UNDERSEA AND HYPERBARIC MEDICAL SOCIETY, INC. 10531 Metropolitan Avenue Kensington, MD 20895-2627 (301) 942-2980

DIVING PHYSIOLOGY IN PLAIN ENGLISH

JOLIE BOOKSPAN, Ph.D.





CONTENTS

REVIEWERS	iii	
PREFACE INTRODUCTION TO THE READER	v	
CHAPTER I DECOMPRESSION TABLES AND COMPUTERS	1	
PART I - BRIEF REVIEW OF PRESSURE Ambient Pressure, 2 How Nitrogen Gets In and Out Of Your Body, 3	2	
PART II - WHERE DECOMPRESSION TABLES AND COMPUTERS COME FROM History, 5 Modern Practice, 6 What Decompression Tables and Computers Calculate, 6	5	
PART III - BASIC TERMS AND CONCEPTS Compartments, 8 Partial Pressure, 10 Nitrogen Tension, 12 Half-times, 14 Fast and Slow Compartments, 17 Saturation and Desaturation, 19 Saturation Diving, 20 Supersaturation, 21 Supersaturation Ratios, 21 M-Values, 22 Table-Based and Model-Based Computers, 23	8	
PART IV - NON-HALDANE DECOMPRESSION MODELS Statistical Models, 24 Series Model, 25 EL Model, 27 Slab Model, 27 Varying Permeability Model, 28 Reduced Gradient Bubble Model, 28	24	

PART V - DIVING WITH GASES OTHER THAN AIR Oxygen Enriched Air, 29 Heliox, 31 Trimix, 32 Gas Switching, 33	29	
CONCLUSION	34	
CHAPTER 2 IMMERSION EFFECTS	35	
PART I - DIVE REFLEX What Is The Dive Reflex? 36 Different In Humans and Marine Animals, 37 Role In Humans, 37 Individual Variation, 38 Mechanisms, 38 Preventing Problems From The Dive Reflex, 40 Summary, 42	36	
PART II - THE P PHENOMENON Why Does It Occur? 43 Mechanical Factors, 44 Chemical Factors, 45 Environmental Factors, 46 Personal Factors, 47 Factors Unknown, 47 Handling Diuresis, 49 Rehydrating Underwater, 50 Summary, 51	43	
CHAPTER 3 DIVING IN COLD AND HEAT	53	
PART I -WHY DO YOU GET COLD? How You Lose Heat, 54 Key Concept In Heat Transfer, 57 Skin Temperature and Core Temperature Are Different, 57 How You Conserve Core Heat, 58 How You Gain Body Heat, 60 Summary, 63	54	
PART II - SUSCEPTIBILITY TO COLD What Is Hypothermia (and What Is It Not)? 64 Body Size and Shape, 65 Age, 67 Behavior, 67 Medication, 67 Rest and Exercise, 67	64	

Physical Fitness, 68 Protective Clothing, 68 Gender, 69 Acclimatization, 69 Other Influences, 70 Summary, 71		
PART III - EFFECTS OF DIVING IN THE COLD Respiratory Effects, 72 Vascular Effects, 72 Manual Impairment, 73 Mental Function, 74 Cardiovascular Effects, 74 Metabolic Effects, 74 Renal Effects, 74 Thermostat Effects, 75 Fatigue, 75 Nitrogen Effects, 75 Preventing Cold Injury, 76 Summary, 78	72	
PART IV - DIVING IN THE HEAT Environmental Variables, 79 Human Variables, 80 Shirts or Skins? 82 Preventing Heat Injury, 83 Summary, 84	79	
CHAPTER 4 GENDER FACTS AND FOLKLORE	85	
PART I - ISSUES SPECIFIC TO MEN Penile and Testicular Implants, 86 Infertility, 87 Offspring Gender, 87 Hair Restoration, 87	86	
PART II - ISSUES SPECIFIC TO WOMEN Pregnancy, 89 Oral Contraceptives, 89 Breast Implants, 89	89	
PART III - ISSUES AFFECTING BOTH WOMEN AND MEN Work Load, 91 Diving Accidents, 93 Cardiovascular Health, 93 Spontaneous Pneumothorax, 94 Flexibility and Joint Injury, 94 Joint Structure and Injury, 94 Diver's Acne, 95 Back Pain, 95 Overweight, 96	91	

