

# **CURRICULUM VITAE**

## **MARCO FERRARI**

( ██████████ )

**Professore Emerito di Biochimica (dal 12 luglio 2022)**  
**Professore Ordinario (dal novembre 2000 al 28 febbraio 2022) - Settore Concorsuale 05/E1**  
**Biochimica Generale presso l'Università degli Studi dell'Aquila**

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### **PRINCIPALI INCARICHI ACCADEMICI PREGRESSI**

- **Novembre 2013-ottobre 2019:** Coordinatore del Corso di Dottorato di Ricerca in "Scienze della Salute e dell'Ambiente" per il triennio 2013/2014-2015/2016 e per il triennio 2016/2017-2018/2019 (XXIX-XXXIV Ciclo)
- **Novembre 2010-ottobre 2013:** Coordinatore del Corso di Dottorato di Ricerca in "Imaging Molecolare ed Ultrastrutturale " (XXVI-XXVIII Ciclo)
- **Luglio 2012-marzo 2015:** Coordinatore della Sezione di "Medicina Clinica e Molecolare" presso il Dipartimento di Medicina Clinica, Sanità Pubblica, Scienze della Vita e dell'Ambiente
- **Novembre 2010:** Membro del Comitato Scientifico della Facoltà di Scienze Motorie
- **2008-2012:** Vicedirettore del Dipartimento di Scienze della Salute
- **2009-2012:** Vicepresidente del CAD del Corso di Laurea Magistrale in Medicina e Chirurgia
- **2002-2007:** Direttore della Scuola di Specializzazione in Medicina dello Sport
- **2001-2005:** Membro del CAD del Corso di Laurea Interfacoltà di Biotecnologie
- **2002-2005:** Presidente del Corso di Laurea Specialistica in Biotecnologie Mediche
- **2000-2006:** Membro della Commissione Scientifica di Ateneo
- **1994-2008:** Responsabile ERASMUS per il Corso di Laurea Magistrale in Odontoiatria e Protesi Dentaria
- **1997-2001:** Responsabile del sito Web della Facoltà di Medicina
- **1990-1998:** Membro della Commissione Scientifica della Biblioteca della Facoltà di Medicina
- **1996-1997:** Membro del Consiglio di Amministrazione dell'Università degli Studi dell'Aquila
- **1990-1993:** Membro del Comitato Tecnico-Scientifico del Centro di Servizi Interdipartimentali di Risonanza Magnetica Nucleare
- **1990-1995:** Componente del Consiglio di Gestione del Centro di Ricerca Inter Universitario "Studio dei meccanismi molecolari coinvolti nel danno tissutale da ipossia ed iperossia e di molecole che modificano tali lesioni"

### **CONTRIBUTO NELL'AMBITO DELLA COMMISSIONE "ABILITAZIONE SCIENTIFICA NAZIONALE" (ASN)**

<b>ASN</b>	<b>RUOLO</b>	<b>SETTORE CONCORSUALE</b>
<b>2016</b>	Membro della Commissione dei ricorrenti	05/E1 - BIOCHIMICA GENERALE
<b>2012</b>	Aspirante Commissario sorteggiabile	05/E1 - BIOCHIMICA GENERALE
<b>2016</b>		
<b>2018</b>		
<b>2021</b>		

### **EDUCAZIONE UNIVERSITARIA**

- **Novembre 1980:** Specializzazione in Reumatologia, Università di Roma, "La Sapienza"
- **Luglio 1977:** Laurea in Medicina e Chirurgia con lode, Università di Roma, "La Sapienza"

## POSIZIONI PRECEDENTI

- **Febbraio 1988-ottobre 2000:** Professore Associato di Biochimica presso Facoltà di Medicina e Chirurgia, Università dell'Aquila
- **Agosto-settembre 1991:** "Visiting Associate Professor", Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Agosto-settembre 1989:** "Visiting Associate Professor", Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Luglio 1987-gennaio 1988:** "Visiting Assistant", Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Luglio 1986-giugno 1987:** "Fogarty International Fellowship" at the Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Dicembre 1982-febbraio 1988:** Ricercatore di Ruolo presso il Laboratorio di Fisiopatologia, Istituto Superiore di Sanità, Roma
- **1981-novembre 1982:** Borsista presso l'Istituto Superiore di Sanità, Laboratorio di Farmacologia, Roma.
- **1980:** Borsista Fondazione Anna Villa Rusconi, presso la II Cattedra di Chimica Biologica, Facoltà di Medicina, I Università di Roma
- **Gennaio-dicembre 1979:** Ufficiale Medico del Corpo Sanitario Aeronautico
- **Settembre 1977-febbraio 1978:** Assistente Incaricato di Biochimica Applicata, Facoltà di Medicina, Università di Roma, "La Sapienza"

## 1) PARTECIPAZIONE COME RELATORE SU INVITO A CONVEGNI DI CARATTERE SCIENTIFICO IN ITALIA O ALL'ESTERO

1. **10 aprile 1988:** "New Technologies". (Invited Talk), XI European Congress of Perinatal Medicine, Roma.
2. **15 novembre 1988:** "International Workshop on Quantitative Spectroscopy in Tissue", Università di Erlangen-Nurnberg, Repubblica Federale Tedesca.
3. **2 aprile 1989** "III International Course on Recent Advances in Perinatal Medicine", Erice, Italia.
4. **20 luglio 1989:** "Brain monitoring by near infrared spectroscopy", Università di Mainz, Repubblica Federale Tedesca.
5. **19 settembre 1989:** "*In vivo*" evaluation of cytochrome-c-oxidase copper band", Johns Hopkins University, Baltimore, MD, USA.
6. **24 ottobre 1989:** "Fetal and Neonatal Monitoring", II World Symposium Computers in the Care of the Mother, Fetus and Newborn", Kyoto, Giappone
7. **27 ottobre 1989:** "Near-infrared spectroscopy; Fundamentals and its Clinical Applications", Università di Hokkaido, Sapporo, Giappone.
8. **21 ottobre 1991:** "Optical imaging of brain function and metabolism", Garmisch Partenkirchen, Repubblica Federale Tedesca.
9. **31 marzo 1992:** "Workshop on near infrared spectroscopy", National Institute of Health, Neurological Diseases and Stroke, Chevy Chase, MD, USA.
10. **1 giugno 1992:** "Spettroscopia dei tessuti nel vicino infrarosso risolta e non risolta nel tempo: principi, applicazioni cliniche, prospettive dello imaging", Società Italiana di Fotobiologia, Castiglioncello, Livorno.
11. **27 maggio 1992:** "Time resolved spectroscopy for brain and muscle oxygenation monitoring quantitation", Workshop on Tissue Optics and Spectroscopy, International Conference Photodynamic Therapy and Medical Laser Applications, Milano.
12. **27 settembre 1992:** "The methodology of near IR spectroscopy", Workshop on monitoring in patients with optical tissue sensors, theory, and clinical implications, Kloster Banz, Repubblica Federale Tedesca.
13. **11 gennaio 1993:** "Time resolved spectroscopy of exercising muscle", Johnson Foundation for Molecular Biophysics, University of Pensilvania, Philadelphia, USA.
14. **20 aprile 1993:** "*In vivo* applications of low frequency (280 MHz) ESR spectroscopy/imaging", Minisymposium on "EOR imaging and Overhauser imaging techniques", Sebersdorf, Austria.
15. **19 giugno 1993:** "*In vivo* electron paramagnetic resonance spectroscopy/imaging of paramagnetic species", 8th International Conference on Chemical Modifiers of Cancer Treatment, Kyoto, Giappone.
16. **21 giugno 1993:** "*In vivo* ESR spectroscopy/imaging at low frequency", Università di Showa, Tokyo, Giappone.
17. **23 giugno 1993:** "Recent aspects of ESR (electron spin resonance) and NIR (near-infrared) imaging *in vivo*", Università di Saitama, Giappone.
18. **29 agosto 1993:** "Time resolved spectroscopy", III International Symposium on the Biochemical Monitoring of the Fetus 1993, Bonn, Germania.

