

"12th Five-Year Plan" Innovation Textbook for Higher Education in Chinese Medicine

全国中医药行业高等教育“十二五”创新教材

Chemistry of Chinese Materia Medica

中 药 化 学

(英文版)

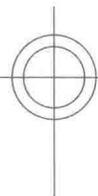
Editor-in-chief GAO Zengping

主 编 高增平

全国百佳图书出版单位

中国中医药出版社

China Press of Traditional Chinese Medicine



“12th Five-Year Plan” Innovation Textbook for Higher Education in Chinese Medicine
全国中医药行业高等教育“十二五”创新教材

Chemistry of Chinese Materia Medica

中药化学

(英文版)

Editor-in-chief GAO Zengping

主 编 高增平



China Press of Traditional Chinese Medicine

中国中医药出版社

Beijing

• 北 京 •

图书在版编目(CIP)数据

中药化学 Chemistry of Chinese Materia Medica: 英文版/高增平主编. —北京: 中国中医药出版社, 2014.8

全国中医药行业高等教育“十二五”创新教材

ISBN 978-7-5132-1933-4

I. ①中… II. ①高… III. ①中药化学-中医学院-教材-英文
IV. ①R284

中国版本图书馆 CIP 数据核字(2014)第 122886 号

中国中医药出版社出版
北京市朝阳区北三环东路 28 号易亨大厦 16 层
邮政编码 100013
传真 64405750
河北省欣航测绘院印刷厂印刷
各地新华书店经销

*

开本 787×1092 1/16 印张 29.5 字数 855 千字

2014 年 8 月第 1 版 2014 年 8 月第 1 次印刷

书号 ISBN 978-7-5132-1933-4

*

定价 58.00 元

网址 www.cptcm.com

如有印装质量问题请与本社出版部调换

版权专有 侵权必究

社长热线 010 64405720

购书热线 010 64065415 010 64065413

书店网址 csln.net/qksd/

官方微博 <http://e.weibo.com/cptcm>

“12th Five –Year Plan” Innovation Textbook for Higher Education in Chinese Medicine

Chemistry of Chinese Materia Medica

Editor-in-chief:

GAO Zengping (Beijing University of Chinese Medicine)

Associate Editors:

WU Jinzhong (Fujian University of Traditional Chinese Medicine)

HE Xixin (Guangzhou University of Chinese Medicine)

WANG Jiyan (Changchun University of Chinese Medicine)

LI Bin (Jiangxi University of Traditional Chinese Medicine)

HE Yongzhi (Tianjin University of Traditional Chinese Medicine)

Editorial Board Members in Alphabetical Order:

CHAI Huifang (Guiyang College of Traditional Chinese Medicine)

LIU Aijuan (Beijing University of Chinese Medicine)

QU Yang (Liaoning University of Traditional Chinese Medicine)

SHAO Jing (Gansu University of Traditional Chinese Medicine)

TAN Yongxia (Hubei University of Chinese Medicine)

WANG Wei (Shanxi University of Chinese Medicine)

WU Xia (Capital Medical University)

Content Reviewers:

PENG Jiangnan (University of Texas Health Science Center)

SHI Renbing (Beijing University of Chinese Medicine)

Language Reviewers:

FANG Tingyu (Beijing University of Chinese Medicine)

WEI Xin (Amgen Inc.)

全国中医药行业高等教育“十二五”创新教材
《中药化学》(英文版)编委会

主 编 高增平(北京中医药大学)

副主编 吴锦忠(福建中医药大学)

何细新(广州中医药大学)

王继彦(长春中医药大学)

李 斌(江西中医药大学)

何永志(天津中医药大学)

编 委 (按汉语拼音排序)

柴慧芳(贵阳中医学院)

刘艾娟(北京中医药大学)

曲 扬(辽宁中医药大学)

邵 晶(甘肃中医学院)

谭永霞(湖北中医药大学)

王 薇(陕西中医学院)

吴 霞(首都医科大学)

内容主审 彭江南(美国德克萨斯州立大学

圣安东尼奥健康中心)

石任兵(北京中医药大学)

语言主审 方廷钰(北京中医药大学)

魏 鑫(美国安进公司)

Preface

This book is a “12th Five-Year” innovation textbook for higher education in Chinese medicine. It is the first English textbook in the field of Chemistry of Chinese Materia Medica (title from *Chinese Terms in Traditional Chinese Medicine and Pharmacy*). It is prepared on the basis of Chinese textbooks on Chemistry of Chinese Materia Medica and English books related to natural products. This book is aimed mainly at undergraduate students in Chinese Materia Medica Specialty and other related disciplines. It will also be beneficial to those engaged in pharmaceutical and plant-based industries.

