

**Prof. Gary Walsh,  
University of Limerick**

**Biography**



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## Summary CV

Gary Walsh was appointed Director of Quality, University of Limerick, in February 2015. He also holds a personal chair (Industrial Biotechnology) within the University's department of Chemical and Environmental Sciences. He obtained BSc & PhD degrees from the National University of Ireland at Galway in 1986 and 1989, respectively and more recently a graduate Diploma in Academic Practice from UL in 2009. He held various industrial positions prior to joining the university in 1994.

His **research and scholarship interests** span enzyme and pharmaceutical biotechnology, as well as curriculum design and he was the recipient of the University's special achievement in research award in 2006.

His class 1 **publications** include 10 authored books, 2 edited books, 17 book chapters and 78 journal articles. In addition he has authored 94 refereed conference proceedings, 5 book reviews and 7 reports. Three of his books are international student biotechnology textbooks that have gone to second edition and for which Chinese and Japanese foreign language editions have been published. Citation levels for 2 of his journal articles places them in the top 1% of their academic field (source; Web of Science Essential Science Indicators).

He has presented his work at over 60 international **conferences**, which include 35 guest/keynote presentations. He has served as session/conference chairman at 7 international conferences and as a member of the scientific advisory panel for 14 international conferences.

He has participated in **research grant** proposal applications which have secured €3.4 million in funding, of which his personal share is €2.0 million. He has supervised/continues to supervise 23 researchers (15 postgraduate students and 8 post-doctoral research scientists). He has served as a **grant evaluator** for various scientific funding bodies in Ireland, Holland, Norway, and UK, as well as for the European Research Council.

He has acted as **external examiner** for 14 PhD and 4 MSc research theses in various Irish institutions, as well for University College London and Monash University in Australia. He has/continues to serve as external examiner for undergraduate taught programs in 4 Irish Institutes of Technology and 2 Irish Universities.

He has **taught** various biotechnology modules to first, second, & forth year undergraduate students and was the recipient of the university's excellence in teaching award in 2003. He has served as course director, B.Sc. Industrial Biochemistry for 2 terms (6 years), and also served as the University's (acting) dean, teaching & learning from August to December 2004. He has guest lectured on taught courses at the Grenoble Ecole de Management, France, the University of Jyväskylä, Finland and the National University of Ireland at Galway.

He has served as (founding) **editor**, biotechnology section, of the European Journal of Pharmaceutics and Biopharmaceutics and as a member of the **editorial boards** of Biopharm. International, New Drugs and the Encyclopaedia of Industrial Biotechnology. He has also served as **scientific secretary** and as a member of the board of governors of the European Association of Pharma Biotechnology and is a former Fulbright research visiting professor at the University of Georgia, in the United States.

He chaired the University of Limerick institutional committee preparing for the 2012 institutional **quality review** and was the main author of the associated Institutional Self-Assessment Report.

## Research interests

**Enzyme & Environmental biotechnology:** The development of renewable sources of liquid fuels as an alternative to fossil fuels is receiving increasing global attention due environmental, economic and energy security concerns. The production of bioethanol from cellulose-based raw materials (e.g. grass, straw & wood) is at the forefront of this technology, but a major stumbling block is how to effectively degrade the cellulose to its glucose building blocks (the glucose is then fermented to ethanol, basically by brewing technology). A major ongoing focus of my research group is the identification and use of enzymes (proteins that speed up chemical reactions) derived from thermoacidophilic bacteria (bugs that grow best in boiling acid) to more efficiently achieve cellulose degradation (a process that currently usually entails the use of boiling acid). These enzymes are also academically interesting because they work best under such extreme conditions. An additional focus of my research group is to identify selected enzymes produced by acidophilic bugs which can be used as digestive supplements in humans or animals (working in the acidic environs of the stomach). For example, the identification of acid-active 'lactase' enzymes to degrade milk lactose in the stomach, thereby alleviating lactose intolerance (which effects up to 75% of the world's adult population). An additional element of my lab-based research work focuses upon decreasing the environmental impact of biotechnological processes. For example, one of our projects found that NaOH (alkali) could be replaced by enzymes in cleaning in place (CIP) procedures in the dairy processing industry. Additional projects relate to pharmaceutical biotechnology manufacturing systems, as described below.