19. **12 novembre 1993:** "Near infrared spectroscopy in neonatology", University of Colorado, Denver, USA.
20. **16 novembre 1993:** "Quantitation of human muscle oxygenation by near-infrared time resolved and non-time resolved spectroscopy. Thirty-second annual Eastern Analytical Symposium, Somerset, NJ, USA.
21. **18 novembre 1993:** "Near-infrared spectroscopy *in vivo*", Johns Hopkins University, Baltimore, MD, USA.
22. **24 agosto 1995:** "Present status of electron paramagnetic resonance (EPR) spectroscopy/imaging for free radical detection", Life Sciences 1995, International Conference, Gozd Martuljek, Slovenia.
23. **4 dicembre 1995:** "From continuous wave to frequency-domain near infrared spectroscopy for absolute quantification of the chromophora", Ross Special Conference Hot Topics '95 in Neonatology, Washington, DC, USA.
24. **19 aprile 1996:** "Background and limitations of near infrared spectrophotometry", Symposium: "Neonatal cerebral oxygenation and hemodynamics", Nijmegen, Olanda.
25. **10 settembre 1996:** "Role of near infrared spectroscopy for non-invasive metabolic monitoring", European Society Parenteral Nutrition, Ginevra, Svizzera.
26. **19 settembre 1996:** "The role of near infrared spectroscopy for non invasive tissue metabolic monitoring", 41° Congresso Nazionale Società Italiana di Biochimica, Catania.
27. **23 ottobre 1996:** "Oxidative metabolism in muscle", The Royal Society Discussion Meeting Near infrared spectroscopy and imaging of living systems, Londra, UK.
28. **6 giugno 1997:** "Differential NIR-spectroscopy for the *in vivo*" determination of breast tissue composition", Breast Cancer Detection by Near Infrared Spectroscopy and Imaging, Berlino, Germania.
29. **11 settembre 1997:** "Imaging diagnostic techniques using near infrared light", 7<sup>th</sup> Congress of the European Society for Photobiology, Stresa.
30. **10 ottobre 1997:** "Near infrared spectroscopy of muscle", Tor Vergata Symposia on Trend in Biomedicine, Workshop on "*In vivo* near infrared spectroscopy", Università di Roma Tor Vergata.
31. **5 novembre 1997:** "Optical spectroscopy for non invasive diagnosis", Seminario sulla scienza in Italia organizzato dalla Ambasciata Italiana nel Regno Unito, Londra, UK.
32. **20 novembre 1997:** "Potential role of near-infrared spectroscopy for breast cancer detection", 36<sup>th</sup> Annual Eastern Analytical Symposium, Somerset, NJ, USA.
33. **18 agosto 1998:** "The role of near infrared spectroscopy in the evaluation of muscle diseases", 1<sup>st</sup> International Symposium on Medical Near Infrared Spectroscopy, Tokyo, Giappone.
34. **21 settembre 1998:** "The role of near infrared spectroscopy in the physiology of exercise", Japan Women's College of Physical Education, Tokyo, Giappone.
35. **22 settembre 1998:** "Advantages and limits of near infrared spectroscopy methods to measure muscle oxidative metabolism", Tokyo Medical University, Tokyo, Giappone.
36. **1 ottobre 1998:** "Ruolo delle diverse metodiche nella valutazione dell'emodinamica cerebrale. Near infrared spectroscopy", XV Congresso nazionale di "Neurosonologia", L'Aquila.
37. **14 giugno 1999:** "Outstanding role of NIRS in clinical medicine". 9<sup>th</sup> International Conference on Near-Infrared Spectroscopy Towards the Third Millennium, Verona.
38. **12 settembre 2000:** "Near infrared spectroscopy". 32<sup>nd</sup> National Congress of the Italian Society of Clinical Biochemistry and Clinical Molecular Biology, Rimini.
39. **4 ottobre 2001:** "Insight into muscle oxidative metabolism gained by near infrared spectroscopy: problems and prospects", Workshop "Non-invasive investigation of muscle function", Marseille, France.
40. **7 dicembre 2009:** "Shifting of frontal cortex activation during intermittent maximal handgrip exercise revealed by functional near-infrared topography". 446 WE-Heraeus-Seminar, Workshop "Optical Imaging of Brain Function", Bad Honnef, Germany
41. **15 ottobre 2010:** "NIRS: A historical perspective". (Keynote Talk). Functional Near Infrared Spectroscopy 2010 Conference. Harvard University, Cambridge, MA, USA
42. **9 novembre 2010:** "The use of near infrared spectroscopy in understanding skeletal muscle physiology: recent developments". Royal Society Theo Murphy International Scientific Meeting. Making Light Work: Illuminating the Future of Biomedical Optics. Kavli Royal Society Centre, Newport Pagnell, Buckinghamshire, UK
43. **30 settembre 2012:** "Muscle oxygen saturation monitoring by wireless near-infrared spectroscopy". XXXII World Congress of Sports Medicine. Roma, Italia. Symposium: Methodologies and systems for evaluating and monitoring training and sport performance.
44. **12 ottobre 2017:** "The first 40 years of non-invasive medical near-infrared spectroscopy (NIRS) research: from localized brain/muscle oximetry to wearable-wireless functional NIRS/DOT". 2f-NIRS 2017: 4<sup>ème</sup> réunion annuelle du réseau français des utilisateurs du NIRS. Lille, Francia.

