Preface

In Vitro and In Vivo Cell Senescence

Cell senescence, i.e., the process whereby cells permanently lose the possibility to proliferate without undergoing cell death, can be observed in vitro as well as in vivo, and occurs in a plethora of distinct model organisms. In both cases, cell senescence can be physiological, constituting a safeguard mechanism against cells that have accumulated potentially dangerous genetic alterations, or can be triggered by exogenous perturbations, such as the administration of DNA-damaging agents at low doses. This book provides a detailed description of the most common techniques for the investigation of cell senescence, in model organisms encompassing bacteria (Escherichia coli), fungi (Saccharomyces cerevisiae and Podospora anserina), worms (Caenorhabditis elegans), flies (Drosophila melanogaster), zebrafish (Danio rerio), and mammalian cells. The techniques presented in this book not only cover the study of all the biochemical and functional manifestations of senescence at the cellular level but also include protocols for population analysis and high-throughput approaches in suitable model organisms, as described by worldwide renowned experts of the field.

Chapter Organization

The book is composed of three types of chapters. Four review chapters open the book to provide a solid theoretical background on cell senescence, its morphological and biochemical manifestations and its pathophysiological relevance. Twenty-three protocol chapters follow, detailing the methods to investigate the morphological and biochemical features of senescence at the cellular level, in cultured mammalian cells. Finally, seven protocol chapters provide techniques for the study of cell senescence in lower model organisms, including methods for population studies. Each of these 30 protocols starts with an Abstract and includes four major sections: Introduction, Materials, Methods, and Notes. The “Abstract” presents an overview of the technique(s) detailed in the chapter. The “Introduction” provides a short theoretical view of the procedure and of its applications. “Materials” recapitulate the buffers, reagents, solutions, disposables, and equipments necessary to carry out the protocol(s). “Methods” describe step-by-step how the technique(s) must be carried out. Finally, the “Notes” section, which is the hallmark of Methods in Molecular Biology series, indicates not only the sources of problems and how to identify and overcome them, but also safety information, alternative procedures, and hints for the correct interpretation of experimental results.
**Brief Content of the Chapters**

Chapter 1 provides an overview on cell senescence and its dynamic links with autophagy, an important cytoprotective mechanism. Chapters 2 and 3 discuss the regulation of cell senescence by critical signaling molecules such as the mammalian target of rapamycin (mTOR) and p53. Chapter 4 summarizes the morphological and biochemical markers that have been associated with cell senescence. In Chapters 5–23, protocols for the investigation of senescence-associated alterations in cultured cells are provided, including the following: morphological features (Chapter 5), cell cycle blockage (Chapter 6), cell cycle-arresting proteins (Chapter 7), senescence-associated β-galactosidase (Chapters 8 and 9), senescence-associated secretory phenotype and chemokine signaling (Chapters 10 and 11), senescence-associated heterochromatin foci (Chapter 12), DNA damage (Chapter 13), telomerase activity and telomere length (Chapters 14 and 15), alterations of the nuclear envelope (Chapter 16), multiple markers of oxidative stress (Chapters 17–20), BRAF, sirtuin, and p66SHC signaling during senescence (Chapters 21–23). In Chapters 24–27, protocols for the study of cell senescence in global terms are detailed, including a method for the study of metabolomic alterations (Chapter 24), a technique to apply genome-wide RNAi approaches to cell senescence research (Chapter 25), and multiparametric strategies (Chapters 26 and 27). Finally, in Chapters 28–34, protocols applicable to lower model organisms are described, encompassing techniques to assess senescence in *Escherichia coli* (Chapter 28), *Podospora anserina* (Chapter 29), *Saccharomyces cerevisiae* (Chapter 30), *Caenorhabditis elegans* (Chapters 31 and 32), *Drosophila melanogaster* (Chapter 33), and *Danio rerio* (Chapter 34).

**Potential Audience of This Book**

In the first instance, this book will be of interest not only for undergraduate and graduate students but also for more experienced scientists who are approaching the study of cell senescence. In addition, the audience of this book encompasses:

- Libraries of universities and public biological/biomedical research institutions.
- Scientists interested in molecular and cell biology, biochemistry, pharmacology, genetics, systems biology, medicine, public health, and in life sciences in general.
- Specialists and experts in model organisms including bacteria, fungi, worms, flies, and mammals.
- Medical oncologists and scientists working in oncology.
- Pharmaceutical companies and developers of new drugs.

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# Contents

*Preface* ................................................................. v
*Contributors* .......................................................... ix

1 Cell Senescence as Both a Dynamic and a Static Phenotype .................. 1
   *Andrew R.J. Young, Masako Narita, and Masashi Narita*

2 Senescence Regulation by mTOR .................................... 15
   *Vjekoslav Dulic*

3 Senescence Regulation by the p53 Protein Family ....................... 37
   *Yingjuan Qian and Xinbin Chen*

4 Markers of Cellular Senescence .................................... 63
   *Amancio Carnero*

5 Biomarkers of Cell Senescence Assessed by Imaging Cytometry .......... 83
   *Hong Zhao and Zbigniew Darzynkiewicz*

6 Cytofluorometric Assessment of Cell Cycle Progression ................. 93
   *Ilio Vitale, Mohamed Jemai, Lorenzo Galluzzi, Didier Metivier, Maria Castedo, and Guido Kroemer*