**Pharmaceutical biotechnology (Biopharmaceuticals):** Biopharmaceuticals are drugs (mainly proteins such as insulin and antibodies, but also pieces of DNA called 'gene therapy' products) that are synthesized biologically (as opposed to chemically), usually via genetic engineering. These products are at the cutting edge of the pharmaceutical sector, recording sales of \$140 billion in 2013. My research in this area focuses largely upon altering the method of manufacturing (bioprocessing) of these products in order to achieve manufacturing more economically and making it more environmentally friendly in the process (green pharmaceutical manufacturing) We also work on stabilizing such proteins by attaching a chemical called PEG to them, as well as on the identification & analysis of trends/ likely future directions in biopharmaceutical production systems/ products/regulatory science.

**Education related.**

Curriculum design and development, particularly with reference to pharmaceutical biotechnology/ protein biotechnology.

**Quotations from the acknowledgements section of several former PhD students:**

*'I have to begin by acknowledging my fantastic supervisor Gary. I would like to express my sincere gratitude to you for your expert guidance, support, enthusiasm, and unwavering faith in my abilities'.*

*'My greatest debt is to my supervisor Dr. Gary Walsh, not only for his expert help and guidance, clever ideas and excellent teaching but also for being a continuous source of inspiration, providing encouragement especially when most needed, showing unending patience and always making time for me in his busy schedule'.*

*'Firstly, I'd like to thank Gary Walsh, my supervisor, for constantly being available for advice, always being helpful and doing everything he could to make life bearable while completing the thesis. I can't speak highly enough of his contribution to me in completing this thesis and of his attributes as a supervisor'.*

*'I would like to express my sincere gratitude to Dr. Gary Walsh for his excellent supervision and guidance, support and faith, which made this work possible'.*

*'I owe my deepest gratitude to my fantastic supervisors, Gary and Tom. I simply would never have finished this work without their great teamwork, exceptional guidance, encouragement and support. Both their doors were always open for any enquiry'.*

*'My sincere thanks and gratitude to my wonderful supervisors, Prof Gary Walsh and Dr Tom O'Dwyer for their time, continuous guidance, support and encouragement throughout this project'.*

*I would like to sincerely thank Prof. Gary Walsh, my supervisor, for constantly making himself available to me for advice and support. His assistance and insight were of a profound help. I can't speak highly enough about his attributes as a scientist and supervisor'.*

## Teaching duties

The syllabus of the 3 core modules I routinely taught until appointment as Director of Quality are summarized below. In addition to these I contributed to a first year introductory biochemistry module for Industrial Biochemistry students, and to an introductory science module taught to first year nurses.

### **BC 4718 (Industrial Biochemistry 2)**

*Animal cell culture (circa 5 lectures)*

Overview and introduction to animal cell culture. Animal cell culture, media, methods and apparatus. Animal cell culture; production of industrially useful products.

*The drug development process & patenting (circa. 6 lectures)*

Regulatory route for new drugs in USA & EU and ICH. Patenting in biotechnology.

*Biopharmaceutical manufacture; (circa 7 Lectures)*

Sources of biopharmaceuticals. Upstream processing. Downstream processing. Post translational modifications and their significance. Product QC and the range and significance of potential product impurities.

*Specific biopharmaceuticals; Case studies (circa 6 lecture equivalent).*

### **BC 4705 (Industrial Biochemistry 1)**

Practical Aspects of Pharmaceutical Manufacture: International Pharmacopoeia. GMP in the Pharmaceutical Industry. The Pharmaceutical Facility; Clean Rooms, Cleaning Decontamination and Sanitation. Generation of Water for Pharmaceutical/Biopharmaceutical Processing. Product Flow Through the Facility and Associated Documentation. Validation of methodology and industrial processes in biotechnology. Industrial enzymes and proteins; range, applications and selected case studies. Stabilizing proteins for industrial use. Environment and Industry, the Environmental Protection Agency (EPA) and IPPC Licensing for biotechnology.

