

Martin Eastwood

Principles of
Human Nutrition

SECOND EDITION



Blackwell
Publishing

A Wiley Company

Contents

Acknowledgements

Chapter 1 Introduction and overview

LITERATURE

WEBSITES OF INTEREST

OVERVIEW

NUTRIENTS

ESSENTIAL NUTRIENTS

FOOD UTILISATION

METABOLISM OF NUTRIENTS

NUTRITIONAL DEFICIENCY AND EXCESS

THINKING POINT

Part I Factors influencing the food that a community eats

Chapter 2 History of food

HISTORY OF DIET AROUND THE WORLD

HISTORY OF EUROPEAN DIET

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

WEBSITES

Chapter 3 Social, population and environmental influences on nutrition

SOCIAL BASIS OF NUTRITION

DEPRIVATION

CLIMATIC CHANGE

AGRICULTURE

POLLUTION

WAR

SMOKING

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

WEBSITES

Part II Calculating how much food a community eats

Chapter 4 The food chain

INTRODUCTION

NON-NUTRIENTS IN THE FOOD CHAIN

TOXINS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

WEBSITES

INTRODUCTION

WATER STANDARDS
CONTAMINANTS
SEWAGE
WATER-BORNE PATHOGENS
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
WEBSITES

Chapter 5 Nutritional requirements

OPTIMAL REQUIREMENTS OF NUTRIENTS
DEVELOPMENT OF NUTRITIONAL AND DIETARY
GUIDELINES
DIETARY REFERENCE VALUES AND
MEASUREMENTS
LIFETIME VARIATION IN NUTRITIONAL
REQUIREMENTS
NUTRITIONAL REQUIREMENTS FOR ENERGY
DIETARY PLANNING AND GUIDELINES
EVIDENCE-BASED NUTRITION
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING
WEBSITES

Chapter 6 Nutritional epidemiology

INTRODUCTION
HISTORICAL STUDIES

EPIDEMIOLOGICAL RESEARCH METHODOLOGY
TYPES OF NUTRITIONAL STUDY
SELECTION OF POPULATION
MEASUREMENT OF OUTCOME
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

Part III Factors influencing how an individual metabolises nutrients

Chapter 7 Genetics

INTRODUCTION
VOCABULARY OF GENETICS
PRINCIPLES OF INHERITANCE
KEY POINTS
THINKING POINT
POPULATION GENETICS
KEY POINTS
THINKING POINT
FURTHER READING
HUMAN GENOME PROJECT
HUMAN GENOME METHODOLOGY
KEY POINTS
THINKING POINTS
FURTHER READING

WEBSITES

GENOME METHODOLOGY

GENE MAPPING

INTRODUCTION

CELL COMPARTMENTS

THE BIOCHEMICAL BASIS OF GENE

TRANSCRIPTION

PROTEIN SYNTHESIS AND TRANSCRIPTION

HUMAN GENETIC VARIATION

ENZYMES AND ISOENZYMES

KEY POINTS

THINKING POINTS

FURTHER READING

WEBSITES

INTRODUCTION

FURTHER READING

GENETICS AND ANTHROPOLOGY

FURTHER READING

FOOD MODIFICATION IN PLANTS AND ANIMALS

TECHNIQUES OF GENETIC ENGINEERING

THINKING POINT

FURTHER READING

WEBSITES

INTRODUCTION

GENETIC DISORDERS

CHROMOSOME DISORDERS

GENE THERAPY

KEY POINTS

THINKING POINT

FURTHER READING

WEBSITES

DIRECT TESTS FOR INDIVIDUAL GENES

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

Part IV Calculating the nutritional status of an individual

Chapter 8 Evaluation of dietary intake

INTRODUCTION

METHODS OF MEASURING FOOD INTAKE

SOURCES OF ERROR

CONVERTING FOOD INTAKE TO NUTRIENT INTAKE

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

WEBSITES

Chapter 9 Measurements of energy

INTRODUCTION

ENERGY BALANCE

ENERGY EXPENDITURE AT REST

REGULATION OF ENERGY BALANCE

ENERGY REQUIREMENTS
MEASUREMENT OF ENERGY EXPENDITURE
MEASUREMENT OF INTERMEDIARY METABOLISM
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING

Chapter 10 Body composition

INTRODUCTION
MEASURING THE COMPOSITION OF THE MAJOR
BODY COMPARTMENTS
ESTIMATING BODY COMPOSITION
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

Part V Nutrients and non-nutrients

Chapter 11 Principles, amino acids and proteins

ESSENTIAL NUTRIENTS
SOMETIMES ESSENTIAL NUTRIENTS: NUTRIENTS
THAT ONLY IN PART MEET THE CRITERIA OF BEING
ESSENTIAL
NON-ESSENTIAL NUTRIENTS: NUTRIENTS THAT IN
NO RESPECT MEET THE CRITERIA OF BEING

ESSENTIAL

FURTHER READING

INTRODUCTION

ENANTIOMERS

CHIRALITY AND NUTRITIONAL BIOCHEMISTRY

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

CLASSIFICATION OF AMINO ACIDS

AMINO ACID STRUCTURE

ESSENTIAL AND NON-ESSENTIAL AMINO ACIDS IN
NUTRITION

NON-PROTEIN AMINO ACIDS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

WEBSITE

INTRODUCTION

PROTEIN STRUCTURE

A PERIODIC TABLE OF PROTEINS

CONTROL OF PROTEIN FUNCTION

SELECTIVE DEGRADATION OF PROTEINS

ALLOSTERIC PROTEINS AND ENZYMES

PRIONS

PROTEINS AND EVOLUTION

NUTRITIONAL REQUIREMENTS OF AMINO ACIDS
AND PROTEIN

[KEY POINTS](#)
[THINKING POINTS](#)
[NEED TO UNDERSTAND](#)
[FURTHER READING](#)
[WEBSITE](#)

[*Chapter 12*](#) [Lipids](#)

[INTRODUCTION](#)
[ESSENTIAL FATTY ACIDS](#)
[GLYCEROL TRIESTERS](#)
[CHOLESTEROL AND STEROLS](#)
[FUNCTIONS OF LIPIDS](#)
[RECOMMENDED INTAKE OF FATTY ACIDS](#)
[KEY POINTS](#)
[THINKING POINTS](#)
[NEED TO UNDERSTAND](#)
[FURTHER READING](#)
[WEBSITES](#)

[*Chapter 13*](#) [Carbohydrates](#)

[INTRODUCTION](#)
[TYPES AND FORMS OF SUGAR](#)
[SUGARS IN PREPARED FOODS](#)
[SUGARS IN SPECIFIC FOODS](#)
[MONOSACCHARIDES](#)
[DISACCHARIDES](#)
[KEY POINTS](#)
[THINKING POINT](#)
[NEED TO UNDERSTAND](#)

FURTHER READING

INTRODUCTION

CELLULOSE AND GLYCOGEN

STARCH

PHYSICAL AND CHEMICAL PROPERTIES OF
STARCH

STRUCTURE OF STARCH IN FOOD

INTERACTION OF STARCHES AND SUGARS WITH
OTHER FOOD COMPOUNDS

NUTRITIONAL REQUIREMENTS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

WEBSITE

Chapter 14 Dietary fibre

INTRODUCTION

DEFINITION OF DIETARY FIBRE

DISTRIBUTION OF FIBRE IN PLANTS

CHEMISTRY OF FIBRE

OTHER FIBRES

QUANTITATIVE MEASUREMENT OF FIBRE

PHYSICAL PROPERTIES OF FIBRE

ACTIONS OF FIBRE ALONG THE
GASTROINTESTINAL TRACT

RECOMMENDED INTAKE

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND
FURTHER READING
WEBSITE

Chapter 15 Alcohol as a nutrient

INTRODUCTION
SOCIOECONOMIC AND SOCIOMEDICAL ASPECTS
ALCOHOL ABSORPTION AND METABOLISM
EXCESSIVE INTAKE OF ALCOHOL
ALCOHOL METABOLISM
ALCOHOL AND XENOBIOTICS
EFFECTS OF ALCOHOL ON INDIVIDUAL ORGANS
AND TISSUES
ALCOHOL IN THE YOUNG
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING
WEB SITES