## 2) DIREZIONE O PARTECIPAZIONE ALLE ATTIVITA' DI UN GRUPPO DI RICERCA CARATTERIZZATO DA COLLABORAZIONI A LIVELLO NAZIONALE O INTERNAZIONALE

Il finanziamento della ricerca (1988-2021) è stato garantito da: Università degli Studi dell'Aquila, Agenzie internazionali (EU) e nazionali (MIUR), e sponsor industriali (Sclavo, Italia; Hamamatsu Photonics, Giappone; Ohmatex, Danimarca; Technogym, Italia)

### ➤ PARTECIPAZIONI A PROGETTI DI RICERCA NAZIONALI ED INTERNAZIONALI

#### • COLLABORAZIONI INTERNAZIONALI RATIFICATE DA ACCORDI BILATERALI

- a. **1988-1999** Italia-USA. La NIRS è stata un obiettivo dell'area XVI (Salute del bambino. Medicina perinatale) della cooperazione USA-Italia in Salute e Biomedicina. (Responsabili USA: E. Gratton e R. Traystman; responsabile italiano: M. Ferrari).
- b. **1995-1999** Italia-Giappone. Accordo quadriennale di cooperazione scientifica e tecnologica Italia-Giappone per la tematica "Optical diagnosis of living tissues" (Responsabile giapponese: Y. Yamada; responsabile italiano: M. Ferrari).
- c. **2007-2009** Italia-Quebec. Programma di scambio. The Italian Ministry of Foreign Affairs and the Ministry of International Relations of Quebec. "Exploring cerebral plasticity by adopting new optical imaging techniques as compared to classical functional imaging".

#### • INVESTIGATORE PRINCIPALE O RESPONSABILE DELLA UNITÀ DI RICERCA LOCALE

##### a. MIUR

- ✓ **1992-1995** Progetto Nazionale "Patologia da radicali liberi e degli equilibri redox", Ricerca dal titolo: "Spettroscopia EPR *in vivo* a bassa frequenza ed imaging di radicali liberi sensibili alle tensioni di ossigeno" (Responsabile locale: M. Ferrari).
- ✓ **1998-1999** Progetto Nazionale "Regolazione redox di processi cellulari", Ricerca dal titolo: "Stress ossidativo in un modello sperimentale di shock: aspetti morfologici, bioenergetici e fisiopatologici" (Responsabile locale: M. Ferrari).
- ✓ **2000-2001** PRIN Progetto Nazionale "Sviluppo e valutazione pre-clinica di sistemi ottici ad acquisizione multipla per il monitoraggio non invasivo dell'emodinamica e del metabolismo ossidativo nel muscolo e nel cervello" (Coordinatore nazionale: Prof. A. Cubeddu, Politecnico di Milano; Coordinatore locale: M. Ferrari).

##### b. UNIONE EUROPEA

- ✓ **1993-1996**. "Near infrared spectrophotometry and imaging". Azione Concertata nell'ambito del III Programma Quadro dell'Unione Europea BIOMED A (Responsabile: P. Rolfe, Università di Keele, UK; M. Ferrari, membro del comitato di gestione del progetto).
- ✓ **1996-1998**. "Near infrared spectrophotometry and imaging for the functional assessment of biological tissue". Progetto nell'ambito del IV Programma Quadro dell'Unione Europea BIOMED 2. (Responsabile: P. Rolfe, Università di Keele, UK; M. Ferrari, membro comitato di gestione del progetto e responsabile di sottoprogetto) (Contratto N. BMH4-CT96-1658).
- ✓ **1999-2001**. "Imaging of the language functions in the brain" (Contratto PS 1046) (Responsabile: R. Ilmoniemi, Università di Helsinki, Finlandia).
- ✓ **2001-2003** Thematic network "Optical methods for medical diagnosis and monitoring of diseases" della Unione Europea (Responsabile scientifico: Prof. R. Steiner, Università di Ulm, Germania) (Contratto QLC1-CT-2000-01464).

##### c. CNR

- ✓ **1989** Studio *in vivo* di radicali endogeni e di spin labels con tecniche di ESR imaging e di ESR a bassa frequenza per la valutazione dello stato anossico/ischemico di cellule ed organi. (Responsabile: M. Ferrari) (N. 89.02565.04).
- ✓ **1989-1991** Progetto Bilaterale Italia-USA. Studio del metabolismo e della emodinamica cerebrale mediante il monitoraggio ottico non invasivo nel vicino infrarosso. (Responsabile: M. Ferrari, Responsabile USA: R. Traystman, Johns Hopkins University) (N. 89.04165.04, 90.01475.04, 91.00253.04).
- ✓ **1992-1994**. Progetto Bilaterale Italia-USA. Studio della ossigenazione e del consumo di ossigeno cerebrale e muscolare mediante metodi ottici non invasivi utilizzando spettroscopia nel vicino infrarosso risolta e non risolta nel tempo. (Responsabile: M. Ferrari) (N. 92.01027.04, 93.00282.04, 94.02408.04).

- ✓ **1995-1996.** Progetto Bilaterale Italia-USA. Ottimizzazione delle metodiche di spettroscopia nel vicino infrarosso risolta nel tempo ed in frequenza per il monitoraggio non invasivo dell'ossigenazione e dell'emodinamica cerebrale e muscolare, e dello stato redox della citocromo ossidasi. (Responsabile: M. Ferrari; Responsabile USA: R. Traystman, Johns Hopkins University). (N. 95.00838.04, 96.00094.04).
- ✓ **1997.** Seminario bilaterale Italia/Giappone. Sapporo. "Recent advances and further developments of near-infrared optical methods for non invasive tissue monitoring in medicine". (Responsabile: M. Ferrari), nell'ambito di "Accordo quadriennale (1995-1999) Italia-Giappone. di cooperazione scientifica e tecnologica Italia-Giappone per la tematica "Optical diagnosis of living tissues" (Responsabile giapponese: Y. Yamada; responsabile italiano: M. Ferrari).

#### **d. NATO**

- ✓ **1991-1992.** "Brain hemodynamics study by non invasive near infrared optical monitoring". (Responsabili scientifici: R.J. Traystman, Johns Hopkins University e M. Ferrari) (CRG 910208).

#### **e. COMITATO ITALIANO TELETHON**

- ✓ **1992-1993.** "Non invasive evaluation of muscular oxygenation and oxygen consumption by fiber optic near infrared spectroscopy in neuromuscular diseases". (Responsabile: M. Ferrari) (Progetto 183).
- ✓ **1994-1995.** "Evaluation of the results of the muscular dystrophy physiotherapy treatment by near infrared spectroscopy". (Responsabile: M. Ferrari) (Progetto 501).

