

INTRODUCTION	XIV
PLANT-DERIVED DRUGS	XIV
STUDY BACKGROUND	XIV
STUDY GOALS AND OBJECTIVES	XV
INTENDED AUDIENCE.....	XVI
SCOPE AND FORMAT	XVI
ANALYST CREDENTIALS.....	XVIII
RELATED BCC PUBLICATIONS	XVIII
REPORTS	XVIII
MONTHLY NEWSLETTERS	XVIII
BCC ON-LINE SERVICES.....	XVIII
 EXECUTIVE SUMMARY	 XX
SUMMARY TABLE <i>GLOBAL MARKET FOR PLANT-DERIVED DRUGS, THROUGH</i>	
<i>2007 (\$ BILLIONS)</i>	XX
SUMMARY FIGURE <i>GLOBAL MARKET FOR PLANT-DERIVED DRUGS, 1999-2007</i>	
<i>(\$ BILLIONS)</i>	XX
 OVERVIEW OF PLANT-DERIVED DRUGS	 1
DEFINITION	1
WHAT IS A PLANT-DERIVED DRUG?	1
TYPES OF PLANT-DERIVED DRUGS	2
HISTORY OF PLANT-BASED DRUGS	2
HISTORY OF PLANT-BASED DRUGS (CONTINUED).....	3
ORIGINS, PROPERTIES, AND APPLICATIONS OF PLANT-	
DERIVED DRUGS	4
BOTANICAL ORIGINS OF PLANT-DERIVED DRUGS.....	5
PROPERTIES.....	5
Alkaloids	6
Central Nervous System Inhibitors and Stimulants	6
Morphine	6
Cinchona.....	6
Vinca Alkaloids	7
Terpenes.....	7
Taxol	7
Steroids.....	7
Menthol	8
Central Nervous System Depressants	8
Glycosides	8
Anthraglycosides.....	8
Cardiac Glycosides	9
Flavonoids	9
Saponins	9
Glycyrrhizin.....	9
Echinacea.....	10

Calendula Officinalis	10
Other Plant Substances.....	10
Coumarins	10
Psoralens	10
Capsaicinoids	11
Phenols	11
Tannins.....	11
Proanthocyanins	11
Anthraquinones	11
Miscellaneous Substances	12
MEDICAL APPLICATIONS.....	12
<i>TABLE 1 MEDICAL APPLICATIONS OF PLANT DERIVED DRUGS</i>	12
<i>TABLE 1 (CONTINUED)</i>	13
INDUSTRY STRUCTURE	13
PRODUCTION PROCESS.....	13
Primary Production	13
Bulk Processing and Production of Extracts	14
Formulation of Medications	15
Distribution.....	15
<i>FIGURE 1 STRUCTURE OF THE PLANT-DERIVED DRUGS INDUSTRY</i>	16
PRIMARY PRODUCERS.....	16
Commercial Growers	17
Wild-Collectors.....	17
BULK PRODUCERS.....	17
U.S.....	17
<i>TABLE 2 NUMBER OF U.S. BULK PRODUCERS OF PLANT AND OTHER</i> <i>MEDICINALS, 1997</i>	18
<i>FIGURE 2 U.S. BULK PRODUCERS OF PLANT AND OTHER MEDICINALS, 1997</i> <i>(%)</i>	18
Major Bulk Producers.....	18
<i>TABLE 3 MAJOR BULK PRODUCERS OF PLANT-BASED MEDICINALS</i>	19
Smaller Bulk Producers	19
FORMULATORS.....	20
<i>TABLE 4 MAJOR FORMULATORS OF PLANT-DERIVED DRUGS</i>	20
CHANNELS OF DISTRIBUTION	20
<i>FIGURE 3 U.S. DISTRIBUTION CHANNELS FOR PLANT-DERIVED DRUGS</i>	21
Wholesalers.....	21
Hospitals and Other Healthcare Institutions	22
<i>TABLE 5 U.S. INSTITUTIONAL DRUG DISTRIBUTION CHANNELS, 2001 (\$</i> <i>BILLIONS)</i>	22
<i>FIGURE 4 U.S. INSTITUTIONAL DRUG DISTRIBUTION CHANNELS, 2001</i> <i>(PERCENTAGE OF TOTAL INSTITUTIONAL SALES)</i>	23
Retailers.....	23
<i>TABLE 6 U.S. PRESCRIPTION DRUG RETAIL DISTRIBUTION CHANNELS, 2001</i> <i>(\$ BILLIONS)</i>	24
<i>FIGURE 5 U.S. PRESCRIPTION DRUG RETAIL DISTRIBUTION CHANNELS, 2001</i> <i>(% OF TOTAL SALES)</i>	24

