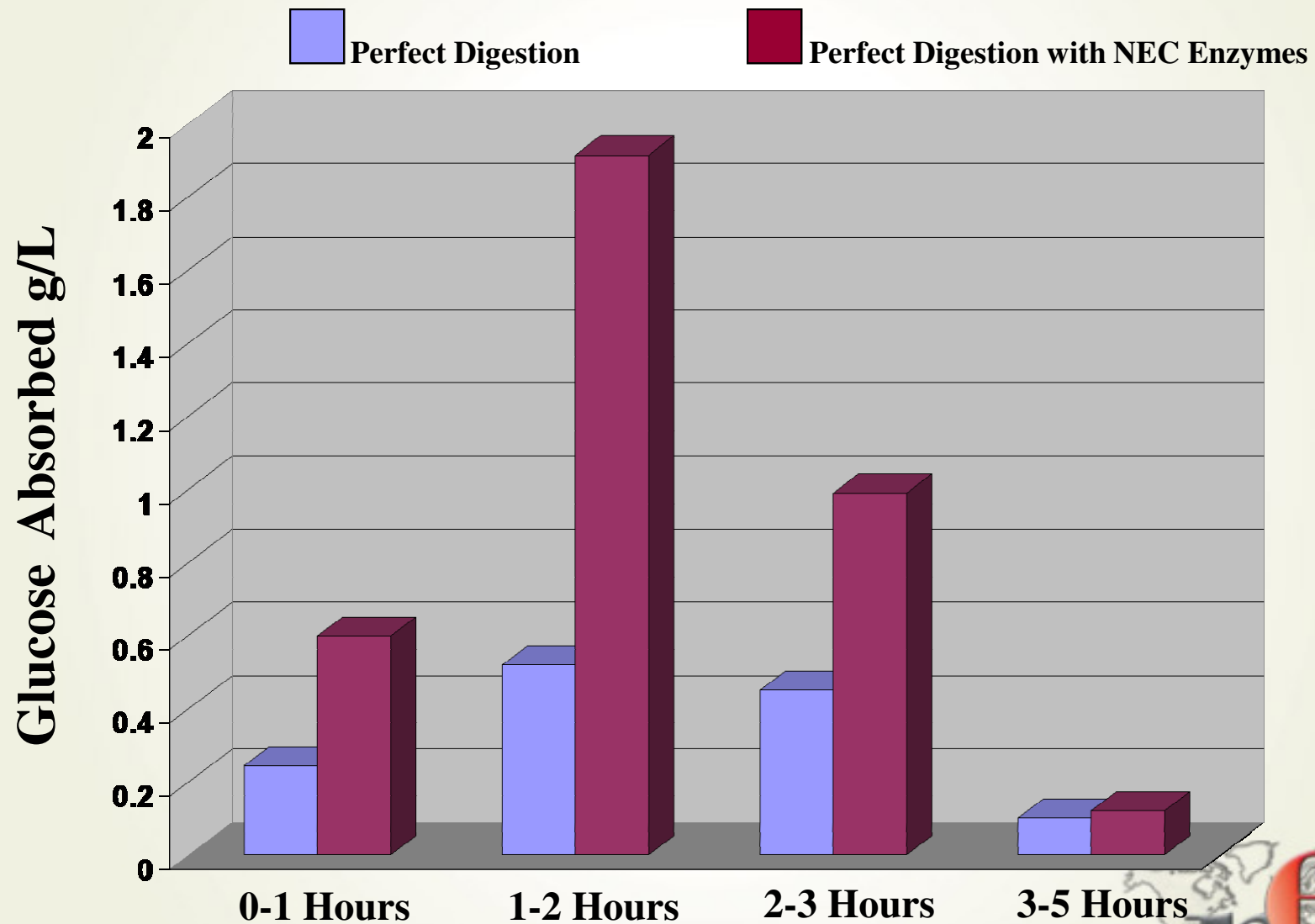
Most of us fall in between these two extreme conditions



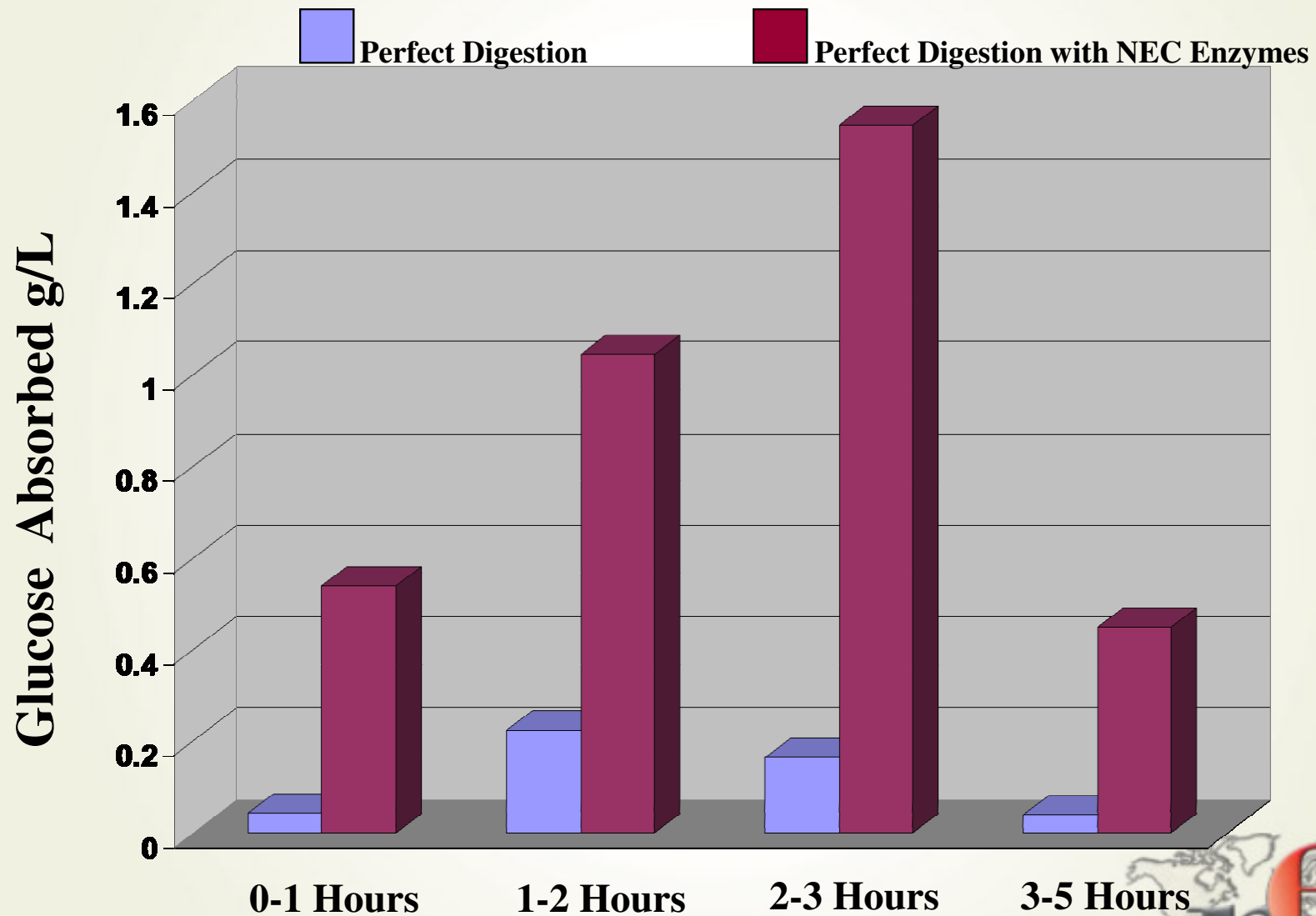
