

Contents

Acknowledgments ix

Introduction 1

1

The Nature of Low-Frequency Electromagnetic Fields **17**

Frequency Spectrum of Electromagnetic Sources **17**

Field Equations and Boundary Conditions **25**

2

Sources of Low-Frequency Fields **32**

Magnetic Fields **33**

Electric Fields **75**

3

Natural Sources of Exposure **94**

The Earth's Magnetic Field **94**

The Earth's Electric Field **96**

Methods of Field Measurement **97**

4

The Coupling of Electromagnetic Fields to the Body **101**

Interaction of Fields with the Human Body and Biological Materials **101**

Basic Properties of Dielectrics **102**

Permittivity and Conductivity of Biological Materials **103**

The Coupling of Low-Frequency Electric Fields to Conducting Dielectrics **105**

Distortion of the External Electric Field Due to Coupling **107**

The Coupling of Low-Frequency Magnetic Fields to the Body **114**

Electric Fields from the Lorentz Force **114**

Electric Fields from the Faraday Effect **115**

The Coupling of Internal Electric Fields to the Cell Membrane **116**

5

Natural Sources of Noise **118**

Thermal Noise in the Cell Membrane **121**

Membrane Noise for Long Cylindrical Cells **122**

Large Aggregates of Cells **123**

6

Observed Interactions with Electromagnetic Fields **126**

Magnetite and Magnetic Fields **126**

Field Effects on the Pineal Gland **127**

Rectification and Nonlinear Processes **130**

Healing Bone Fractures by the Faraday Effect **132**

Resonances and Window Effects **133**

The Lednev Model **139**

7

Questions for Future Research **148**

Notes 157

Glossary 163

Bibliography 173

Index 183