#### **f. CONFERENZA DEI RETTORI DELLE UNIVERSITÀ ITALIANE**

- ✓ **1997-1999** Programma Vigoni (collaborazione Italia-Germania). "Studio funzionale del cervello nell'uomo mediante spettroscopia nel vicino infrarosso". (Responsabili Scientifici: Prof. A. Villringer -Department of Neurology, Charité University Medicine Berlin, Berlin, Germany e M. Ferrari).

#### **g. CONTRIBUTI PRIVATI**

- ✓ **1997-1998** Fondazione Cassa di Risparmio della Provincia dell'Aquila. Progetto: Ottimizzazione delle strategie diagnostiche e terapeutiche medico/chirurgiche in pazienti con malattie cerebrovascolari mediante spettroscopia a fibre ottiche non invasiva. (Responsabile: M. Ferrari).
- ✓ **2005-2012** Hamamatsu Photonics K.K. (Japan). Progetto: "Evaluation of skeletal muscle oxidative metabolism and hemodynamic response of brain prefrontal cortex during motor tasks of different complexity by near infrared spectroscopy" (Responsabili: M. Ferrari, V. Quaresima).

#### **• CO-INVESTIGATORE O MEMBRO DELL'UNITÀ DI RICERCA LOCALE**

- ✓ **2015-2018:** Progetto di ricerca con l'industria "Ohmatex ApS" (Viby, Denmark) per il progetto dal titolo: "Development and validation of the NIRS technology as a means of assessing oxidative metabolism in muscle tissue of astronauts at rest and during exercise." <http://www.ohmatex.dk/?p=1611>. (Responsabile Prof.ssa V. Quaresima).
- ✓ **2014-2016:** Responsabile del progetto di ricerca finanziato dalla Fondazione Cassa di Risparmio (L'Aquila) (Bando 2014) per il progetto dal titolo: "Nuovi approcci riabilitativi multidisciplinari dell'ictus: impiego di test cognitivi concomitantemente all'utilizzo di una tecnica non invasiva di neuroimaging funzionale (fNIRS)". (Responsabile Prof.ssa V. Quaresima).
- ✓ **2005-2012:** Progetto di ricerca con l'industria Hamamatsu Photonics K.K. (Hamamatsu City, Japan) per il progetto dal titolo: "Evaluation of skeletal muscle oxidative metabolism and hemodynamic response of brain prefrontal cortex during motor tasks of different complexity by near infrared spectroscopy". (Responsabile Prof.ssa V. Quaresima).
- ✓ **2004-2008:** "Academic Frontier Project" in collaborazione con "Japan Women's College of Physical Education" (Tokyo, Japan) dal titolo: "Integrative study of circulatory regulation during exercise". (Responsabile Prof.ssa V. Quaresima).
- ✓ **30 gennaio 2006- 29 gennaio 2008:** Programma di Ricerca di Interesse Nazionale - PRIN 2005 (Italia) dal titolo: "fNIRS per lo studio non invasivo dell'attivazione della corteccia cerebrale dell'uomo durante diversi stimoli". (Coordinatore nazionale: Prof. A. Cubeddu, Politecnico di Milano; Responsabile scientifico dell'Unità di Ricerca dell'Università dell'Aquila Prof.ssa V. Quaresima).

- ✓ **2005:** Progetto di ricerca con l'industria Technogym S.p.A. (Cesena, Italia) per il progetto dal titolo: "Valutazione dell'effetto di diverse modalità di esercizio con Technogym Cardio Wave e altri attrezzi cardiovascolari sul metabolismo ossidativo di diversi gruppi muscolari mediante spettroscopia nel vicino infrarosso". (Responsabile Prof.ssa V. Quaresima).
- ✓ **1991-1992.** Studio e progettazione di strumentazione per spettroscopia risolta nel tempo, applicata a mezzi densi diffondenti e assorbenti, con particolare riguardo al monitoraggio non invasivo della ossigenazione cerebrale e muscolare. (Responsabile scientifico: Prof. P. Bruscaioni, Università di Firenze) (CNR 91.02086.11, 92.03264.11).

### 3) PARTECIPAZIONE A COMITATI EDITORIALI DI RIVISTE

- **1993-presente:** Membro dell'Editorial Advisory Board **Journal of Near Infrared Spectroscopy** Print ISSN: 0967-0335 <http://www.impublications.com/content/journal-near-infrared-spectroscopy> (IM Publications)
- **2012-presente:** Review Editor **Frontiers in Brain Imaging Methods** ISSN: 1662453X [http://www.frontiersin.org/Brain\\_Imaging\\_Methods](http://www.frontiersin.org/Brain_Imaging_Methods) (Frontiers)
- **2012-presente:** Editorial Board Member of **Biomedical Spectroscopy and Imaging** ISSN print: 2212-8794; ISSN online: 2212-8808 <http://www.iospress.nl/journal/biomedical-spectroscopy-and-imaging/> (IOS Press)
- **2017-presente:** Review Editor of **Frontiers in Human Neuroscience**, ISSN: 16625161. <http://journal.frontiersin.org/journal/human-neuroscience>
- **1996-2019:** Editorial Board Member of **Journal of Biomedical Optics** ISSN: 1083-3668 <http://spie.org/x866.xml> (SPIE)
- **1996-2004:** Editorial Board Member of **Physics in Medicine and Biology** ISSN: 001319155

### 4) ATTIVITA' COME GUEST EDITOR DI NUMERI SPECIALI DI RIVISTE INTERNAZIONALI

- **2016** Co-editore del fascicolo speciale (che include 15 articoli) "Clinical Near-Infrared Spectroscopy and Imaging". Editori: **Ferrari M**, Culver J, Y. Hoshi, H. Wabnitz. *Journal of Biomedical Optics*. Volume 21 (9) settembre
- **2016** Co-editore del fascicolo speciale (che include 14 articoli) "Special Section on Clinical Near-Infrared Spectroscopy and Imaging of the Brain". Editori: **Ferrari M**, Culver J, Hoshi Y, Wabnitz H. *Neurophotonics*. Volume 3 (3) luglio-settembre
- **2014** Co-editore del fascicolo speciale (che include 59 articoli, 636 pagine) "Special issue Celebrating 20 Years of Functional Near Infrared Spectroscopy (fNIRS)" Editori: Boas D, Elwell, **Ferrari M**, Taga G. *Neuroimage*. Volume 85, Part 1, Pages 1-636 (15 January 2014)
- **2012** Co-editore del fascicolo speciale (che include 17 articoli, 254 pagine) "Medical near infrared spectroscopy 35 years after the discovery". Editori: **Ferrari M**, Norris KH, Sowa MG. *Journal of Near Infrared Spectroscopy*. Volume 20, fascicolo 1, 2012
- **2007** Co-editore del fascicolo speciale "Pioneers in biomedical optics: special section honoring Professor Frans F. Jobsis of Duke University". Editori: Delpy DT, **Ferrari M**, Piantadosi CA, Tamura M. *Journal of Biomedical Optics*. Volume 12, fascicolo 6, 2007.