Eating Disorders, 97 Anabolic Steroids and Steroid Substitutes, 98 Air Consumption, 98 Slipping Weight Belt, 99 Hernia, 99		
PART IV - THE FOLKLORE Decompression Sickness, 100 Hypothermia, 101 Hyperthermia, 103 Dehydration, 104 Drag, 105 Sharks, 105	100	
CONCLUSION	106	
CHAPTER 5 DIVING INJURIES	10	
PART I - LUNG INJURIES Breath-hold Injury, 108 Pneumothorax, 109 Bronchitis, 110 Emphysema, 111 Asthma, 111 Pneumonia, 111 Preventing Diving Lung Injury, 112	108	
PART II - DECOMPRESSION SICKNESS How Decompression Sickness Occurs, 113 Where Are The Bubbles? 114 Mechanical Effects Of DCS, 115 Biochemical Effects Of DCS, 116 Where Do Bubbles Hurt You? 116 Is It DCS or AGE? 118 Factors Affecting Risk of Decompression Sickness, 119 Bubbles Not All Bad? 121 Preventing Decompression Sickness, 121 Summary, 122	113	
PART III - OXYGEN TOXICITY Defenses Against Oxygen, 123 Free Radicals, 125 Pulmonary O ₂ Toxicity, 126 Central Nervous System (CNS) O ₂ Toxicity, 127 An Intriguing Twist, 127 When Is O ₂ Toxic? 127 Susceptibility to Oxygen Toxicity, 129 Treating Oxygen Toxicity, 130 Preventing Oxygen Toxicity, 130 Summary, 131	123	

Diving Physiology In Plain English • xi

PART IV - DIVING HEADACHES Does Diving Cure A Headache? 133 Does Diving Cure A Hangover? 133 Does Diving Cause A Headache? 134	133
Preventing Headaches, 136 PART V - SWIMMER'S EAR What Is Swimmer's Ear? 138 Symptoms, 138 Causes, 138 Treating Swimmer's Ear, 140 Preventing Swimmer's Ear, 141 PART VI - MARINE STINGS Poison and Venom, 142 Why Do They Sting Us? 142	138 142
What Happens When They Sting Us? 143 Treating Stings, 144 Preventing Stings, 146	
CHAPTER 6	147
PART I - FAT'S NOT ALL BAD When Fat Helps In Sports, 148 When Fat Hinders Sports, 148 What About Diving? 148	148
PART II - WHY SHOULD DIVERS GET FIT? Increased Heat Tolerance, 150 Increased Cold Tolerance, 150 Better Health, 151 Diving Safety, 151 Injury Reduction, 151 Delayed Aging, 152 Positive Mood, 152 Fat Loss, 153 Summary, 153	150
PART III - ASPECTS OF FITNESS What Is Fitness? 154 Why Different Aspects Of Fitness? 154 What Are The Different Aspects Of Fitness? 155	154
Summary, 156 PART IV - HOW TO GET FIT Cardiovascular Endurance, 157 Anaerobic Capacity, 158 Strength, 158 Muscular Endurance, 160	157

Power, 160 Flexibility, 161 Size, 163 Firm, 163 Can You Have It All? 163 Summary, 164	
PART V - TAILORING FITNESS FOR DIVING Results Are Specific To The Exercise, 165 Don't Worry About Being Exact, 165 Some Exercises Are Counterproductive, 166 Getting In Shape For Diving, 166 Summary, 167	165
PART VI - GETTING OUT OF SHAPE AND HOW TO AVOID IT How To Get Out Of Shape, 168 What Goes Bad? 169 How Long Does It Take? 170 Does It Hurt? 170 Preventing Getting Out Of Shape, 171 Summary, 171	168
CHAPTER 7 NUTRITION FOR DIVERS	172
PART I - DIVERS AND DIETING Poor Food Habits, 173 Dehydration, 174 Fatigue, 174 Reduced Cold Tolerance, 174 Possible Risk of Heart Disease, 174 Summary, 175	173
PART II - HOW TO LOSE WEIGHT WITHOUT DIETING Cut Fats, 176 Substitute, 176 Don't Go Hungry, 177 Less Sugar, 177 Be Prepared, 177 Take Your Time, 177 More Physical Activity, 177 Summary, 178	176
PART III - BONE HEALTH What Is Osteoporosis? 180 Why Young Divers Need to Know, 181 Factors Affecting Risk, 181 Where Diving Fits In, 182 How Much Calcium Do You Need? 182 Calcium Sources, 182 Preventing Osteoporosis, 183 Summary, 183	180

PART IV - FLUID REPLACEMENT FOR DIVERS Why Not Dehydrate? 185 How You Lose Body Water, 186 How You Conserve Body Water, 187 Why Replacement? 187 Water, 187 Electrolyte Replacers, 188 Carbohydrate Loaders, 189 Carbohydrate Replacers, 190 Not Harmful To Divers, 191 Alcohol, 193 Caffeine, 194 Preventing Dehydration, 194 Summary of Fluid Replacement Options, 194	185
ANNOTATED GLOSSARY	197
APPENDIX PRESSURE CONVERSIONS	231
FIGURES	233
INDEX	235