### **BC 4903 (Biomolecules)**

Introduction to module: The range of biomolecules. Evolution of biomolecules

Structure, properties & functions of: Amino acids, peptides & proteins, Carbohydrates, Lipids & Nucleic acids (DNA, RNA and their building blocks) Vitamins and other biomolecules.

The dynamics of life: Overview of metabolism. Glycolysis, a central metabolic pathway.

## Evidence of teaching quality

Overall winner, 2003 excellence in teaching award, University of Limerick.

### **UL Module Satisfaction Survey results (BC 4903):**

2014: Student satisfaction rating (satisfied or very satisfied): 74%

2013: Student satisfaction rating (satisfied or very satisfied): 86%

**Student Evaluation of Teaching (SET) results for Gary Walsh**, as independently undertaken by the University's Centre for Teaching and Learning (CTL).

Forth year module (assessed 2012) (BC 4718; to Galway students via videolink)	Overall teaching effectiveness; <b>5.0</b> out of 5.0 Overall module effectiveness; <b>5.0</b> out of 5.0
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Forth year module (assessed 2012) (BC 4718; to UL students)	Overall teaching effectiveness; <b>4.7</b> out of 5.0 Overall module effectiveness; <b>4.7</b> out of 5.0
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Second year Module (assessed 2012) (BC 4705; small group teaching)	Overall teaching effectiveness; <b>4.7</b> out of 5.0 Overall module effectiveness; <b>4.7</b> out of 5.0
Third year Module (assessed 2009) (BC 4705; small group teaching)	Overall teaching effectiveness; <b>5.0</b> out of 5.0 Overall module effectiveness; <b>4.7</b> out of 5.0
Forth year module (assessed 2009) (BC 4718; small group teaching)	Overall teaching effectiveness; <b>5.0</b> out of 5.0 Overall module effectiveness; <b>4.7</b> out of 5.0
Forth year module (assessed 2003) (BC 4708; Small group teaching):	Overall teaching effectiveness; <b>4.9</b> out of 5.0 Overall module effectiveness; <b>4.7</b> out of 5.0
First year module (assessed 2003) (BC 4401; Small group teaching)	Overall lecture effectiveness; <b>4.9</b> out of 5.0 Overall module effectiveness; not asked
Second year module (assessed 2003) (BC 4903; Large group teaching):	Overall lecture effectiveness; <b>4.6</b> out of 5.0 Overall module effectiveness; <b>4.5</b> out of 5.0

### Publications overview

	Total Number Published	Number as Lead Author	Total Pages
<b>Refereed Journal Papers</b>	<b>78</b>	<b>71</b>	<b>472</b>
<b>Books</b>	<b>10</b>	<b>9</b>	<b>3,804</b>
<b>Book Chapters</b>	<b>17</b>	<b>16</b>	<b>277</b>
<b>Edited Books</b>	<b>2</b>	<b>2</b>	<b>884</b>

	Total Number
<b>Refereed Conference Proceedings</b>	<b>94</b>
<b>Presentations at Conferences</b>	<b>96</b>
<b>Seminars/Colloquia/Workshop</b>	<b>9</b>
<b>Reports</b>	<b>7</b>
<b>Other (Please specify)</b>	<b>8</b>

### Evidence of overall publications quality:

#### *Web of Knowledge (WOK) listed journal publications metrics*

<b>Number of WOK publications:</b>	<b>74</b>
<b>Sum of times cited:</b>	<b>1719</b>
<b>Times cited without self-citations</b>	<b>1651</b>
<b>Average citations per publication:</b>	<b>23</b>
<b>h-index:</b>	<b>17</b>

**10 journal articles published in Nature Biotechnology** (2013 journal impact factor of 39, ranked 9<sup>th</sup> of the 11,570 journals listed in InCites™ Journal citation reports<sup>®</sup>). Citation levels for 2 of these articles places them in the top 1% of their academic field (source; Web of Science Essential Science Indicators)

### ***Published review of books:***

#### **Reviews of: Biopharmaceuticals, biochem & biotechnol, 2<sup>nd</sup> ed:**

"...contains just about everything that anyone would want to know about the subject...It's all here in this easy-to-read textbook." (*Biochemistry and Molecular Education*, March/April 2004)

"...well written... (and) copiously illustrated..." (*Chemistry & Industry*, 17th January 2005)