7 Quantification of Cell Cycle-Arresting Proteins .......................... 121
   *Oliver Kepp, Isabelle Martins, Laurie Menger, Mickaël Michaud, Sandy Adjemian, Abdul Qader Sukkurwala, Lorenzo Galluzzi, and Guido Kroemer*

8 Colorimetric Detection of Senescence-Associated β Galactosidase ...... 143
   *Koji Itahana, Yoko Itahana, and Goberdhan P. Dimri*

9 Chemiluminescent Detection of Senescence-Associated β Galactosidase 157
   *Vinicius Bassaneze, Ayumi Aurea Miyakawa, and José Eduardo Krieger*

10 Detection of the Senescence-Associated Secretory Phenotype (SASP) .... 165
    *Francis Rodier*

11 Unbiased Characterization of the Senescence-Associated Secretome
    Using SILAC-Based Quantitative Proteomics ....................... 175
    *Juan Carlos Acosta, Ambrosius P. Snijders, and Jesús Gil*

12 Detection of Senescence-Associated Heterochromatin Foci (SAHF) ...... 185
    *Katherine M. Aird and Rugang Zhang*

13 Monitoring DNA Damage During Cell Senescence .......................... 197
    *Glyn Nelson and Thomas von Zglinicki*

14 Assessment and Quantification of Telomerase Enzyme Activity ........... 215
    *Michelle F. Maritz, Laura A. Richards, and Karen L. MacKenzie*

15 Methods for the Assessment of Telomere Status .......................... 233
    *Asako J. Nakamura*
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Detection of Nuclear Envelope Alterations in Senescence</td>
<td>243</td>
</tr>
<tr>
<td></td>
<td>Clea Bárcena, Fernando G. Osorio, and José María Pérez Freije</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Measuring Reactive Oxygen Species in Senescent Cells</td>
<td>253</td>
</tr>
<tr>
<td></td>
<td>João F. Passos, Satomi Miwa, and Thomas von Zglinicki</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Quantification of Protein Carbonylation</td>
<td>265</td>
</tr>
<tr>
<td></td>
<td>Nancy B. Wehr and Rodney L. Levine</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Assays for the Measurement of Lipid Peroxidation</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>Ana Cipak Gasparovic, Morana Jaganjac, Branka Mihaljevic, Suzana Borovic Sunjic, and Neven Zarkovic</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Raman Spectroscopy for the Detection of AGEs/ALEs</td>
<td>297</td>
</tr>
<tr>
<td></td>
<td>J. Renwick Beattie, John J. McGarvey, and Alan W. Stitt</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Monitoring Oncogenic B-RAF-Induced Senescence in Melanocytes</td>
<td>313</td>
</tr>
<tr>
<td></td>
<td>Sieu L. Tran and Helen Rizos</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Methods to Investigate the Role of SIRT1 in Endothelial Senescence</td>
<td>327</td>
</tr>
<tr>
<td></td>
<td>Bo Bai and Yu Wang</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Monitoring Nutrient Signaling Through the Longevity Protein p66SHC1</td>
<td>341</td>
</tr>
<tr>
<td></td>
<td>Sofia Chiatamone Ranieri and Giovambattista Pani</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Profiling the Metabolic Signature of Senescence</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Florian M. Geier, Silke Fuchs, Gabriel Valbuena, Armand M. Leroi, and Jacob G. Bundy</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Genome-Wide RNAi Screening to Identify Regulators of Oncogene-Induced Cellular Senescence</td>
<td>373</td>
</tr>
<tr>
<td></td>
<td>Narendra Wajapeyee, Sara K. Deibler, and Michael R. Green</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>An Integrated Approach for Monitoring Cell Senescence</td>
<td>383</td>
</tr>
<tr>
<td></td>
<td>Tatiana V. Pospelova, Zhanna V. Chitikova, and Valery A. Pospelov</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Robust Multiparametric Assessment of Cellular Senescence</td>
<td>409</td>
</tr>
<tr>
<td></td>
<td>Clara Correia-Melo, Diana Jurk, and João F. Passos</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Assessing Chronological Aging in Bacteria</td>
<td>421</td>
</tr>
<tr>
<td></td>
<td>Stavros Gonidakis and Valter D. Longo</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Assessing Organismal Aging in the Filamentous Fungus Podospora anserina</td>
<td>439</td>
</tr>
<tr>
<td></td>
<td>Heinz D. Osiewacz, Andrea Hamann, and Sandra Zintel</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Assessing Chronological Aging in Saccharomyces cerevisiae</td>
<td>463</td>
</tr>
<tr>
<td></td>
<td>Jia Hu, Min Wei, Mario G. Mirisola, and Valter D. Longo</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Assessing Aging and Senescent Decline in Caenorhabditis elegans: Cohort Survival Analysis</td>
<td>473</td>
</tr>
<tr>
<td></td>
<td>Eirini Lionaki and Nektarios Tavernarakis</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>High-Throughput and Longitudinal Analysis of Aging and Senescent Decline in Caenorhabditis elegans</td>
<td>485</td>
</tr>
<tr>
<td></td>
<td>Eirini Lionaki and Nektarios Tavernarakis</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Assessing Senescence in Drosophila Using Video Tracking</td>
<td>501</td>
</tr>
<tr>
<td></td>
<td>Reza Ardekani, Simon Tavaré, and John Tower</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Assessing Vascular Senescence in Zebrafish</td>
<td>517</td>
</tr>
<tr>
<td></td>
<td>Sandra Donnini, Antonio Giachetti, and Marina Ziche</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td>533</td>
</tr>
</tbody>
</table>
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