Condition 1: Perfect Digestion



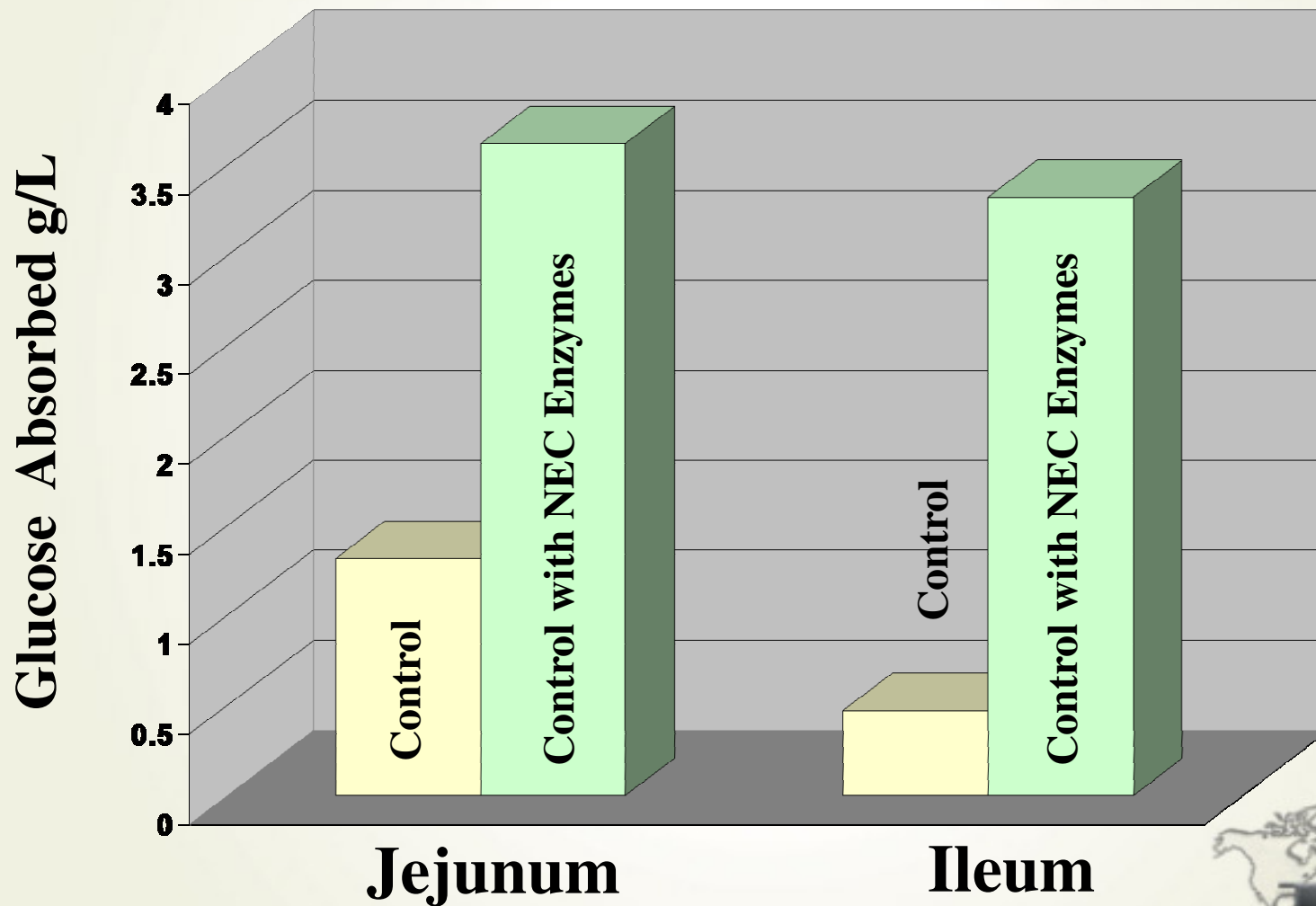
Digestion of Carbohydrates in Jejunum