### 5) ATTIVITA' COME REVISORE SCIENTIFICO

- **Revisore per riviste scientifiche internazionali:**  
Annals of the New York Academy of Sciences, Brain Research, European Journal of Applied Physiology, Medical & Biological Engineering & Computing, Frontier in Human Neurosciences, Intensive Care Medicine, Journal of Applied Physiology, Journal of Cerebral Blood Flow and Metabolism, Journal of Electromyography and Kinesiology, Journal of Neuroscience Methods, Medicine & Science and Sports & Exercise, NeuroImage, Neurophotonics, Neurorehabilitation & Neural Repair, Neuroscience, Physiological Measurements, Physics in Medicine & Biology, PLOS Biology, Proceedings of the National Academy of Sciences (U.S.A), Scientific Reports, Stroke.
- **Revisore per agenzie di ricerca internazionali:**
  - Belgio: Eurostar; FWO - Research Foundation Flanders.
  - Canada: Canadian Institutes of Health Research.
  - Danimarca: 2011-2013. Membro del "Peer review panel of the Danish Council for Strategic Research" (DK).

- Francia: French National Research Agency.
  - Germania: Laserlab Europe.
  - Svizzera: Politecnico Federale di Losanna; Swiss National Science Foundation; Japanese-Swiss Science and Technology Cooperation program.
  - UK: The Leverhulme Trust; Medical Research Council; Wellcome Trust; Action Research; Engineering and Physical Science Research Council; Royal Society; Sparks-The children's medical research charity.
  - UK: 2010-2012. Membro del "Engineering and Physical Science Research Council College".
  - USA: National Science Foundation.
- *Revisore di tesi di dottorato nazionali ed internazionali*
  - *Valutatore per la promozione accademica di ricercatori internazionali*

## 6) PARTECIPAZIONE AL COLLEGIO DEI DOCENTI DI DOTTORATO DI RICERCA

AA	DOTTORATO DI RICERCA <i>(presso Ateneo dell'Aquila)</i>
2021-2022	"Scienze della Salute e dell'Ambiente"
da 2013/2014 a 2019/2020	"Scienze della Salute e dell'Ambiente"
da 2007/2008 a 2012/2013	"Imaging Molecolare ed Ultrastrutturale"
da 1995/1996 a 2006-2007	"Biotecnologie"
da 1990/1991 a 1994/1995	"Formazione e Trattamento di Immagini Biomediche"
da 1988/1989 a 1989-1990	"Enzimologia Applicata alle Scienze Mediche"

## 7) CONSEGUIMENTO DI PREMI E RICONOSCIMENTI PER L'ATTIVA' SCIENTIFICA ED AFFILIAZIONI A SOCIETA' SCIENTIFICHE

### a) PREMI

- 1987 "Fogarty International Fellowship" to support the Postdoc at the Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA

### b) AFFILIAZIONI A SOCIETA' SCIENTIFICHE INTERNAZIONALI

- **1985-presente**: Membro "International Society on Oxygen Transport to Tissue"
- **2013-presente**: Membro "Functional Near Infrared Spectroscopy Society"

### c) ATTIVITÀ PROFESSIONALI A CONGRESSI SCIENTIFICI INTERNAZIONALI

- **2022**: Biophotonics in Exercise Science, Sports Medicine, Health Monitoring Technologies, and Wearables III. (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers), 22-27 January (Conference BO308).
- **2021**: Biophotonics in Exercise Science, Sports Medicine, Health Monitoring Technologies, and Wearables II. (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers), 6-11 March (Conference BO308).

- **2020:** Biophotonics in Exercise Science, Sports Medicine, Health Monitoring Technologies, and Wearables. (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers), 1-6 February (Conference 11237)
- **2019:** Optical Tomography and Spectroscopy of Tissue XIII (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers), 2-7 February
- **2018:** 2<sup>nd</sup> International Neuroergonomics Conference (**Member of the Scientific Committee**) Drexel University, Philadelphia, PA USA; June 27-29
- **2018:** First Joint Italian French Workshop on “Cerebral Oximetry and functional Near-Infrared Spectroscopy (ifNIRS2018)” (**Member of the Scientific Committee**) (13-15 giugno, Politecnico di Milano, Milano, Italia)
- **2017:** Optical Tomography and Spectroscopy of Tissue XII (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers)
- **2015:** Optical Tomography and Spectroscopy of Tissue XI (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers)
- **2014-2021:** Membro del Board della “Functional Near Infrared Spectroscopy Society”
- **2013:** Optical Tomography and Spectroscopy of Tissue X (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers)
- **2011:** Optical Tomography and Spectroscopy of Tissue IX (**Conference Program Committee**) San Francisco, California, USA, SPIE (Society of Photo-Optical Instrumentation Engineers),
- **2010:** “**Chair**” Functional Near-Infrared Spectroscopy: 2010 Conference (15-17 ottobre, Harvard University, Cambridge, MA, USA)
- **2004:** **Membro del Comitato Scientifico** di "32<sup>nd</sup> International Society on Oxygen Transport to Tissue meeting", (21-26 agosto, Bari, Italia)
- **2002:** **Membro del Program Committee** “BOPM 2002 Asian Symposium on Biomedical Optics and Photomedicine”, (21-23 October, Hokkaido University, Sapporo, Japan)
- **2001-2004:** Membro del Comitato Esecutivo di "International Society on Oxygen Transport to Tissue"
- **2001:** Workshop “Noninvasive investigation of muscle function” (**Conference Program Committee**) (4-6 ottobre) Marseille, France.
- **1998:** Seminario bilaterale Italia/Giappone. Recent advances and further developments of near-infrared optical methods for noninvasive tissue monitoring in medicine. (**Organizzatore italiano**) 24-28 febbraio 1998, Università di Hokkaido, Giappone.
- **1997:** "Photon propagation in tissues III", Biomedical Optics Society Europe '97, (**Conference Chair**), 4-8 settembre, San Remo, Italia.
- **1997:** "Optical tomography and Spectroscopy of Tissue: Theory, Instrumentation, and Human Studies II", Biomedical Optics 1997 Symposium, (**Conference Program Committee**), 8-14 febbraio, San José, California, USA.
- **1995:** "Optical tomography, photon migration, and spectroscopy of tissue and model media: theory, human studies, and instrumentation", Biomedical Optics 1995 Symposium, (**Conference Program Committee**), 5-7 febbraio, San José, California, USA.
- **1993:** "Quantification and localization using diffused photon in a highly scattering media", International Symposium on Biomedical Optics Europe, (**Conference Chair**), 1-5 settembre, Budapest, Ungheria.