OTHER PARTICIPANTS	24
Independent Research Institutions	25
U.S.	25
Other Countries	25
Regulatory Agencies	26
U.S.	26
Countries Outside the U.S.....	27
Countries with the Same Regulatory	
Requirements for All Products	28
Countries Requiring Less Stringent Evidence	
for Herbal Medicines	28
Countries with Special Regulatory	
Requirements for Herbal Medicines	29
Countries Exempting Herbal Medicines from	
Most or All Regulatory Requirements	30
METHODOLOGY AND INFORMATION SOURCES	31
COMMERCIAL DRUGS	31
FIGURE 6 MARKET PROJECTION METHODOLOGY (COMMERCIAL PRODUCTS	
AND APPLICATIONS).....	32
DEVELOPMENTAL DRUGS	32
FDA APPROVAL PROCESS	33
TABLE 7 FDA APPROVAL PROCESS FOR NEW DRUGS	33
FIGURE 7 MARKET PROJECTION METHODOLOGY (DEVELOPMENTAL	
PRODUCTS AND APPLICATIONS).....	34
MARKET SEGMENTATION	34
FIGURE 8 MARKET SEGMENTATION METHODOLOGY.....	35
MARKET SIZE, SEGMENTATION AND GROWTH TRENDS.....	36
OVERALL MARKET	36
TABLE 8 HISTORICAL AND PROJECTED GLOBAL MARKET GROWTH FOR	
PLANT-DERIVED DRUGS, THROUGH 2007 (\$ BILLIONS).....	36
FIGURE 9 HISTORICAL AND PROJECTED GLOBAL MARKET GROWTH FOR	
PLANT-DERIVED DRUGS, 1999-2007 (\$ BILLIONS)	36
MARKET COMPARISONS	37
MARKET DEFINITIONS	37
MARKET SEGMENTATION	38
SALES OF LEADING PLANT-DERIVED DRUGS.....	38
TABLE 9 PLANT-DERIVED DRUG SHARE OF TOTAL U.S. DRUG MARKET, 2001 (\$	
BILLIONS).....	38
FIGURE 10 PLANT-DERIVED DRUG SHARE OF TOTAL U.S. DRUG MARKET, 2001	
(PERCENT OF TOTAL SALES).....	39
TABLE 10 TOP TWENTY PLANT-DERIVED DRUGS WORLDWIDE, THROUGH 2007	
(\$ MILLIONS).....	39
TABLE 10 (CONTINUED).....	40
SALES OF SINGLE-ENTITY VS. HERBAL MEDICINES	40
TABLE 11 GLOBAL SALES OF SINGLE-ENTITY VS. HERBAL MEDICINES,	
THROUGH 2007 (\$ MILLIONS)	41