This book contains 13 chapters and appendices. The first 12 chapters provide the fundamental knowledge on Chemistry of Chinese Materia Medica. The last chapter devotes to examples of 32 commonly used Chinese herbs, including brief background information, main chemical constituents, and important quality control information. Appendices contain a glossary, a list of Latin names, and abbreviations for commonly used solvents.

The comprehensive work has called for collaborative effort of specialists from 12 universities, namely the Beijing University of Chinese Medicine, Guangzhou University of Chinese Medicine, Tianjin University of Traditional Chinese Medicine, Fujian University of Traditional Chinese Medicine, Changchun University of Chinese Medicine, Liaoning University of Traditional Chinese Medicine, Hubei University of Chinese Medicine, Capital Medical University, Jiangxi University of Traditional Chinese Medicine, Shanxi University of Chinese Medicine, Gansu University of Traditional Chinese Medicine, and Guiyang College of Traditional Chinese Medicine. Here I would like to express my gratitude to all the leaders of the aforementioned universities and colleges for their tremendous support to the editors.

I am particularly grateful to Professor ZHAI Shuangqing, vice president of Beijing University of Chinese Medicine, for his encouragement and guidance. Without his help, publication of this textbook would not have been possible. I am also

deeply indebted to Dr. ZHU Henian for his support of the many editorial meetings for this book. I would like to extend my heartfelt thanks to Prof. YAN Yonghong, Prof. TANG Minke, Prof. NI Jian, Prof. DONG Ling, and LI Gongyu of the Beijing University of Chinese Medicine, Prof. XIE Ming and Prof. CAI Qian of the Liaoning University of Traditional Chinese Medicine, and my graduate students FEI Ye, FU Shenzhen, SONG Panhong, DAI Wentao, ZHANG Peng, and others for proofreading and helping me with editorial meeting arrangement. Finally, I want to acknowledge hundreds of students I have taught over the years, who unknowingly have encouraged me to write this textbook.

We all hope readers will give us suggestions for future improvement.

GAO Zengping, Ph.D., Professor
Beijing University of Chinese Medicine

Feb. 10th, 2014

CONTENTS

PART ONE BASIC PRINCIPLES

Chapter 1	General Introduction to Chemistry of Chinese Materia Medica	
	Medica	3
1	The Conception of Chemistry of Chinese Materia Medica	3
2	The Application of Chemistry of Chinese Materia Medica	4
2.1	To Clarify Effective Compositions of Chinese Herbs	4
2.2	To Facilitate the Development of New Drugs	5
3	The Progress of Chemistry of Chinese Materia Medica	6
3.1	Development in Identification of Effective Compositions of Chinese Herbs	6
3.2	The New Development in Drug Research and Pharmaceutical Industry	7
3.3	The Progress in Quality Control of Chinese Herbs and their Preparations	7
Chapter 2	General Methods for Chemical Investigation of Chinese Herbs	10
1	The Biosynthetic Pathways and Classification of Chemical Constituents from Chinese Herbs	10
1.1	Biosynthetic Pathways	11
1.2	Classification of Chemical Constituents	11
2	The General Methods for Chemical Investigation	13
2.1	Extraction Methods	13
2.2	Isolation Methods	22
2.3	Structure Determination Methods	32

Chapter 3 Carbohydrates and Glycosides	47
1 Carbohydrates	47
1.1 Introduction	47
1.2 Structure and Classification	47
1.3 The properties of carbohydrates	54
2 Glycosides	56
2.1 Introduction	56
2.2 Structure and Classification	56
2.3 General Physicochemical Properties	62
3 Extraction and Isolation Methods	69
3.1 Extraction Methods	69
3.2 Isolation Methods	72
4 Identification	74
4.1 Physicochemical Identification	74
4.2 Chromatography Identification	75
5 Structure Determination	75
5.1 Determination of Physical Constants	75
5.2 Determination of Molecular Formula and Molecular Weight	76
5.3 Identification of Aglycones and Saccharides	76
5.4 Determination of the Linkage Sequence and Position in the Saccharide Moiety	78
5.5 Determination of the Configuration of Glycosidic Linkage	80
Chapter 4 Quinones	83
1 Introduction	83
2 Structure Characteristics and Classification	83
2.1 Benzoquinones	83
2.2 Naphthoquinones	84
2.3 Phenanthraquinones	85
2.4 Anthraquinones	85
3 Physical and Chemical Properties	88
3.1 Physical Properties	88