"This book should be recommended reading for all under-graduate courses in pharmacy and the pharmaceutical sciences ...". (*Cell Biochemistry & Function*, March-April 2005)

#### **Reviews of proteins: biochemistry and biotechnology:**

"Few texts would be considered competitors, and none compare favourably." (*Biochemistry and Molecular Education*, July/August 2002)

"With the potential of a standard reference source on the topic, any molecular biotechnologist will profit greatly from having this excellent book. It is to be hoped that Dr. Walsh will continue to update the text ..." (*Engineering in Life Sciences*, 2004; Vol 5; No. 5)

### **Journal Publications; Enzyme & environmental biotechnology**

Boyce, A. and **Walsh, G.** Characterisation of a novel thermostable endoglucanase from *Alicyclobacillus vulcanalis* of potential application in bioethanol production. *Applied Microbiology and Biotechnology*. *In press*. DOI 10.1007/s00253-015-6474-8

Witt, M., O'Dwyer, T. and **Walsh, G.** Minimisation of phosphorus in the fermentation media of *Escherichia coli* producing a recombinant protein. *International Journal of Environmental Science and Technology*. *In press* (DOI: 10.1007/s13762-014-0604-1)

Boyce, A. and **Walsh, G.** (2012) Identification of fungal proteases potentially suitable for environmentally friendly cleaning-in-place in the dairy industry. *Chemosphere*, 88, 211-218

Turner, K., Pasut, G., Veronese F, Boyce, A. and **Walsh, G.** (2011) Stabilization of a  $\beta$ -galactosidase digestive supplement by covalent attachment of polyethylene glycol. *Biotechnology letters* 33 (3) 617-621.

Boyce, A., Piterina, A. and **Walsh, G.** (2010) Assessment of the potential suitability of selected commercially available enzymes for cleaning in place (CIP) in the dairy industry. *Biofouling*, 26 (7), 837-850.

Hu, X., Robin, S., O'Connell, S., **Walsh, G.** and Wall, J.G. (2010) Engineering of a fungal  $\beta$ -galactosidase to remove product inhibition by galactose. *Applied Microbiology and Biotechnology* 87, 1773-1782

Cliffe, F. **Walsh, G.** and O'Dwyer, T. (2010) Utilisation of Phosphorous Nutrient Content in Industrial Scale Plasmid DNA Production: A Waste Minimisation Study. *Journal of cleaner production*. 18, 1066-1072.

O'Connell, S. and **Walsh, G.** (2010) A novel acid-active  $\beta$ -galactosidase and its incorporation in a two-segment lactase enzyme supplement for the treatment of lactose intolerance. *Applied Microbiology and Biotechnology*, 86, 517- 524

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- Boyce, A. and **Walsh, G.** (2007) Production, purification and application-relevant characterisation of an endo-1,3(4)- $\beta$ -glucanase from *Rhizomucor miehei*. *Applied microbiology and biotechnology*. 76 (4) 835-841.
- O'Connell, S. and **Walsh, G.** (2007) Purification and properties of a  $\beta$ -galactosidase with potential application as a digestive supplement. *Applied Biochemistry & Biotechnology*, 141 (1) 1-14.
- O'Connell, S. and **Walsh, G.** (2006) Physicochemical characteristics of commercial lactases relevant to their application in the alleviation of lactose intolerance. *Applied Biochemistry & Biotechnology*. 134 (2), 179-191.
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- Walsh, G.** Murphy R, Killeen G and Power R. (2005) Quantification of supplemental enzymes in animal feedingstuffs by radial enzyme diffusion. *Applied microbiology & biotechnology*, 67 (1), 70-74.
- Casey, A. and **Walsh, G.** (2004) Identification and characterization of a phytase of potential commercial interest. *Journal of Biotechnology*. 110 (3), 313-322
- Casey, A. and **Walsh, G.** (2003) Purification and characterization of an extracellular phytase from *Aspergillus niger* ATCC 9142. *Bioresource technology*, 86 (2), 183-188
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- Walsh, G.**, Power, R. F. and Headon, D. R. (1994). Enzymes in the animal feed industry. *Trends in food science and technology*. 5, 81-87 (reprinted from trends in biotechnology).

