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Preface

The human gastrointestinal tract microorganisms, termed the “microbiota,” have been investigated since the beginning of microbiological studies, when Anthonie van Leeuwenhoek investigated the microorganisms in his own stools. The human microbiota comprises trillions of microbes distributed in various niches throughout the intestinal tract and is one of the most complex microbial ecosystems on earth. The host and its microbiota have co-evolved together, and considering the staggering numbers and diversity, it is therefore not surprising that the microbiota exert a major influence on the host. The original term for the microbiota upon discovery was the “flora” or “microflora,” literally translated as “small plants,” which has a botanical connotation. These terms are still used widely today and internationally recognized. Nevertheless, it is considered more appropriate to use the term microbiota, i.e., “small life” taking into account that the microbiota is predominately comprised of bacteria, a smaller number of yeasts, and some protozoa; hence, this term is used throughout this book. With this book, we have made an attempt to cover all issues associated with the gastrointestinal microbiota, from health to disease and from sampling to identification. Although various books have addressed the intestinal microbiota, this has mainly been from the perspective of disease or nutrition, while the microbiota itself has rarely been the focus. This current book aims to fill this gap and provide the reader with a comprehensive overview of all aspects related to the gastrointestinal microbiota. There have been major scientific advances especially in human intestinal microbiology in the recent past, which are also covered by the contributions.

Early studies were limited to description of the culturable microbes, which as we now realize, made up only a minority of the gastrointestinal tract microbiota. Due to the development of molecular biological techniques over the last decade, microbes can now be detected and studied to a large extent, without the need for culturing. In the first chapter, Kaouther Ben Amor and Elaine Vaughan review the major achievements of recent times in determining the diversity of the microbiota using modern molecular techniques, based on 16S ribosomal RNA, as well as methods to evaluate their activity within the various niches. Research of the gastrointestinal tract microbiota, especially in the case of humans, is often restricted to fecal material. In fact, a range of other sampling techniques are available, which are presented by Angelé Kerckhoffs and colleagues, to access the small intestine, as well as noninvasive sampling methods that are routinely used in medical practice. This is an important issue since feces represent only the luminal material of the terminal colon and will provide insufficient information about other locations of the gut. Anne McCartney and Glenn Gibson describe the succession of the microbiota in infants, as well as the earlier culturing studies, and the methodology to characterize the microbiota

151 down to subspecies level. It has long been recognized that the intestinal microbiota plays
152 an important role in maintaining health in infants. Currently, much attention is also
153 focused on the intestinal microbiota of the elderly, as is discussed in the chapter by Fang
154 He. In western nations, the elderly are becoming an increasingly important segment of the
155 population, and it is becoming increasingly established that intestinal health has a major
156 role in their quality of life.

157 While establishing the microbiota diversity and their activity (live versus dead) is a
158 major challenge, it is essential to know and understand their effects on the host. The
159 intestinal microbiota has a major influence on the development and maintenance of our
160 immune system as described by Marie-Christiane Moreau. Because of their direct contact
161 with the host, the activity and interaction of the microbiota with the intestinal mucosa may
162 be more important than the activity of microbes in the lumen, as described by Wai Ling
163 Chow and Yuan-Kun Lee. The human microbiota also play a major role in our nutrition.
164 Barry Goldin reviews the myriad of metabolic possibilities of the human microbiota
165 concerning the metabolism of food ingredients and drugs we consume, as well as host-
166 derived substrates. Max Bingham focuses on the metabolism by the microbiota of
167 polyphenols, which are considered to be key active constituents of fruits and vegetables
168 and responsible for many of the health protective effects of diets rich in these foods.
169 Today, functional genomics technologies are developing and will facilitate our ability to
170 detect the microbes and determine the molecular mechanisms of their impact on the host.
171 Through the sequencing of an ever-increasing number of microbiota genomes, and elegant
172 molecular studies, a further understanding is being obtained into the molecular functioning
173 of the host-microbiota interactions, a dynamic area that is discussed by Peter Bron,
174 Michiel Kleerebezem, and Willem de Vos.