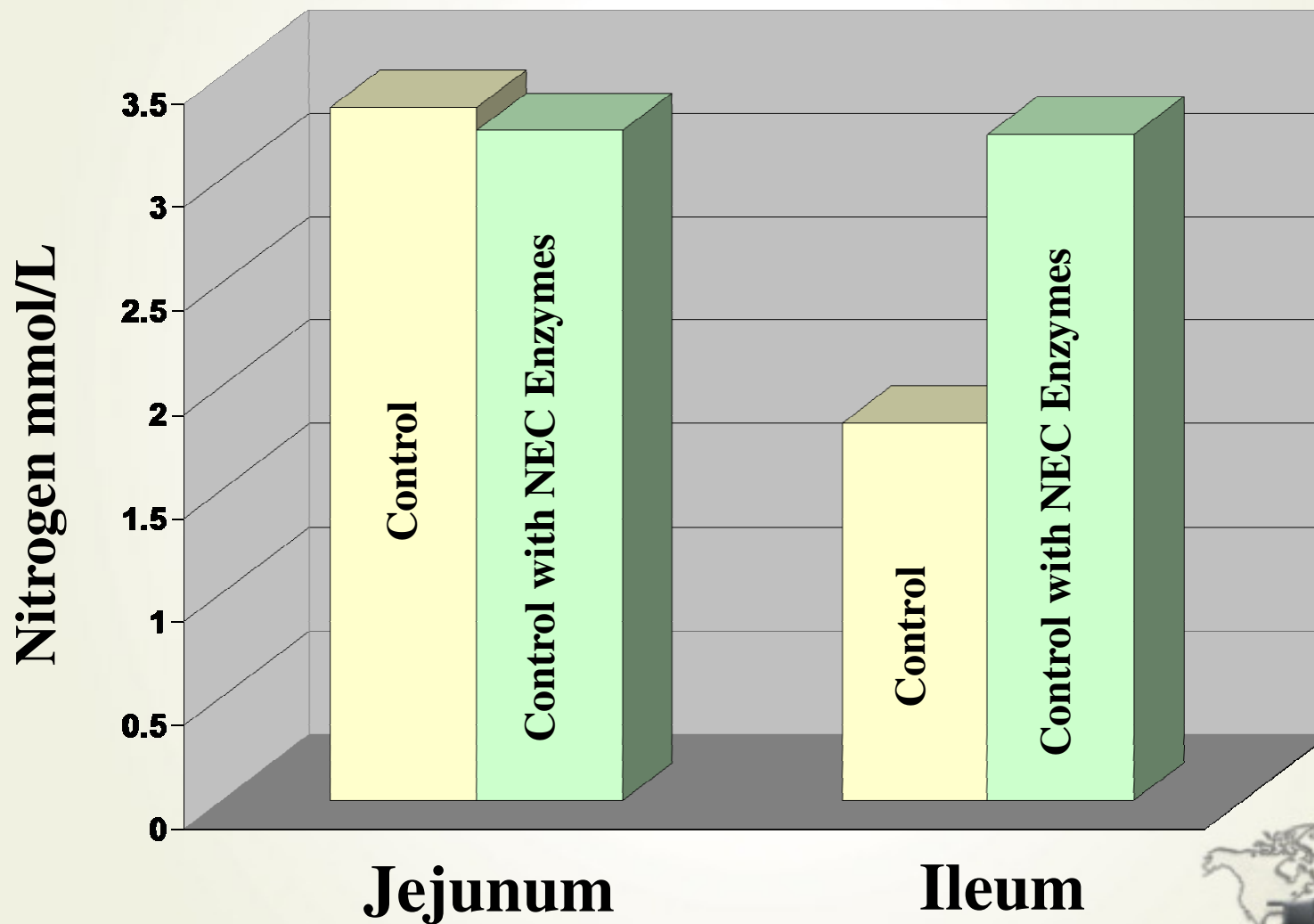
Digestion of Carbohydrates in Ileum



Carbohydrate Digestion: Small Intestine Perfect Digestion