#### 8) INCARICHI DI RICERCA (FELLOWSHIP) PRESSO QUALIFICATI CENTRI DI RICERCA

- **Agosto-settembre 1991:** "**Visiting Associate Professor**", Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Agosto-settembre 1989:** "**Visiting Associate Professor**", Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Luglio 1987-gennaio 1988:** "**Visiting Assistant**", Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA
- **Luglio 1986-giugno 1987:** "**Fogarty International Fellowship**" at the Department of Anesthesiology and Critical Care, Faculty of Medicine, Johns Hopkins University, Baltimore, MD, USA



## 9) DIDATTICA

### a) UNIVERSITA' DEGLI STUDI DELL'AQUILA

#### • CORSI DI LAUREA

- AA 2008-2009/2021-2022: Corso di Diagnostica non invasiva e/o *imaging* molecolare (CI: Approfondimenti Biomedici Applicati alle Scienze Tecnico-Diagnostiche) presso Corso di Laurea Magistrale - Scienze delle Professioni Sanitarie Tecnico-Diagnostiche
- AA 2002-2003/2020-2021: Corso di Biochimica presso il Corso di Laurea Magistrale-Odontoiatria e Protesi Dentaria
- AA 2020-2021/2020-2021: Corso di Biochimica Applicata e Metodologie di Laboratorio (CI: Biochimica) presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 2018-2019/2019-2020: Corso di Biochimica Applicata (CI: Biochimica) presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 2009-2010/2018-2019: Corso di Metodologie di Laboratorio (CI: Medicina di Laboratorio e Diagnostica Integrata; Coordinatore) presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 2003-2004/2008-2009: Corso di Biochimica (idoneità) presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 1995-1996/1999-2000: Corso di Biochimica Clinica (CI: Medicina di Laboratorio) presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 1989-1990/1993-1994: Corso di Biochimica Applicata (Corso Integrato Biochimica I) presso Corso di Laurea Magistrale - Medicina e Chirurgia presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 1990-1991/1991-1992: Corso di Chimica Biologica (Corso Integrato Biochimica I) presso Corso di Laurea Magistrale - Medicina e Chirurgia
- AA 1988-1989/2001-2002: Corso di Chimica Biologica presso Corso di Laurea in Odontoiatria e Protesi Dentaria
- AA 2001-2002/2004-2005: Corso di Biochimica presso Corso di Laurea Interfacoltà di Biotecnologie
- AA 2003-2004/2004-2005: Corso di Biochimica cellulare e biochimica sistematica umana (C.I. Biochimica cellulare, biochimica sistematica umana e basi biochimiche degli stati patologici) presso Corso di Laurea Interfacoltà di Biotecnologie
- AA 2008-2009/2017-2018: Corso di Biochimica (CI: Biochimica, Chimica e Merceologia degli Alimenti) presso Corso di Laurea Triennale in Dietistica
- AA 2005-2006/2009-2010: Corso di Biochimica Applicata presso Corso di Laurea Triennale in Tecniche di Laboratorio Biomedico
- AA 2005-2006/2007-2008: Corso di Biochimica (CI: Fisica, Biologia, Genetica e Biochimica) presso Corso di Laurea Triennale in Infermiere
- AA 1999-2001: Corso di Biochimica Cellulare presso Diploma Universitario Tecnici in Biotecnologie
- AA 1998-2001: Corso di Biochimica Applicata presso Diploma Universitario Tecnico Sanitario di Laboratorio Biomedico
- AA 1994-2000: Corso di Biochimica Clinica presso Diploma Universitario Tecnico Sanitario di Laboratorio Biomedico
- AA 1993-1996: Corso di Biochimica Clinica presso Diploma Universitario in Scienze Infermieristiche
- AA 1994-1996: Corso di Biofisica presso Diploma Universitario Tecnico Sanitario di Laboratorio Biomedico

#### • SCUOLE DI SPECIALIZZAZIONE (S.S.)

- AA 2005-2006/2020-2021: Biochimica, Scuola di Specializzazione in Farmacologia
- AA 2008-2009/2020-2021: Biochimica, Scuola di Specializzazione in Fisica Medica
- AA 1999-2000/2007-2008: Biochimica Applicata, S.S. Biochimica Clinica
- AA 1997-1998/2007-2008: Biochimica Applicata, S.S. Patologia Clinica
- AA 1991-1992/2007-2008: Biochimica e Biofisica, S.S. Cardiologia
- AA 1997-1998/1999-2000: Biochimica Clinica, S.S. Patologia Clinica
- AA 1992-1993/1995-1996: Biochimica, S.S. Cardiochirurgia
- AA 2005-2006/2007-2008: Biochimica, S.S. Dermatologia e Venerologia
- AA 2005-2006/2007-2008: Ingegneria chimica biotecnologica, S.S. Ortopedia e Traumatologia

- **SCUOLE SPECIALI**

- **AA 1989-1990:** Chimica e Biochimica, Scuola Speciale in Tecnici di Cosmetologia
- **AA 1991-1994; 1995-1996:** Chimica e Biochimica, Scuola Speciale in Tecnici di Igiene Ambientale e del Lavoro
- **AA 1991-1996:** Chimica e Biochimica delle macromolecole, Scuola Speciale in Tecnici di Biotecnologie

**b) UNIVERSITA' DEGLI STUDI DI ROMA SAPIENZA**

- **AA 1980-1981/1981-1982:** Corso di Biologia presso la Scuola Speciale per Terapisti della Riabilitazione
- **AA 1980-1981/1981-1982:** Corso di Aspetti biochimici della funzione renale presso la I Scuola di Specializzazione di Nefrologia

**c) UNIVERSITA' DEGLI STUDI DI CAMERINO AA 1982-1983/1984-1985:**

- Corso Integrativo di Biochimica Applicata presso Corso di Laurea in Chimica e Tecnologie Farmaceutiche (Professore a contratto)

## SINTESI DELL'ATTIVITÀ SCIENTIFICA

La complessiva attività di ricerca è stata oggetto finora di 203 pubblicazioni di cui **168 articoli in riviste con revisori** e 24 atti in estenso di convegno internazionale contenenti dati originali. I risultati delle ricerche sono stati oggetto di oltre 200 comunicazioni a Congressi Internazionali e Nazionali.

Citazioni 8257. H-index: 42. Documenti 174.