FIGURE 11 GLOBAL SALES OF SINGLE-ENTITY VS. HERBAL MEDICINES, 2002-2007 (% MILLIONS).....	42
SALES OF SINGLE-ENTITY DRUGS BY TYPE	42
TABLE 12 WORLDWIDE SINGLE-ENTITY DRUGS BY TYPE, THROUGH 2007 (\$ MILLIONS)	43
FIGURE 12 WORLDWIDE SINGLE-ENTITY DRUGS BY TYPE, 2002 AND 2007 (\$ MILLIONS).....	43
SALES BY MEDICAL APPLICATION	43
TABLE 13 WORLDWIDE SALES OF PLANT-DERIVED DRUGS BY MEDICAL APPLICATION, THROUGH 2007 (\$ MILLIONS).....	44
FIGURE 13 WORLDWIDE SALES OF PLANT-DERIVED DRUGS BY MEDICAL APPLICATION, 2002 AND 2007 (\$ MILLIONS).....	45
SALES BY REGION	45
TABLE 14 GLOBAL SALES OF PLANT-DERIVED DRUGS BY REGION, THROUGH 2007 (\$ MILLIONS).....	46
FIGURE 14 GLOBAL SALES OF PLANT-DERIVED DRUGS BY REGION, 2002 AND 2007 (\$ MILLIONS).....	46
DETAILED MARKET PROJECTIONS.....	47
TRENDS IN MEDICAL APPLICATIONS OF PLANT-DERIVED DRUGS.....	47
DRUGS FOR TREATING PAIN.....	48
Overall Market Trends.....	48
TABLE 15 GLOBAL MARKET FOR PAIN-RELATED DRUGS, THROUGH 2007 (\$ BILLIONS).....	48
FIGURE 15 GLOBAL MARKET FOR PAIN-RELATED DRUGS, 2002 AND 2007 (\$ BILLIONS).....	49
Evolution of Demand	49
Evolution of Demand (Continued).....	50
Market Projection	51
Market for Plant-derived Pain Remedies	51
Market For Plant-Derived Pain Remedies (Continued)	52
Drug Candidates.....	53
Marijuana-based Pain Remedies	53
Ban	53
Current Drugs	54
- GW Pharmaceuticals.....	54
FIGURE 16 TRENDS IN ANNUAL SALES OF AVERAGE NEW DRUG (\$ MILLIONS)	55
ANTI-INFECTION DRUGS	56
Overall Market Trends.....	56
TABLE 16 GLOBAL MARKET FOR ANTI-INFECTION DRUGS, THROUGH 2007 (\$ BILLIONS).....	56
FIGURE 17 MARKET FOR ANTI-INFECTION DRUGS, 2002-2007 (\$ BILLIONS).....	57
Overall Market Trends (Continued)	58
Market for Plant-derived Anti-infection Drugs.....	59
TABLE 17 MARKET FOR MAJOR PLANT-DERIVED ANTI-INFECTION DRUGS, THROUGH 2007 (\$ MILLIONS).....	60
Drug Candidates.....	60

Calanolide A.....	60
Hpatitis A/B Ativiral.....	61
Adrographolide.....	61
CANCER DRUGS.....	61
Overall Market Trends.....	61
Alkylating Agents	62
Antimetabolites.....	62
Mitotic Ihibitors	62
Antitumor Antibiotics.....	62
Other Anti-cancer Drugs	62
<i>TABLE 18 WORLD MARKET FOR CANCER-RELATED DRUGS, THROUGH 2007 (\$</i>	
<i>BILLIONS).....</i>	<i>63</i>
<i>FIGURE 18 WORLD MARKET FOR CANCER-RELATED DRUGS, 2002 AND 2007 (\$</i>	
<i>BILLIONS).....</i>	<i>63</i>
Market for Plant-derived Anti-Cancer Drugs	64
Market for Plant-derived Anti-Cancer Drugs	
(Continued)	65
<i>TABLE 19 GLOBAL MARKET FOR MAJOR PLANT-DERIVED MITOTIC ANTI-</i>	
<i>CANCER DRUGS, THROUGH 2007 (\$ MILLIONS).....</i>	<i>66</i>
Drug Candidates.....	66
DERMATOLOGICAL TREATMENTS.....	67
Overall Market Trends.....	67
<i>TABLE 20 GLOBAL MARKET FOR DERMATOLOGICAL DRUGS, THROUGH 2007</i>	
<i>(\$ BILLIONS).....</i>	<i>68</i>
<i>FIGURE 19 GLOBAL MARKET FOR DERMATOLOGICAL DRUGS, 2002 AND 2007</i>	
<i>(\$ BILLIONS).....</i>	<i>68</i>
Overall Market Trends (Continued)	69
Market for Plant-derived Dermatological Drugs	70
Glucocortisoids	70
Aloe	70
Psoralen.....	70
Others.....	71
<i>TABLE 21 GLOBAL MARKET FOR MAJOR PLANT-DERIVED DERMATOLOGICAL</i>	
<i>DRUGS, THROUGH 2007 (\$ MILLIONS).....</i>	<i>71</i>
Drug Candidates.....	72
CARDIOVASCULAR DRUGS	72
Overall Market Trends.....	72
<i>TABLE 22 GLOBAL MARKET FOR CARDIOVASCULAR DRUGS, THROUGH 2007 (\$</i>	
<i>BILLIONS).....</i>	<i>73</i>
<i>FIGURE 20 GLOBAL MARKET FOR CARDIOVASCULAR DRUGS, 2002 AND 2007 (\$</i>	
<i>BILLIONS).....</i>	<i>73</i>
Market for Plant-derived Cardiovascular Drugs	74
<i>TABLE 23 GLOBAL MARKET FOR MAJOR PLANT-DERIVED CARDIOVASCULAR</i>	
<i>DRUGS, THROUGH 2007 (\$ MILLIONS).....</i>	<i>75</i>
<i>TABLE 23 (CONTINUED).....</i>	<i>76</i>
Drug Candidates.....	76
GASTROINTESTINAL DRUGS.....	77
Overall Market Trends.....	77

