

Contents

0. Prolegomenon	11
1. Preliminary considerations	
1.1. Stochastic and deterministic models in biology	15
1.1.1. Comparisons with deterministic models	15
1.1.2. Equipollent and conjunct models	18
1.2. The structure of biological populations	21
1.2.1. Elements of bio-logic	21
1.2.2. Distinguishability and indistinguishability	23
1.2.3. Equivalence relations and graphs	24
1.2.4. Descendants, generations and families	27
1.2.5. The temporal structure of populations and biological objects	30
1.2.6. Characteristic distributions for some biological populations	35
2. Population growth models	
2.1. Stochastic population processes	41
2.1.1. Point processes as models of stochastic populations	41
2.1.2. Homogeneous birth-and-death processes	44
2.1.3. A random walk example	46
2.1.4. Birth, death and diffusion processes	50
2.2. Population processes in Euclidean space	53
2.2.1. Homogeneous spatial models	53
2.2.2. Birth, death and migration processes in R^2 and R^3	55
2.3. Intrinsic processes	59
2.3.1. Multiple-phase processes	59
2.3.2. The life cycle process	68
2.3.3. The birth, death and marks transmission process	74
2.3.4. Interdependent (self)-replicating process	78
2.3.5. Point mutation processes	84
2.4. Stochastic demographic models	97
2.4.1. The discrete time model	97
2.4.2. A model related to human populations	103
2.4.3. Population growth of the sexes	106

2.4.4. The reproductive process	110
2.5. Other growth models and derived processes	118
2.5.1. The cumulative process	118
2.5.2. The Prendiville (logistic) process	120
2.5.3. Some problems of survival and extinction	123
3. Population dynamics processes	
3.1. Some multi-dimensional Markov jump processes	127
3.1.1. Consuel processes	127
3.1.2. A generalized n -dimensional ($n \geq 2$) linear growth process	133
3.2. Immigration-emigration processes	134
3.2.1. The Kendall process	134
3.2.2. Immigration and emigration processes	136
3.2.3. Intermigration and colonization	141
3.2.4. Taxis and kinesis as dispersion processes	144
3.3. Competition processes	148
3.3.1. Some introductory remarks	148
3.3.2. Stochastic competition processes	151
3.3.3. Quasi-competition processes	155
3.3.4. Population excess and cannibalism	157
3.4. Poikilopoiesis models	163
3.4.1. A stochastic approach to embryogenesis	163
3.4.2. Hematopoiesis models	165
4. Evolutionary processes	
4.1. Basic problems, models and methods	170
4.1.1. Paradigm for the stochastic evolutionary processes	170
4.1.2. Classical genetic stochastic models	178
4.1.3. Tendency to homozygosity	185
4.1.4. Diffusion approximations	188
4.1.5. Non-Mendelian situations	191
4.1.6. Direct product Galton-Watson chains	193
4.2. Random drift and systematic evolutionary processes	201
4.2.1. Random drift	201
4.2.2. Selection	203
4.2.3. Mutation	204
4.3. Problems of molecular genetics	206
4.3.1. Growing point of donor DNA attachment model	206
4.3.2. An example of a random system with complete connections	209

5. Models in physiology and pathology	
5.1. Stochastic models in physiology	213
5.1.1. Models of the appearance and the transmission of the neural flux	213
5.1.2. Chemical mediation processes	217
5.1.3. Some problems of stochastic networks	221
5.1.4. A model of muscle contraction	224
5.1.5. Renewal processes in pharmacology	228
5.1.6. Multicompartment systems	231
5.2. Models in pathology	234
5.2.1. The process of infection	234
5.2.2. The clinical process	240
5.2.3. Stochastic models for tumour growth	247
5.2.4. Some stochastic aspects of chemotherapy	253
5.2.5. Competing risks of illness	254
5.2.6. Control of biological processes	257
5.3. Epidemic processes	262
5.3.1. The classical models	262
5.3.2. A general approach to epidemics	269
5.3.3. Epidemic Markov chains	272
References	278
Notation index	323
Subject index	325
Author index	331