Chapter 16 Vitamins

NOMENCLATURE AND CLASSIFICATION OF
VITAMINS
FACTORS INFLUENCING THE UTILISATION OF
VITAMINS
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

INTRODUCTION

ACTION OF VITAMIN A

AVAILABILITY OF VITAMIN A

VITAMIN A DEFICIENCY

VITAMIN A EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

SYNTHESIS OF VITAMIN C

ACTION OF VITAMIN C

AVAILABILITY OF VITAMIN C

VITAMIN C DEFICIENCY

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF BIOTIN

AVAILABILITY OF BIOTIN

BIOTIN DEFICIENCY

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

SYNTHESIS OF NIACIN

ACTION OF NIACIN

AVAILABILITY OF NIACIN

NIACIN DEFICIENCY

NIACIN EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF PANTOTHENIC ACID

AVAILABILITY OF PANTOTHENIC ACID

PANTOTHENIC ACID DEFICIENCY AND EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF RIBOFLAVIN

AVAILABILITY OF RIBOFLAVIN

RIBOFLAVIN DEFICIENCY AND EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF THIAMIN

AVAILABILITY OF THIAMIN

THIAMIN DEFICIENCY

THIAMIN EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF PYRIDOXINE

AVAILABILITY OF PYRIDOXINE

PYRIDOXINE DEFICIENCY AND EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE REQUIREMENTS

KEY POINTS

FURTHER READING

INTRODUCTION

AVAILABILITY OF CARNITINE

ACTION OF CARNITINE

CARNITINE DEFICIENCY

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF INOSITOL

AVAILABILITY OF INOSITOL

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF LIPOTROPES

AVAILABILITY OF LIPOTROPES

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF FOLIC ACID

AVAILABILITY OF FOLIC ACID

FOLIC ACID DEFICIENCY

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

SYNTHESIS OF VITAMIN B₁₂

ACTION OF VITAMIN B₁₂

AVAILABILITY OF VITAMIN B₁₂

VITAMIN B₁₂ DEFICIENCY

VITAMIN B₁₂ EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

SYNTHESIS OF VITAMIN D

ACTIONS OF VITAMIN D

AVAILABILITY OF VITAMIN D

VITAMIN D DEFICIENCY

VITAMIN D EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

ACTION OF VITAMIN K

AVAILABILITY OF VITAMIN K

VITAMIN K DEFICIENCY

VITAMIN K EXCESS

RECOMMENDED REQUIREMENTS

BODY STORE MEASUREMENTS
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING
INTRODUCTION
ACTION OF VITAMIN E
AVAILABILITY OF VITAMIN E
DEFICIENCY AND EXCESS OF VITAMIN E
RECOMMENDED REQUIREMENTS
BODY STORE MEASUREMENTS
KEY POINTS
NEED TO UNDERSTAND
FURTHER READING

Chapter 17 Plant secondary metabolites and herbs

INTRODUCTION
CHEMISTRY
METABOLIC REGULATORY ROLE
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING
WEBSITE
INTRODUCTION
NOMENCLATURE
BENEFICIAL EFFECTS
ADVERSE EFFECTS

CAFFEINE
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING
WEBSITE

Chapter 18 Water, electrolytes, minerals and trace elements

INTRODUCTION
WATER BALANCES IN THE BODY
CLINICAL SIGNS OF WATER DEPLETION
EXCESSIVE WATER INTAKE
RECOMMENDED REQUIREMENTS
BODY STORE MEASUREMENTS
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING
SODIUM
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING
POTASSIUM
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING

CALCIUM

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

IRON

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

INTRODUCTION

DIETARY INTERACTIONS OF TRACE ELEMENTS

FURTHER READING

INDIVIDUAL TRACE ELEMENTS

KEY POINT

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

Chapter 19 Non-nutritive components of food

FOOD ADDITIVES

FOOD PRESERVATIVES

PROCESSING AIDS

KEY POINTS

THINKING POINTS

Chapter 20 Agricultural chemicals in the food chain

INTRODUCTION

AGROCHEMICALS

LABELLING AND CLASSIFICATION OF PESTICIDES

NATURAL METHODS OF CONTROL

PRINCIPLES OF PESTICIDE METABOLISM

INSECTICIDES

FUNGICIDES

HERBICIDES

TOXIC EFFECTS OF PESTICIDES

WATER SUPPLIES

CONTROL OF PESTICIDES

MONITORING PESTICIDE CONTAMINANTS OF
FOOD

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

WEBSITES

Chapter 21 Drugs and nutrition

INTRODUCTION

EFFECT OF DRUGS ON FOOD INTAKE

EFFECTS OF DRUGS ON HEPATIC FUNCTION

DRUG INTERACTIONS IN THE GASTROINTESTINAL
TRACT

EFFECT OF DRUGS ON METABOLISM

DRUGS ASSOCIATED WITH INCREASED LOSS OF
NUTRIENTS

KEY POINTS

THINKING POINT
NEED TO UNDERSTAND
FURTHER READING

Part VI Eating, digestion and metabolism

Chapter 22 Smell and taste

INTRODUCTION
OLFACTION
GUSTATION
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING
WEBSITE

Chapter 23 Intake and satiety

INTRODUCTION
AGE AND APPETITE
SATIETY AND NUTRITION SELECTION
BEHAVIOURAL AND QUALITATIVE ASPECTS OF
FOOD INTAKE
BIOLOGICAL AND QUANTITATIVE BASIS OF
HUNGER AND SATIETY
ROLE OF THE GUT IN CONTROLLING FOOD INTAKE
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND

FURTHER READING

Chapter 24 The gastrointestinal tract and food availability

INTRODUCTION

GASTROINTESTINAL TRACT

BRAIN-GUT AXIS

CIRCADIAN RHYTHMS

POST-PRANDIAL PHYSIOLOGICAL CONTROL OF
EVENTS ALONG THE GASTROINTESTINAL TRACT

PERIODICITY OF EATING

MUCINS

MOUTH

SWALLOWING

STOMACH

SMALL INTESTINE

COLON

PREBIOTICS AND SYNBIOTICS

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

Chapter 25 Carbohydrate digestion and absorption

INTRODUCTION

DIETARY CARBOHYDRATE AND THE INTESTINAL
ABSORPTION OF SUGARS

STARCH

COMPLEXES AND INTERACTIONS WITH OTHER
FOOD COMPONENTS

ASSESSMENT OF DIETARY CARBOHYDRATE
DIGESTIBILITY

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

Chapter 26 Protein absorption

INTRODUCTION

DIGESTION AND ABSORPTION OF PROTEINS

CELLULAR UPTAKE OF PROTEIN HYDROLYSIS

PRODUCTS

DEVELOPMENT OF PROTEIN ABSORPTION

KEY POINTS

THINKING POINT

NEED TO UNDERSTAND

FURTHER READING

Chapter 27 Lipid absorption

INTRODUCTION

PHASES OF DIGESTION AND ABSORPTION OF
LIPIDS

TRANSPORT OF LIPIDS INTO THE BLOOD

APOLIPOPROTEINS

LIPOPROTEINS

LIPID ABSORPTION IN EARLY LIFE

KEY POINTS

THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

Chapter 28 Foetal and placental nutrition

INTRODUCTION
PLACENTAL CIRCULATION
MONOSACCHARIDES
AMINO ACIDS
LIPIDS AND RELATED COMPOUNDS
VITAMINS
INORGANIC NUTRIENTS, MACROMINERALS AND
IRON
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING

Chapter 29 Thermodynamics and metabolism

INTRODUCTION
THE FIRST AND SECOND LAWS OF
THERMODYNAMICS
ENTHALPY
ENTROPY
WORK
INTERMEDIARY METABOLISM
SIGNALLING
KEY POINTS

THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

Chapter 30 Mitochondria

INTRODUCTION
MITOCHONDRIAL GENES
MITOCHONDRIAL FUNCTIONS AND DISTRIBUTION
I MITOCHONDRIAL ELECTRON TRANSPORT AND
ATP
MITOCHONDRIAL RESPONSE TO EXTERNAL
FACTORS
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