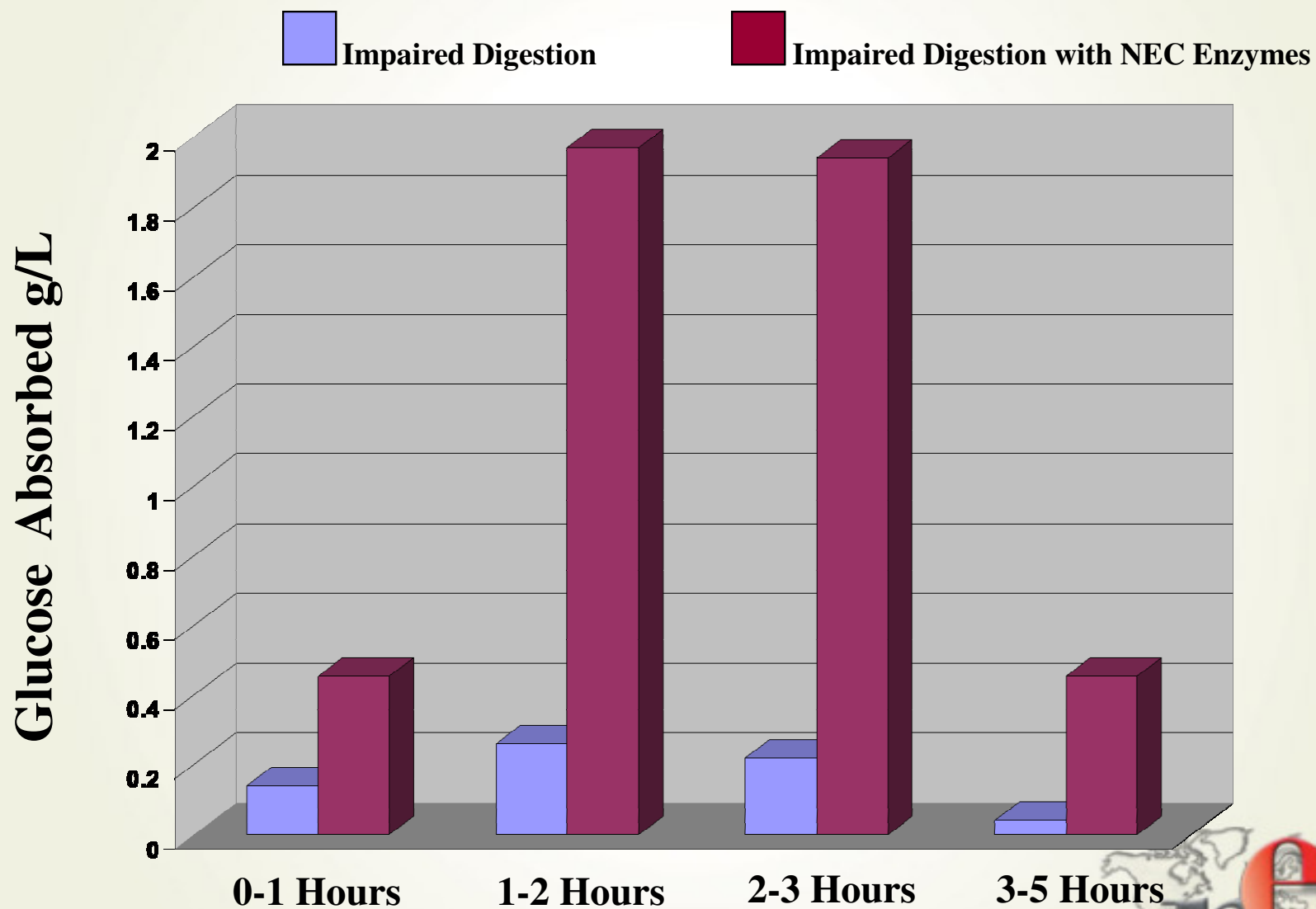
Protein Digestion: Small Intestine Perfect Digestion



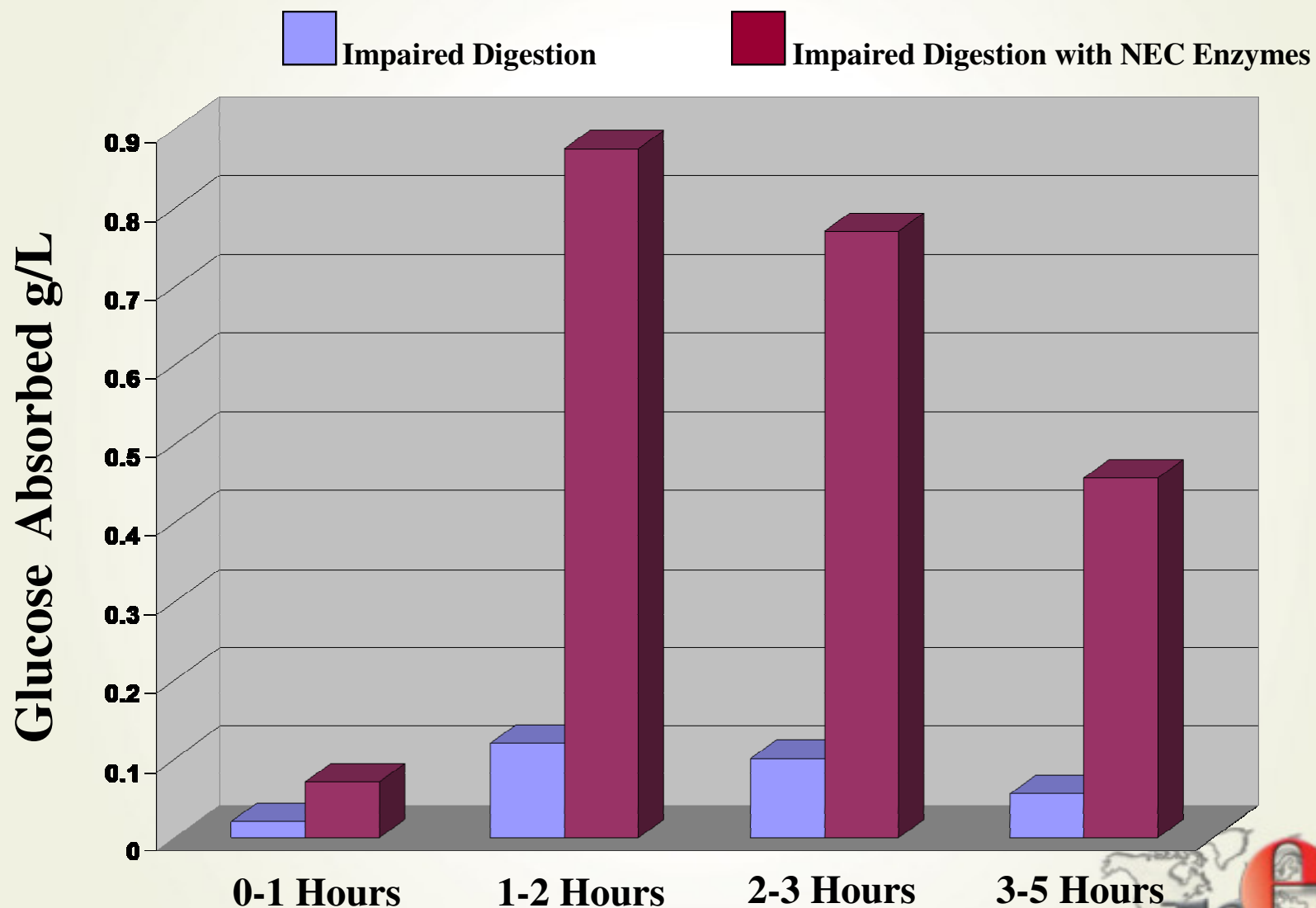