Killeen, J., Hynes, M., Power, R., **Walsh, G.** and Headon, D. (1993). An ultrafiltration method for the removal of interfering agents and its application to the determination of free ammonia in solutions of oxystarch by the berthelot reaction method. *Analytical Biochemistry*, 215, 284-291.

**Walsh, G.**, Power, R. F. and Headon, D. R. (1993). Enzymes in the animal feed industry. *Trends in biotechnology*, 11, 424-430.

### **Journal publications; Pharmaceutical biotechnology**

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**Walsh, G.** (2013) Milestones and moderate progress in 2012 drug approvals. *Biopharm International*. 26, (4), 54-56.

Ryan, M.J. and **Walsh, G.** (2012) Veterinary-based biopharmaceuticals. *Trends in Biotechnology* **30** (12), 615-620.

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**Walsh, G.** (2007) Engineering Biopharmaceuticals. *BioPharm international*. 20 (11) 64-68.

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Williams, G. and **Walsh, G.** (2005) Scaling the biobusiness information mountain. *Nature Biotechnology*, 23 (1), 147-149.

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**Walsh, G.** (2004) Second generation biopharmaceuticals. *European journal of pharmaceutics and biopharmaceutics*. 58 (2) 185-196

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**Walsh, G.** (2002) Biopharmaceuticals – first versus second-generation products. *New Drugs*. 2 (2), 26-32

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**Walsh, G.** (2002) Eine neue generation von biopharmazeutika. *Labor Praxis*, 10, 30-33 (Reprinted from new drugs – see entry directly above)

**Walsh, G.** (2001) Monoclonal antibody based therapeutics. *Pharmaceutical Technology Europe*, 13, (3) 70-76

**Walsh, G.** (2001) Biopharmaceuticals; status 2001. *New Drugs* 1 (1) 58-61

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**Walsh, G.** (1995). Biopharmaceuticals, the bodies own drugs. *Biologist* 42 (5) 209-212.

De Koning, W., **Walsh, G.**, Wrenn, E., and Headon, D.,(1994). Recombinant reproduction. *Nature biotechnology* 12, 988-992.

### **Journal publications; education**

**Walsh, G.** (2010) The importance of and an approach to comprehensive reflective practice. *Biochemistry and molecular biology education*. 38 (1) 1-3.

**Walsh, G.** and Muller, R. (2007) The pharmaceutical biotechnology content of pharmacy programs within Europe: a survey. *Pharmacy Education*. 7 (1) 27-33.

**Walsh, G.** (2007) Protein engineering: case studies of commercialized engineered products. *Biochemistry and molecular biology education*, 35 (1), 2-8

Boyce, A. and **Walsh, G.** (2005) A series of enzymology-based experiments designed to mimic an applied research project. *Biochemistry and molecular biology education*. 33 (6) 420-425.

Boyce, A., Casey, A. and **Walsh, G.** (2004) A phytase enzyme-based biochemistry practical particularly suited to students undertaking courses in biotechnology and environmental science. *Biochemistry and molecular biology education*. 32, 5, 336-340

**Walsh, G.** (2001) Core concepts suitable for education and training for the biopharmaceutical industry. *Drug Information Journal*, 35, (3) 985-991

**Walsh, G.** (2000) A suggested module detailing biopharmaceuticals suitable for inclusion in undergraduate biochemistry/applied biochemistry programmes. *Biochemical Education*, 28 (2) 89-92

Murphy, B. and **Walsh, G.** (1999) A suggested postgraduate curriculum for education and training for the biopharmaceutical industry. *Quality assurance journal*. 3, 109-118. (Reprinted from the *Drug Information Journal*).

Murphy, B. and **Walsh, G.** (1999) A suggested postgraduate curriculum for education and training for the biopharmaceutical industry. *Drug Information Journal*, 33, 615-626

**Walsh, G.**, O'Shaughnessy, B., Shanley, N. and Tobin, J.J. (1998) A simple immunoassay-based system capable of detecting antibody raised against human IgG. *Biochemical Education* 26, 157-160

## Publications; Books

### Student textbooks:

**Walsh, G.** (2014) *Proteins; biochemistry and biotechnology*, second edition. 431 pages. J. Wiley & sons, Chichester UK.