3.2	Chemical Properties	89
4	Extraction and Isolation Methods	92
4.1	Extraction Methods	92
4.2	Isolation Methods	92
5	Identification	94
5.1	Physicochemical Identification	94
5.2	Chromatography Identification	94
6	Structure Elucidation	94
6.1	Chemical Methods	94
6.2	Spectroscopic Analysis of Anthraquinones	95
Chapter 5	Phenylpropanoids	101
1	Introduction	101
2	Simple Phenylpropanoids	102
2.1	Structure and Classification	102
2.2	Extraction and Isolation Methods	102
3	Coumarins	103
3.1	Introduction	103
3.2	Structure and Classification	104
3.3	General Physicochemical Properties	106
3.4	Extraction and Isolation Methods	108
3.5	Identification	109
3.6	Structure Determination	109
4	Lignans	111
4.1	Introduction	111
4.2	Structure and Classification	111
4.3	General Physicochemical Properties	114
4.4	Extraction and Isolation Methods	115
4.5	Identification	116
4.6	Structure Determination	116
Chapter 6	Flavonoids	120
1	Introduction	120

1.1	Definition of Flavonoids	120
1.2	Distribution of Flavonoids	120
1.3	Pharmacological Activities of Flavonoids	121
1.4	The Biosynthesis of Flavonoids	121
2	Structure and Classification	122
2.1	Flavonoid Aglycones	122
2.2	Flavonoid Glycosides	128
3	Physical and Chemical Properties	129
3.1	Physical Properties	129
3.2	Chemical Properties	130
4	Extraction and Isolation Methods	133
4.1	Extraction Methods	133
4.2	Isolation Methods	133
5	Identification	136
5.1	Physicochemical Identification	136
5.2	TLC Identification	136
6	Structure Elucidation	137
6.1	UV	137
6.2	NMR	140
6.3	MS	146
6.4	An Example for Structural Determination of Flavonoids	149
Chapter 7	Tannins	154
1	Introduction	154
2	Structure and Classification	156
2.1	Hydrolysable Tannins	156
2.2	Condensed Tannins	159
2.3	Complex Tannins	160
3	General Physicochemical Properties	161
3.1	Physical Properties	161
3.2	Chemical Properties	161
4	Extraction and Isolation Methods	161

4.1	Extraction Methods	161
4.2	Isolation Methods	161
5	Identification	163
6	Structure Determination	164
6.1	^1H – NMR	164
6.2	^{13}C – NMR	165
6.3	MS	165
6.4	CD	165
Chapter 8	Alkaloids	168
1	Introduction	168
1.1	Definition of Alkaloids	168
1.2	Distribution of Alkaloids	168
1.3	Pharmacological Activities of Alkaloids	169
2	Structure and Classification	169
3	Physical and Chemical Properties	171
3.1	Physical Properties	171
3.2	Chemical Properties	172
4	Extraction and Isolation Methods	177
4.1	Extraction of Alkaloids	177
4.2	Isolation of Alkaloids	178
5	Identification	183
5.1	Chemical Tests	183
5.2	Chromatography Methods	184
6	Structure Determination	184
6.1	Chemical Methods	184
6.2	Spectroscopy Methods	185
Chapter 9	Steroids	189
1	Introduction	189
1.1	Defination and Classification of Steroids	190
1.2	Color Reactions of Steroids	190
2	Cardiac Glycosides	191