Condition 2: Impaired Digestion



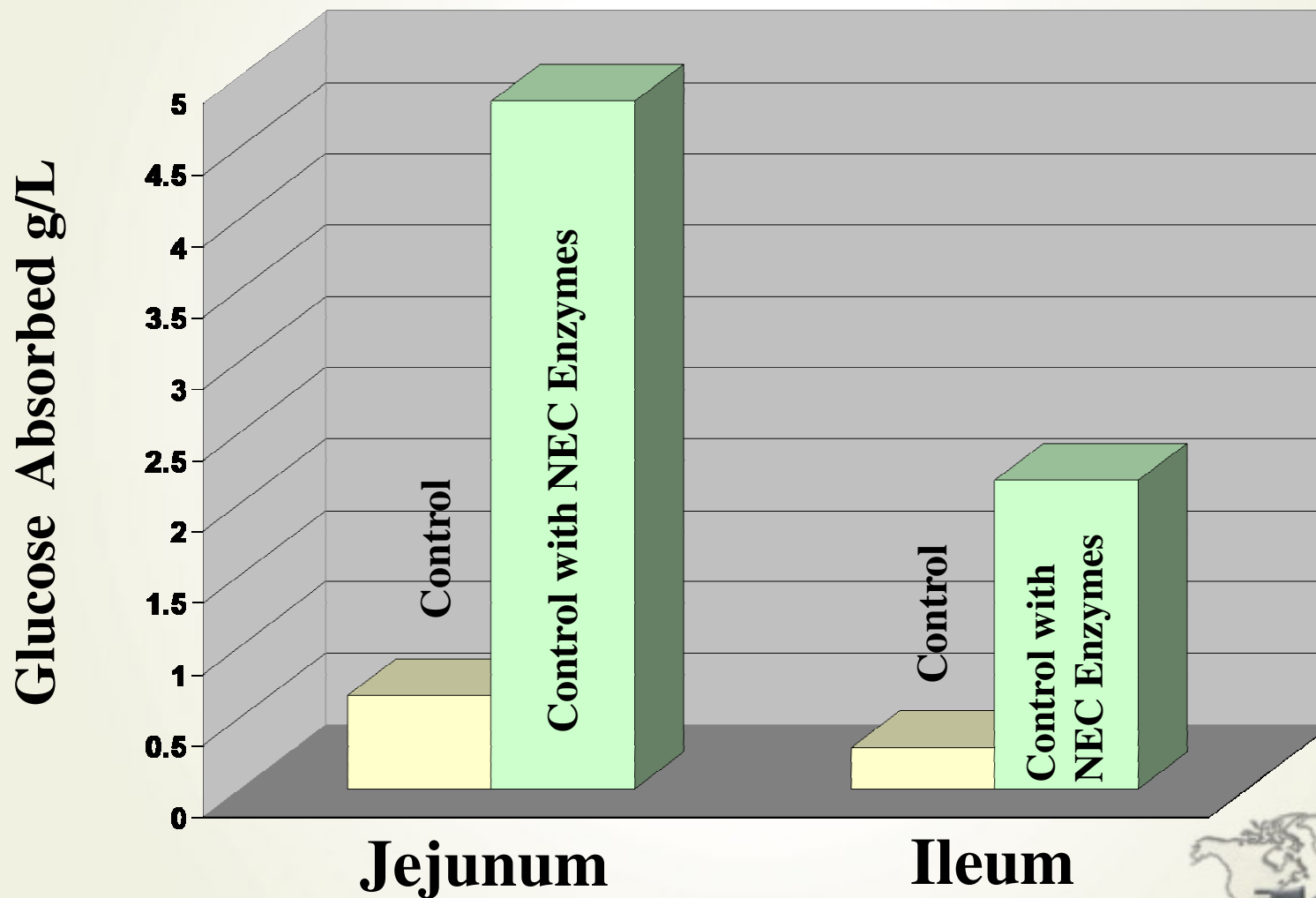
Digestion of Carbohydrates in Jejunum