<i>TABLE 24 GLOBAL MARKET FOR GASTROINTESTINAL DRUGS, THROUGH 2007</i> <i>(\$ BILLIONS)</i>	77
<i>FIGURE 21 GLOBAL MARKET FOR GASTROINTESTINAL DRUGS, 2002 AND 2007</i> <i>(\$ BILLIONS)</i>	78
Market for Plant-derived Gastrointestinal Drugs	79
<i>TABLE 25 GLOBAL MARKET FOR MAJOR PLANT-DERIVED</i> <i>GASTROINTESTINAL DRUGS, THROUGH 2007 (\$ MILLIONS)</i>	80
Drug Candidates.....	81
RESPIRATORY DRUGS.....	81
Overall Market Trends.....	81
<i>TABLE 26 GLOBAL MARKET FOR RESPIRATORY DRUGS, THROUGH 2007 (\$</i> <i>BILLIONS)</i>	82
<i>FIGURE 22 GLOBAL MARKET FOR RESPIRATORY DRUGS, 2002 AND 2007 (\$</i> <i>BILLIONS)</i>	82
Market for Plant-derived Respiratory Drugs	83
Market for Plant-derived Respiratory Drugs (Continuedd)	84
<i>TABLE 27 GLOBAL MARKET FOR MAJOR PLANT-DERIVED RESPIRATORY</i> <i>DRUGS, 2002 AND 2007 (\$ MILLIONS)</i>	85
Drug Candidates.....	86
HORMONES	86
<i>TABLE 28 GLOBAL MARKET FOR PLANT-DERIVED HORMONES, 2002-2007 (\$</i> <i>MILLIONS)</i>	86
Contraception.....	86
Overall Market Trends	86
Market for Plant-derived Contraceptives	87
Hormone Replacement Therapy	87
Overall Market Trends	87
Market For Plant-derived Hormone Replacements	88
OTHER PLANT-DERIVED DRUGS.....	88
<i>TABLE 29 MARKET FOR OTHER PLANT-DERIVED DRUGS, THROUGH 2007 (\$</i> <i>BILLIONS)</i>	89
Galamanthine	89
Ginkgo Biloba	89
L-Dopa.....	90
Prunus Africanus.....	90
Saw Palmetto.....	90
St. John's Wort.....	91
Milk Thistle.....	91
Valerian.....	91
TRENDS IN SALES OF SINGLE-ENTITY VS. HERBAL DRUGS.....	91
<i>TABLE 30 MARKET FOR SINGLE-ENTITY VS. HERBAL DRUGS, 2002-2007 (\$</i> <i>MILLIONS)</i>	92
TRENDS IN SALES OF DIFFERENT TYPES OF DRUGS.....	92
<i>TABLE 31 MARKET FOR SINGLE-ENTITY DRUGS BY TYPE OF DRUG, 2002-2007</i> <i>(\$ MILLIONS)</i>	93
TRENDS IN SALES OF PLANT-DERIVED DRUGS BY REGION.....	93