2.1	Introduction	191
2.2	Structures and Classification	191
2.3	Relationship between Structures of Cardiac Glycosides and Their Cardiac Activities	193
2.4	Physical and Chemical Properties	194
2.5	Extraction and Isolation of Cardiac Glycosides	198
2.6	Identification of Cardiac Glycosides	199
2.7	Spectroscopic Characters of Cardiac Glycosides	200
3	Bile Acids	206
3.1	Introduction	206
3.2	Structure Characters of Bile Acids	207
3.3	Main Properties of Bile Acids	207
3.4	Identification of Bile Acids	208
3.5	Extraction and Isolation of Bile Acids	208
4	C ₂₁ – Steroids	208
5	Phytosterols	209
Chapter 10 Terpenoids and Volatile Oils		212
1	Terpenoids	212
1.1	Introduction	212
1.2	Classification and Representatives of Terpenoids	214
1.3	Physical and Chemical Properties	225
1.4	Extraction and Isolation Methods	228
1.5	Identification	229
1.6	Structure Determination	230
2	Volatile Oils	231
2.1	Introduction	231
2.2	The Composition	232
2.3	Physical and Chemical Properties	233
2.4	Extraction and Isolation Methods	234
2.5	Identification	236
Chapter 11 Saponins		239

1	Introduction	239
2	Structure Characters and Classification	239
2.1	Steroidal Saponins	240
2.2	Triterpenoid Saponins	243
3	Physical and Chemical Properties	249
3.1	Physical Properties	249
3.2	Chemical Properties	250
3.3	Hemolysis Property	251
4	Extraction and Isolation Methods	252
4.1	Extraction Methods	252
4.2	Isolation Methods	253
5	Identification	254
5.1	Physical and Chemical Identification	254
5.2	Chromatography Identification	254
6	Structure Elucidation	254
6.1	UV	255
6.2	IR	255
6.3	MS	255
6.4	NMR	259
Chapter 12	Other Constituents	264
1	Fatty Acids	264
1.1	Introduction	264
1.2	Structure Characters and Classification	265
1.3	Physical and Chemical Properties	267
1.4	Extraction and Isolation Methods	267
2	Organic Sulphur Compounds	267
2.1	Introduction	267
2.2	Organic Sulphur Compounds from Chinese Herbs	268
3	Amino Acids, Proteins, and Enzymes	268
3.1	Amino Acids	268
3.2	Proteins and Enzymes	270

4 Minerals	271
4.1 Introduction	271
4.2 Examples of Mineral	271

PART TWO APPLICATIONS

Chapter 13 Examples of Chinese Herbs	279
Lycii Fructus (<i>Gouqizi</i>)	279
Armeniacae Semen Amarum (<i>Kuxingren</i>)	284
Rhei Radix et Rhizoma (<i>Dahuang</i>)	286
Salviae Miltiorrhizae Radix et Rhizoma (<i>Danshen</i>)	290
Arnebiae Radix (<i>Zicao</i>)	292
Fraxini Cortex (<i>Qinpi</i>)	294
Schisandrae Chinensis Fructus (<i>Wuweizi</i>)	297
Forsythiae Fructus (<i>Lianqiao</i>)	299
Scutellariae Radix (<i>Huangqin</i>)	302
Puerariae Lobatae Radix (<i>Gegen</i>)	305
Sophorae Flos (<i>Huaihua</i>)	308
Ginkgo Folium (<i>Yinxingye</i>)	311
Galla Chinensis (<i>Wubeizi</i>)	316
Cinnamomi Cortex (<i>Rougui</i>)	318
Ephedrae Herba (<i>Mahuang</i>)	321
Coptidis Rhizoma (<i>Huanglian</i>)	325
Daturae Flos (<i>Yangjinhua</i>)	331
Sophorae Flavescentis Radix (<i>Kushen</i>)	336
Stephaniae Tetrandrae Radix (<i>Fangji</i>)	340
Corydalis Rhizoma (<i>Yanhusuo</i>)	343
Periplocae Cortex (<i>Xiangjiapi</i>)	346
Bufonis Venenum (<i>Chansu</i>)	351
Bovis Calculus (<i>Niuhuang</i>)	357
Artemisiae Annuae Herba (<i>Qinghao</i>)	358
Andrographis Herba (<i>Chuanxinlian</i>)	362

Rehmanniae Radix (<i>Dihuang</i>)	366
Menthae Haplocalycis Herba (<i>Bohe</i>)	369
Ginseng Radix et Rhizoma (<i>Renshen</i>)	372
Glycyrrhizae Radix et Rhizoma (<i>Gancao</i>)	380
Bupleuri Radix (<i>Chaihu</i>)	385
Ophiopogonis Radix (<i>Maidong</i>)	391
Allii Sativi Bulbus (<i>Dasuan</i>)	396

APPENDICES

Appendix I Glossary	403
Appendix II Latin Names	442
Appendix III Abbreviations for Commonly Used Solvents	453

PART ONE

BASIC PRINCIPLES