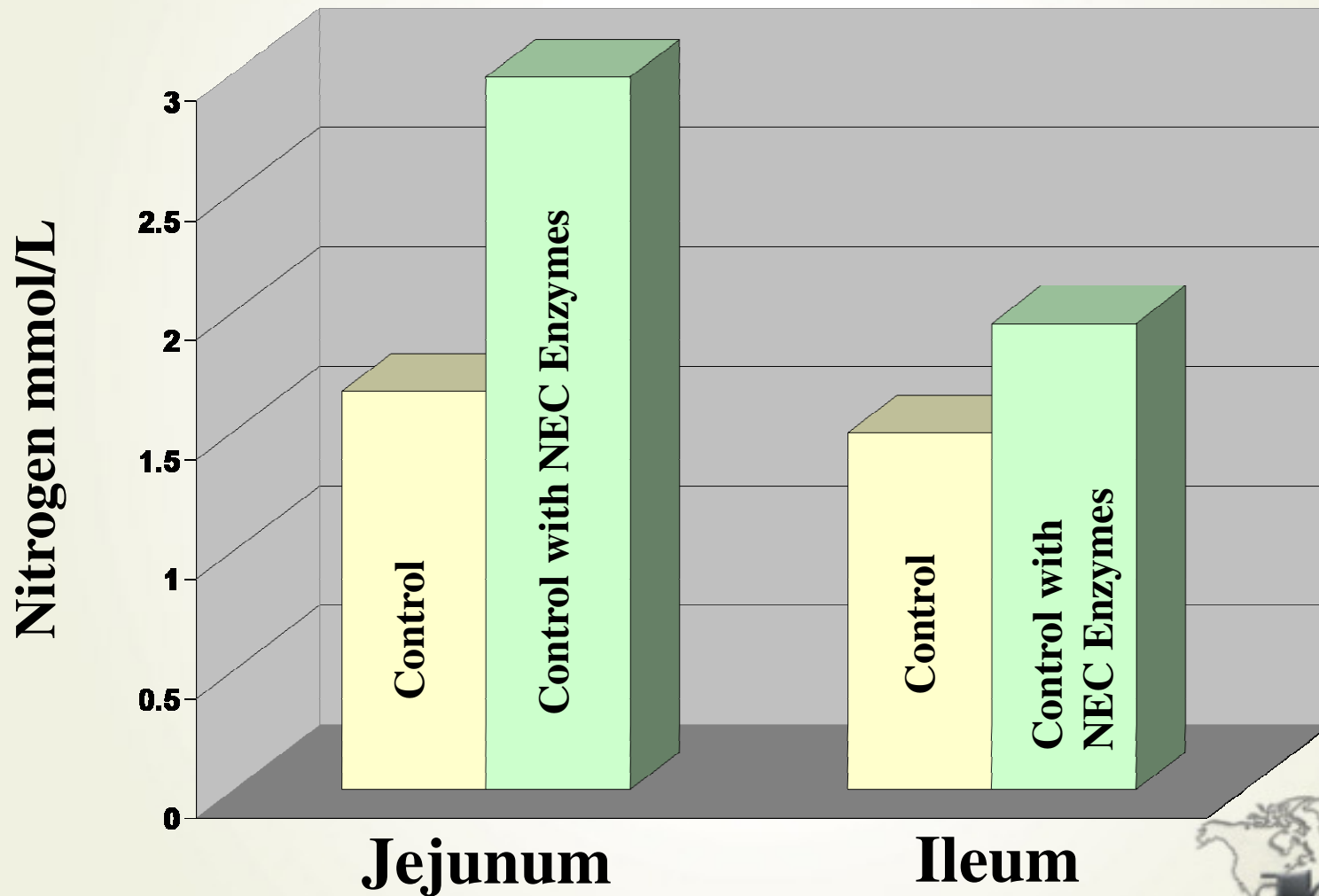
Digestion of Carbohydrates in Ileum



Carbohydrate Digestion: Small Intestine Impaired Digestion



Protein Digestion: Small Intestine Impaired Digestion



Conclusion:

- NEC Fungal enzymes have a broad pH range
- They not only survive stomach acidity but also are active at low pH
- They are safe
- **NEC Fungal Enzymes increase the digestion of proteins and carbohydrates**