Chapter 31 Cytochrome P450

INTRODUCTION
EXPRESSION AND ACTIVITY
CLASSIFICATION
METABOLISM BY P450
P450 GENE CONTROL
P450 ENZYME INDUCTION AND INHIBITION
CYTOCHROME P450 AND CANCER
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING

Chapter 32 Free radicals

INTRODUCTION

OXYGEN AND ITS DERIVATIVES

TRANSITION METALS

HYDROXYL RADICALS IN LIVING SYSTEMS

PROTECTION AGAINST OXYGEN RADICALS IN
BIOLOGICAL SYSTEMS

OXIDATIVE TOXICITY

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

Chapter 33 Carbohydrate metabolism

INTRODUCTION

INDIVIDUAL SUGARS

SUGARS AND DIABETES MELLITUS

GLYCAEMIC RESPONSES TO SUGARS AND
STARCHES

DIETARY CARBOHYDRATES AND LIPID
METABOLISM

CARBOHYDRATES AND THE RESPIRATORY
QUOTIENT

GLUCOSE OXIDATION AND METABOLISM

GLYCOLYSIS

TRICARBOXYLIC ACID CYCLE

PENTOSE PHOSPHATE PATHWAY

METABOLISM IN THE PRESENCE OF ABUNDANT
GLUCOSE

I METABOLISM DURING GLUCOSE I INSUFFICIENCY
OR NEED

GLUCONEOGENESIS

I REGULATION OF FRUCTOSE PHOSPHORYLATION

KETONE BODIES

REGULATION OF GENE EXPRESSION BY GLUCOSE

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

Chapter 34 Lipid metabolism

INTRODUCTION

LIPID SYNTHESIS

CONTROL MECHANISMS

BIOSYNTHESIS OF UNSATURATED FATTY ACIDS

CELLULAR DEGRADATION OF FATTY ACIDS

PEROXIDATION

LIPIDS AS ENERGY STORES

BIOSYNTHESIS OF TRIACYLGLYCEROLS

ACYLGLYCEROL CATABOLISM

TRIACYLGLYCEROLS AS FUELS

FATS AND GENE EXPRESSION

FAT TISSUE

FAT STORES

WEIGHT, MORBIDITY AND LIFE EXPECTATION

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

Chapter 35 Eicosanoids

INTRODUCTION

NOMENCLATURE

THE CYCLO-OXYGENASE PATHWAY

LEUKOTRIENES AND MONO-EICOSATETRAENOIC
ACIDS

EICOSANOIDS AND DIETARY FATTY ACIDS

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

Chapter 36 Cholesterol and lipoproteins

INTRODUCTION

CHOLESTEROL BIOSYNTHESIS

CELL MEMBRANE CHOLESTEROL

CHOLESTEROL CATABOLISM TO BILE ACIDS

GENETIC CONTROL OF PLASMA CHOLESTEROL

HYPERLIPOPROTEINAEMIA

PLASMA CHOLESTEROL CONCENTRATION

KEY POINTS

THINKING POINTS

NEED TO UNDERSTAND

FURTHER READING

Chapter 37 Amino acid metabolism

INTRODUCTION

AMINO ACID SYNTHESIS
CATABOLISM OF AMINO ACIDS
GLUTAMINE
AMMONIA AND UREA
PROTEIN SYNTHESIS AND BREAKDOWN
GENE EXPRESSION
KEY POINTS
THINKING POINT
NEED TO UNDERSTAND
FURTHER READING

Chapter 38 Amino acid neurotransmitters

INTRODUCTION
EXCITATORY NEUROTRANSMITTERS
INHIBITORY NEUROTRANSMITTERS
NITRIC OXIDE
KEY POINTS
THINKING POINTS
NEED TO UNDERSTAND
FURTHER READING

Chapter 39 Organ metabolic fuel selection

INTRODUCTION
POST-ABSORPTION
INTESTINAL EPITHELIUM
LIVER
BRAIN
MUSCLE
WHITE ADIPOSE TISSUE