CONTENTS

List of Figures ............................................................... xi
Foreword ................................................................. xiii

CHAPTER 1 ................................................................. 1
  1.1 Prologue ........................................................... 1
  1.2 Summary .......................................................... 10
  1.3 References ........................................................ 10

CHAPTER 2 ................................................................. 11
  2.1 A Journey into the Demographic Heart of the Matter .... 11
  2.2 The Shape of World Population Growth .................... 18
  2.3 The Emergence of Infertility .................................. 19
  2.4 Longevity, Population Momentum and Migration ....... 22
    2.4.1 Longevity .................................................. 22
    2.4.2 Longevity, Affluence and Infant Mortality .......... 24
    2.4.3 GDP and Health: Mixed Blessings .................... 26
    2.4.4 Population Momentum .................................. 29
    2.4.5 The Key Role Played by Migration .................... 32
    2.4.6 Can China and India Save Us? ......................... 37
    2.4.7 Can Africa Save Us? .................................... 39
  2.5 Forecasting an Uncertain Future ............................ 45
  2.6 Summary .......................................................... 51
  2.7 References ........................................................ 52

CHAPTER 3 ................................................................. 54
  3.1 Female Fertility: Hostage to Affluence, Age and the Search for Self-Fulfilment 54
    3.1.1 The Ascent of Affluence ................................ 54
    3.1.2 Affluence, Infertility and the Malthusian Paradox ... 60
    3.1.3 Examples of Prosperity’s Power ....................... 62
  3.2 The Demographic Transition .................................. 67
  3.3 Socioeducational Factors and Fertility ...................... 71
<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.1 Educational Drivers for Female Infertility</td>
<td>74</td>
</tr>
<tr>
<td>3.3.2 Female Education and Marriage</td>
<td>80</td>
</tr>
<tr>
<td>3.4 The Intersection of Education and Reproductive Biology</td>
<td>84</td>
</tr>
<tr>
<td>3.4.1 The Fundamental Biology of Female Reproduction</td>
<td>84</td>
</tr>
<tr>
<td>3.4.2 Age of Menarche</td>
<td>85</td>
</tr>
<tr>
<td>3.4.3 The Reproductive Years: Over Before You Know It</td>
<td>88</td>
</tr>
<tr>
<td>3.5 How the Immaturity of Human Infants Shapes Our Reproduction</td>
<td>90</td>
</tr>
<tr>
<td>3.6 Reproduction and the Care of Our Offspring</td>
<td>92</td>
</tr>
<tr>
<td>3.6.1 What is the Point of Granny and Grandad?</td>
<td>92</td>
</tr>
<tr>
<td>3.7 Marriage: Virtue or Vestige?</td>
<td>94</td>
</tr>
<tr>
<td>3.8 Importance of Adequate Sex Education</td>
<td>100</td>
</tr>
<tr>
<td>3.8.1 ‘Why Have My Eggs Forsaken Me?’</td>
<td>101</td>
</tr>
<tr>
<td>3.9 Chromosomal Abnormalities and Female Infertility</td>
<td>105</td>
</tr>
<tr>
<td>3.10 The IVF Industry and Maternal Age</td>
<td>109</td>
</tr>
<tr>
<td>3.11 Are There Any Solutions to Age-Dependent Female Infertility?</td>
<td>113</td>
</tr>
<tr>
<td>3.11.1 Oocyte Donation</td>
<td>113</td>
</tr>
<tr>
<td>3.11.2 Oocyte Freezing</td>
<td>115</td>
</tr>
<tr>
<td>3.12 Sociopolitical Issues</td>
<td>116</td>
</tr>
<tr>
<td>3.12.2 A Role for Pro-Natalist Government Policies?</td>
<td>121</td>
</tr>
<tr>
<td>3.13 Summary</td>
<td>125</td>
</tr>
<tr>
<td>3.14 References</td>
<td>128</td>
</tr>
<tr>
<td>CHAPTER 4</td>
<td></td>
</tr>
<tr>
<td>4.1 What is Happening to the Human Male?</td>
<td>132</td>
</tr>
<tr>
<td>4.2 Testicular Cancer</td>
<td>132</td>
</tr>
<tr>
<td>4.3 Cancer and Opulence</td>
<td>137</td>
</tr>
<tr>
<td>4.4 Other Defects of the Male Reproductive Tract</td>
<td>144</td>
</tr>
<tr>
<td>4.5 The Vexed Question of Declining Sperm Counts</td>
<td>145</td>
</tr>
<tr>
<td>4.6 Possible Causes of Declining Sperm Counts</td>
<td>152</td>
</tr>
<tr>
<td>4.6.1 Genetics</td>
<td>152</td>
</tr>
<tr>
<td>4.6.2 Epigenetics</td>
<td>153</td>
</tr>
<tr>
<td>4.6.3 Environmental and Lifestyle Factors</td>
<td>154</td>
</tr>
<tr>
<td>4.7 Environmental Pollution and Semen Quality</td>
<td>159</td>
</tr>
</tbody>
</table>
# Contents

4.8 Falling Testosterone Levels and Semen Quality 165  
4.9 Summary 170  
4.10 References 172  

CHAPTER 5 180  
5.1 The Miracle of Conception 180  
5.1.1 The Human Spermatozoon 180  
5.1.2 The Timing of Insemination 183  
5.1.3 The Ripening of Spermatozoa in the Female Tract 186  
5.1.4 The Complexity of Fertilization 190  
5.2 Summary 200  
5.3 References 200  

CHAPTER 6 203  
6.1 Why Are Men Infertile? 203  
6.1.1 Hamsters and Human Sperm Function 206  
6.2 Oxidative Stress and the Infertile Male 211  
6.2.1 Reactive Oxygen Species 212  
6.2.2 Thaddeus Mann and Oxidative Stress 215  
6.2.3 Oxidative Stress and DNA Damage 219  
6.2.4 Oxidative Sperm DNA Damage and Mutations in Our Children 220  
6.3 Genetic Causes of Male Infertility 225  
6.3.1 Y-Chromosome Deletion 225  
6.3.2 Other Genetic Causes 229  
6.4 Summary 232  
6.5 References 233  

CHAPTER 7 238  
7.1 The Janus Faces of IVF 238  
7.1.1 Steptoe, Edwards and Purdy: The Development of IVF 238  
7.1.2 ICSI and Male Infertility 245  
7.1.3 The rise of ICSI 247  
7.2 Consequences of ART When Conducted at Scale 254  
7.3 Negative Impacts of IVF on the Mutational Load Carried by Children 258  
7.4 Impact of Assisted Conception on Fertility 261  
7.5 Summary 262  
7.6 References 264
# CONTENTS

## CHAPTER 8

8.1 The Gathering Storm  
8.2 The Infertility Trap  
8.2.1 Demographic Factors  
8.2.2 Social Factors  
8.2.3 Economic Factors  
8.2.4 Environmental Factors  
8.2.5 Evolutionary Factors  
8.3 Summary  
8.4 References  

## CHAPTER 9

9.1 How Do We Escape the Trap?  
9.2 Sex Education  
9.3 Remove Reproductive Toxicants  
9.4 Counter Oxidative Stress  
9.5 Elevate the Status of Reproductive Toxicology  
9.6 Find Ways of Working With the IVF Industry  
9.7 Engineer Social Change  
9.8 Summary  
9.9 References  

Acknowledgements  
Index