Fonte: Scopus 14/07/2022.

Citazioni 12487. H-index: 51. Documenti: 265.

Fonte: Google Scholar 14/07/2022.

### RECENTI TEMATICHE DI RICERCA

Ha svolto e svolge, in collaborazione con il proprio gruppo, attività di ricerca finalizzata allo studio, mediante la spettroscopia a fibre ottiche multicanale nel vicino infrarosso (NIRS dall'inglese "near infrared spectroscopy") ed un approccio multidisciplinare, dei meccanismi vascolari e metabolici che regolano l'ossigenazione ed il metabolismo del tessuto cerebrale e muscolare. La tecnica ottica NIRS, che sfrutta le caratteristiche dell'interazione della luce nell'intervallo 700-1000 nm con i tessuti, consente di monitorare in maniera non invasiva lo stato di ossigenazione dell'emoglobina. Il Prof. Ferrari si è occupato dello sviluppo di questa metodologia fin dal 1982.

L'attività di ricerca degli ultimi dieci anni, svolta anche in collaborazione con gruppi di ricerca internazionali e nazionali, è stata rivolta principalmente sui seguenti argomenti:

- Sviluppo, validazione e valutazione di nuove applicazioni cliniche di ossimetri tissutali e strumentazioni di imaging molecolare ottico basate sull'uso della spettroscopia NIRS a fibre ottiche in onda continua, risolta nel tempo ed in frequenza.
- Studi di biochimica *in vivo* mediante NIRS funzionale (fNIRS), una tecnica di imaging cerebrale di tipo vascolare, per la comprensione delle funzioni della corteccia cerebrale prefrontale/frontale in risposta a stimoli cognitivi e motori di diversa complessità su volontari sani e pazienti.
- Studio del metabolismo ossidativo e dell'emodinamica a livello del muscolo scheletrico per contribuire alla comprensione del meccanismo della fatica muscolare durante esercizio e della cinetica del metabolismo ossidativo durante la fase di transizione riposo-esercizio.

Ha collaborato e pubblicato articoli scientifici oggetto di "peer review" insieme a diversi ricercatori (biochimici, bioingegneri, fisiologi, clinici, fisici medici, psicologi, scienziati dello sport) appartenenti alle seguenti istituzioni straniere:

- Queensland University of Technology, University of Sydney, and Edith Cowan University (**Australia**)
- Centre de Médecine du Sport CCAS, and Université de Lyon, Montpellier-1 University (**France**)
- Humboldt-Universität zu Berlin (**Germany**)
- Hiroshima University Faculty of Medicine, Hokkaido University, Kyoto University, Kyushu University, Kanoya National Institute of Fitness and Sports, and University of Tokyo (**Japan**)
- Radboud University Nijmegen Medical Centre (**The Netherlands**)
- Qatar Orthopaedic and Sports Medicine Hospital (**Qatar**)
- Karolinska Institutet (**Sweden**)
- Université de Genève Faculté de Médecine, and University Hospital Zurich (**Switzerland**)
- University of Aberdeen, University College London, University of Essex, and University of Exeter (**United Kingdom**)
- Harvard Medical School, University of Georgia, University of Pennsylvania, University of Pittsburgh, and Tufts University (**USA**)

### 2010-PRESENTE

#### a) COLLABORAZIONI CON ISTITUZIONI INTERNAZIONALI/NAZIONALI

- Faculty of Health Sciences, University of Sydney, Lidcombe (Australia)
- School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Joondalup (Australia)
- Montpellier-1 University, Montpellier (France)
- Research and Education Centre, Aspetar, Doha (Qatar)
- Harvard Medical School, Charlestown, Massachusetts (USA)
- University of Zurich (Switzerland)
- Dipartimento di Fisica, Politecnico di Milano (Italia)
- Dipartimento di Psicologia, Università degli Studi di Padova (Italia)
- Dipartimento di Scienze Motorie Umane e della Salute, Università degli Studi di Roma 4 (Italia)

## b) RECENTI COLLABORAZIONI CON INDUSTRIE

- Artinis Medical Systems (The Netherlands) ([www.artinis.com](http://www.artinis.com))  
(validazione di strumentazione fNIRS a 28 canali)
- Ohmatex ApS, Viby (Denmark) ([www.ohmatex.dk](http://www.ohmatex.dk))  
(validazione di "wearable integrated textile EMG and muscle oximetry")

## ATTIVITA' SCIENTIFICA IN DETTAGLIO

Dal punto di vista cronologico l'Enzimologia è stato l'interesse prevalente nei primi anni di addestramento scientifico presso l'Istituto di Chimica Biologica della I Università di Roma sotto la guida del Prof. Paolo Fasella. Dal 1978 l'attività di ricerca, svolta presso l'Università di Roma "Sapienza", l'Istituto Superiore di Sanità, la "Johns Hopkins University" di Baltimora (USA) e dal 1988 presso l'Università dell'Aquila ed in collaborazione con numerose istituzioni italiane ed estere ed industrie internazionali, si è focalizzata principalmente su alcuni **aspetti avanzati della Biochimica Applicata e dell'Imaging Molecolare in vivo nell'uomo**. In particolare, sulla possibilità di monitorare in maniera non invasiva in un organismo vivente l'utilizzazione dell'ossigeno a livello cellulare. Data la quasi mancanza di tecniche non distruttive per studiare l'ossigenazione, ha contribuito a livello internazionale allo sviluppo di una tecnica spettroscopica la **spettroscopia a fibre ottiche nel vicino infrarosso (NIRS)** (700-1100 nm) in continua, risolta nello spazio, nel tempo ed in frequenza.

La NIRS, tenuto conto della relativa trasparenza dei tessuti a queste lunghezze d'onda e che l'assorbitore prevalente è l'emoglobina, consente di misurare in maniera non invasiva l'ossigenazione dell'emoglobina e lo stato redox della citocromo-c-ossidasi tissutale.

Gran parte del lavoro sperimentale è stato focalizzato sullo sviluppo e validazione della NIRS *in vivo* prima in modelli sperimentali animali e successivamente nell'uomo. Le ricerche hanno consentito:

- l'ottimizzazione di diverse strumentazioni a fibre ottiche per NIRS *in vivo* ed algoritmi per il monitoraggio quantitativo, sul tessuto cerebrale e muscolare intatto, del volume emoglobinico, della saturazione della emoglobina, dello stato redox della citocromo-c-ossidasi e del tempo di circolo;
- lo studio di alcuni aspetti della biochimica e fisiopatologia del cervello e del muscolo quali: i) la relazione fra lo stato redox della citocromo-c-ossidasi e la disponibilità in ossigeno cerebrale, ii) l'esercizio ed il consumo di ossigeno muscolare.