**Walsh, G.** (2007) *Pharmaceutical Biotechnology: Concepts and Applications*. 480 pages. J. Wiley & sons, Chichester, UK.

**Walsh, G.** (2003) *Biopharmaceuticals: Biochemistry & Biotechnology*, second edition. 551 pages, J. Wiley & sons, Chichester. Chinese edition, 2007

**Walsh, G.** (2002) *Proteins; biochemistry and biotechnology*. 546 pages. J. Wiley & sons, Chichester UK. Japanese edition: 2003, Chinese edition: 2006

**Walsh, G.** (1998) *Biopharmaceuticals: Biochemistry & Biotechnology*. First edition. 431 pages J. Wiley & sons, Chichester.

**Walsh, G.**, and Headon, D.R. (1994) *Protein Biotechnology*, 371 pages. J. Wiley & sons, Chichester. Chinese edition, 1996

### Books; Other

**Walsh, G.** (Ed). (2009) *Post-translational modification of protein biopharmaceuticals*. Wiley-Blackwell, Weinheim, Germany. 370 pages.

Tobin, J.J. and **Walsh, G.** (2008) *Medical Product Regulatory Affairs*. Wiley-Blackwell, Weinheim, Germany. 283 pages.

Moore, S. **Walsh G.** and Riskey, A. (2007) *Teaching at College and University: Effective Strategies and Key Principles*. Open University Press at McGraw Hill Education, Berkshire, UK. 152 pages. (Galician foreign language edition; 2008. Spanish edition; 2012)

**Walsh, G.** and McGrath, B. (2006) *Directory of therapeutic enzymes*. Taylor & Francis, CRC press, London, UK. 303 pages.

Spada, S. and **Walsh, G.** (2005) *Directory of approved biopharmaceutical products*. Taylor & Francis publishers, London, UK. 256 pages.

**Walsh, G.** and Murphy, B. (Eds.) (1999) *Biopharmaceuticals; an industrial perspective*. 514 pages Kluwer academic publishers, the Netherlands.

## Chapters in books

**Walsh, G.** (2013) Posttranslational modifications to improve biopharmaceuticals. In: Knablein, J. (Ed) Modern biopharmaceuticals: recent success stories. PP 469-489. Wiley-Blackwell Weinheim, Germany.

**Walsh, G.** (2012) Drug approval in the European Union and the United States. In; Kayser, O. and Warzecha, H. (eds). Pharmaceutical biotechnology. 257-267 Wiley-Blackwell, Weinheim.

**Walsh, G.** (2011) Drug approval in the European Union and the United States. In: Wink, M (Ed), An introduction to molecular biotechnology, second edition, updated. Pp 499-508. Wiley Blackwell, Weinheim, Germany.

Robinson, G. **Walsh, G.** and O'Dwyer, T. (2010). The degradation of oligonucleotide-based pharmaceutical products by selected chemical means. In: Theophanides, M. and T. Theophanides, (Eds) Environmental Engineering and Sustainability. ISBN: 978-960-6672-97-2, pp 349-359. ATINER publications, Greece.

**Walsh, G.** (2009) Regulatory requirements for human biopharmaceuticals: European Union. In: Flickinger, M. (Ed.) Encyclopedia of Industrial Biotechnology: bioprocess, bioseparation and cell technology. J. Wiley & sons, Volume 6, pp 4245-4257.

**Walsh, G.** (2009) Post translational modifications in the context of biopharmaceuticals, an introductory overview. In: Walsh, G (Ed). Post-translational modification of protein biopharmaceuticals. Wiley-Blackwell, Weinheim, Germany. Pages 1-14.

**Walsh, G.** (2009) Market development of biopharmaceuticals. M. Engelhard, K. Hagen, M. Boysen (Eds). Genetic Engineering in Livestock. New Applications and Interdisciplinary Perspectives. Pages 69-91 Springer-Verlag, Berlin.

**Walsh, G.** (2006) Drug approval in the European Union and the United States. In: Wink, M (Ed), An introduction to molecular biotechnology. PP 651-662. Wiley VCH, Weinheim, Germany.

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