TABLE 32 DRUG EXPENDITURES BY GEOGRAPHICAL MARKET, 2002-2007 (\$ MILLIONS) 94

OTHER PLANT-DERIVED DRUGS INDUSTRY DEVELOPMENTS	95
TECHNICAL DEVELOPMENTS	95
CULTIVATION	95
EXTRACTION	95
PLANT PART SUBSTITUTION	96
PLANT CELL CULTURE.....	97
MOLECULAR FARMING	98
Issues.....	99
Solutions	99
Other Impediments	99
ENVIRONMENTAL TRENDS.....	100
HABITAT DESTRUCTION	100
PRESERVATION LEGISLATION	100
BIOPHARMING	101
LEGAL/REGULATORY DEVELOPMENTS	101
INTERNATIONAL TREATIES AND LEGISLATION.....	101
The Convention on International Trade in Endangered Species (CITES).....	102
The World Heritage Convention	103
The Convention on Biological Diversity	104
The Cartagena Protocol	105
The Precautionary Principle	105
Biopharming.....	106
NATIONAL LEGAL/REGULATORY FRAMEWORKS.....	106
Endangered Species and Biodiversity	106
U.S.	106
Endangered Species Act and CITES	106
Issues.....	107
Convention on Biodiversity	107
European Union	107
CITES.....	108
Convention on Biodiversity	108
Brazil	108
The National Environmental Policy.....	108
Conservation Units	109
Issues.....	109
Drug Safety	110
International Standardization	110
INDUSTRY STRUCTURE	111
MARKET LEADERS	111
SALES AND MARKET SHARES	111

<i>TABLE 33 PLANT-DERIVED DRUG SALES BY LEADING DRUG COMPANIES, 2001</i>	111
<i>TABLE 33 (CONTINUED)</i>	112
<i>TABLE 34 LEADING PLANT-DERIVED DRUG COMPANIES' ESTIMATED MARKET</i>	
<i>SHARES, 2001 (\$ BILLIONS, %)</i>	112
INTELLECTUAL PROPERTY	113
Bioprospecting	113
OTHER COMPANIES TO WATCH	114
EPICYTE PHARMACEUTICAL, INC.	114
OXFORD NATURAL PRODUCTS PLC.....	115
PHYTOMEDICS, INC.....	115
PHYTON, INC.....	116
PHYTOPHARM PLC	116
PRODIGENE, INC.....	117
SHAMAN PHARMACEUTICALS, INC.....	117
Shaman Pharmaceuticals, Inc. (Continued).....	118
CONCLUSION.....	119
PLANT-DERIVED DRUGS AT A CROSSROADS	119
Patent Protection/Intellectual Property Issues	119
Patent Revocation	120
TRIPS	120
U.S. Market.....	120
INCREASING DIFFICULTY OF BIOPROSPECTING	120
OTHER REGULATORY CHALLENGES	121
ALTERNATIVE DRUG DISCOVERY PLATFORMS	121
LACK OF KNOWLEDGE ABOUT PLANT-DERIVED DRUGS	122
OBSTACLES TO START-UP FIRMS	122
APPENDIX: ORIGINS AND PROPERTIES OF PLANT-DERIVED DRUGS.....	123
ORIGINS AND PROPERTIES OF PLANT-DERIVED DRUGS	
(CONTINUED)	124
ORIGINS AND PROPERTIES OF PLANT-DERIVED DRUGS	
(CONTINUED)	125
ORIGINS AND PROPERTIES OF PLANT-DERIVED DRUGS	
(CONTINUED)	126
ORIGINS AND PROPERTIES OF PLANT-DERIVED DRUGS	
(CONTINUED)	127