

Contents

1. Introduction	1
Why study evolution?	1
The map of evolution	3
Pillars of evolution	5
2. Mechanics	13
Overview	13
Introduction: the scale of mechanism	14
Random change	15
Systematic change	19
Quantitative inheritance: a full understanding of mechanics must include an assessment of polygenic traits	27
Interactions among genes and traits: trade-offs and constraints shackle adaptive evolution	31
Plasticity: malleable responses are adaptive solutions to varying environments	34
A challenge to the genetical theory of adaptive evolution: can developmental and behavioural plasticity force genes to follow traits?	40
Mechanics of population growth and decline	48
The limits of mechanics: mechanics, though essential, is an insufficient explanation for evolution	49
Reflection	50
3. Function	53
Overview	53
Introduction: where traits meet the environment	54
The fitness-mapping function	60
Fitness sets and the fitness-generating function	62
The adaptive function	66
Mappings	75
Multiple traits	80
Optimal trait values	83
Reflection	86
4. Structure	89
Overview	89
Introduction: mapping traits onto fitness	90
Traits and function	91

Traits, states, and strategies	98
Optimization	103
Constraints and reinforcement	111
Structure at different scales	116
The structure matrix	118
Where traits fail to map onto function	133
Reflection	135
5. Scale	137
Overview	137
Introduction: backward-looking adaptation	138
Shortcuts in modelling evolution	142
Size and allometry	144
Grain: how the scale of environment influences evolution	146
Multi-level adaptation	167
Prescriptions: avoiding the fallacies of simplicity and complexity	172
Reflection	176
6. Dynamics	179
Overview	179
Introduction	180
Growth and decline	182
Density dependence and demography	183
Adaptive dynamics and the G-function	187
The adaptive landscape	191
Evolutionary branching	194
Red Queen dynamics	198
Spatial dynamics	200
Bet-hedging	203
Trophic interactions	206
Reflection	214
7. Adaptation	217
Overview	217
Introduction: explanations for life	218
The possible, the ephemeral, and the feasible	238
Epiphenomena: where are the trees?	241
Maladaptation: lost expectations or promised success?	244
Reflection: the thread of evolution	247
References	249
Index	265