175 In the past, the gastrointestinal tract microbiota has received attention in particular in
176 relation to disease. Fergus Shanahan, Barbara Sheil, and coworkers review the relationship
177 between the intestinal microbiota and inflammatory bowel diseases, as well as give an
178 overview of the probiotic clinical trials and the potential mechanisms of probiotics for
179 ameliorating these intestinal diseases. Through its metabolism, the intestinal microbiota is
180 thought to play an important role in both the etiology and prevention of colorectal cancer,
181 as discussed by Patricia Heavey, Ian Rowland, and Joseph Rafter. In addition to diseases
182 of the gastrointestinal tract, Pirkka Kirjavainen and Gregor Reid also discuss that diseases
183 such as allergy are being recognized to have an “intestinal component,” again mediated
184 through the interaction between the microbiota and the intestinal immune system.

185 In order to gain a better understanding of the composition and functioning of the
186 intestinal microbiota and how this can be influenced, intestinal models have been
187 developed; this allows for a simplification of the complex intestinal ecosystem as presented
188 by Harri Mäkivuokko and Päivi Nurminen. For our understanding, experimental animals
189 have been and are indispensable, as described by Anders Henriksson, especially with the
190 availability of various knockout animal models for disease. Also the use of animals with
191 a “human” microbiota provide valuable models to investigate the influence of substances on
192 the microbiota and host physiology. The best animal models to show the importance of
193 the intestinal microbiota are germ-free animals. Their physiological differences compared
194 to conventional animals are striking and show clearer than any other model the role
195 intestinal microbes play, as discussed by Elisabeth Norin and Tore Midtvedt. Because of its
196 influence on the health and well being of the host, strategies have been devised to alter the
197 composition and/or activity of the intestinal microbiota. Antibiotics have long been known
198 to alter the composition of the intestinal microbiota, as discussed by Åsa Sullivan and Carl
199 Erik Nord, which may lead to various side effects, depending on the activity spectrum of the
200 antibiotic. Methods to improve the activity and composition of the intestinal microbiota

201 include probiotics, microbes ingested orally that provide beneficial effects, and prebiotics
202 substrates that are selectively metabolized by the beneficial native gastrointestinal tract
203 microbes, as discussed in the chapters by Chandraprakash Khedkar and Arthur Ouwehand,
204 and Ross Crittenden and Martin Playne, respectively.

205 The major part of the book deals with the microbiota of humans, and when animals
206 are studied, it is often as a model for humans. Minna Rinkinen describes the microbiota of
207 companion animals, an area that has received very little attention to date, although the
208 well being of pets can contribute significantly to the well being of the owner. In the case of
209 farm animals, discussed by Alojz Bomba and colleagues, there is an important economic
210 drive where the role of the microbiota on performance is a major focus. This will only
211 become more important from 2006 onward as antimicrobial growth promoters will be
212 prohibited in the European Union.

213 We are most grateful to the authors who have been willing to share their knowledge
214 and experience in their field of intestinal microbiology. They are all busy researchers
215 and yet they committed themselves to writing these chapters. It has been a pleasure to
216 cooperate with these experts for the production of this book. Together their excellent
217 contributions provide state-of-the-art research on the human intestinal microbiology, as
218 well as informative chapters about the animal microbiota for comparative purposes. Elaine
219 Vaughan also acknowledges the staff and colleagues of Unilever Research and
220 Development, Vlaardingen, Laboratory of Microbiology, Wageningen University, and
221 Wageningen Center of Food Sciences, for inspiring discussions on intestinal micro-
222 biology. Arthur Ouwehand similarly acknowledges the support and inspiration from the
223 colleagues at Danisco Innovation and the Functional Foods Forum, University of Turku.
224 We hope all readers will share our excitement for this dynamic subject that impacts on all
225 our lives.

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