*I 48 anni di attività scientifica possono essere così riassunti:*

### 1974-1979. STUDI DI ENZIMOLOGIA CLINICA

- a) Purificazione di due enzimi del metabolismo purinico ipoxantina-guanina fosforibosiltransferasi (HGPRT) e fosforibosil pirofosfosintetasi (PRPPsintetasi) da globuli rossi umani con isolamento di tre varianti dell'HGPRT e chiarimento di alcuni aspetti della reazione di IMPpirofosforolisi catalizzata dall'HGPRT, in particolare l'attivazione da guanina e lo scambio IMP-GMP.
- b) Messa a punto di un originale metodo di dosaggio spettrofotometrico per la PRPPsintetasi.
- c) Messa a punto di un metodo di dosaggio della collagenasi da liquido sinoviale.
- d) Caratterizzazione degli isoenzimi della lattico deidrogenasi in sottopopolazioni di granulociti eosinofili ed in linfociti isolati da soggetti normali e patologici. È stato dimostrato un differente pattern elettroforetico in due sottopopolazioni di eosinofili aventi diversi recettori di superficie ed attività killer.

### • 1989-1994. SVILUPPO DI METODI PER LA RILEVAZIONE *IN VIVO*, IN MODELLI SPERIMENTALI ANIMALI, DI RADICALI LIBERI MEDIANTE TECNICHE DI RISONANZA DI SPIN ELETTRONICO (ESR)

Studio del metabolismo dei radicali liberi esogeni e la loro localizzazione spaziale, dell'influenza delle tensioni di ossigeno sulla velocità metabolica di radicali liberi nitrossidi e della produzione in situ di radicali liberi endogeni in modelli sperimentali animali.

- a. Studio in vitro del ruolo antiossidante e pro-ossidante dell'acido ascorbico e del suo intermedio radicalico nel plasma umano a cui veniva aggiunto ferro esogeno, simulando lo stress ossidativo come conseguenza dei disordini del metabolismo dello ione metallico.
- b. Mediante un prototipo di "imager" ESR operante a bassa frequenza sviluppato nell'Università dell'Aquila, studio nel ratto della cinetica di assorbimento, distribuzione, riduzione ed eliminazione del PCA, un radicale nitrossido sensibile alle tensioni di ossigeno. Mappatura della distribuzione del PCA durante la cinetica di riduzione metabolica mediante proiezioni monodimensionali longitudinali e bidimensionali trasversali e longitudinali.

- c. Mediante spettroscopia ESR a bassa frequenza, determinazione *in vivo* della generazione del radicale ossido nitrico nella regione superiore dell'addome del topo in un modello sperimentale di shock settico.
- **1979-PRESENTE. SVILUPPO DI UNA TECNOLOGIA NON INVASIVA PER IL MONITORAGGIO DELLA SATURAZIONE DELL'EMOGLOBINA E DELLO STATO REDOX DELLA CITOCROMO C OSSIDASI NEI TESSUTI INTATTI ED IN PARTICOLARE QUELLO CEREBRALE E MUSCOLARE USANDO LA SPETTROSCOPIA NEL VICINO INFRAROSSO (NIRS).**

In collaborazione con laboratori ed industrie internazionali, è stata sviluppata la spettroscopia a fibre ottiche nel vicino infrarosso (NIRS) (700-1100 nm) in continua, risolta nello spazio, nel tempo ed in frequenza.

Queste metodiche, tenuto conto della relativa trasparenza dei tessuti a queste lunghezze d'onda e che l'assorbitore prevalente è l'emoglobina, consentono di misurare direttamente ed in maniera non invasiva l'ossigenazione dell'emoglobina e lo stato redox della citocromo-c-ossidasi tissutali.

- **1980-1982** In collaborazione con ENIRICERCHE (Monterotondo, Roma) sono stati costruiti strumenti originali che sono stati utilizzati in diversi modelli sperimentali. Varie situazioni circolatorie hanno confermato la possibilità di ottenere informazioni precise sulle variazioni di contenuto ed ossigenazione dell'emoglobina cerebrale e muscolare. Per la prima volta i dati spettrali sono stati correlati con altre misure della funzionalità circolatoria (pressione arteriosa, flusso e volume ematico locale). Le variazioni di trasmittanza diffusa osservate sono state spiegate sulla base di effetti fisiofarmacologici noti e sulle proprietà spettrali della emoglobina. Si è avuta inoltre evidenza diretta delle variazioni spettrali della citocromo-c-ossidasi misurando spettri sul cranio di ratto prima e dopo la sostituzione completa del sangue con una emulsione di trasportatori artificiali di ossigeno (perfluorocarboni-PFC). Si è potuta osservare una variazione dell'ampiezza della banda della citocromo-c-ossidasi al variare delle condizioni respiratorie in animali completamente privi di emoglobina.  
È stato sviluppato un sistema per la misura continua del flusso ematico locale cerebrale utilizzando termistori riscaldati da impulsi brevi. Le emulsioni di PFC e la loro citotossicità sono state caratterizzate mediante microscopia elettronica ed analisi automatica della immagine
- **1983-1984** Costruzione di uno fotometro a fibre ottiche utilizzando 4 lunghezze d'onda per uso clinico. Questo strumento è stato il secondo al mondo ad essere utilizzato su pazienti dopo quello costruito dalla Duke University negli Stati Uniti. Misure di ossigenazione corticale su volontari durante la respirazione di diverse miscele di gas e la variazione dell'attività respiratoria.  
*Brevetto congiunto Eniricerche-Istituto Superiore di Sanità-CNR depositato in Italia ed esteso a diversi paesi.*
- **1984-1988** Le potenzialità della NIRS come strumento di diagnostica non invasiva cerebrale sono state valutate presso la I Università di Roma su pazienti cerebrovascolari durante il test di compressione delle arterie carotidi e su neonati immaturi in terapia intensiva. Sono state esaminate le variazioni di contenuto e l'ossigenazione dell'emoglobina in diverse situazioni fisiopatologiche e definite le specifiche di strumenti per le due diverse aree cliniche. Queste esperienze sono servite all'Eniricerche, in collaborazione con una società di diagnostica medica del gruppo (Sclavo), per realizzare un fotometro di seconda generazione per uso clinico. Questi studi NIRS clinici sull'adulto sono stati i primi al mondo; quelli sul neonato sono stati i primi in Europa ed i secondi al mondo. Nel 1988, con la riorganizzazione industriale del gruppo ENI, terminò l'attività industriale di sviluppo della strumentazione NIRS in Italia.  
Sulla base di queste ed altre successive sperimentazioni internazionali sono state sviluppate negli ultimi trenta anni diverse strumentazioni commerciali, chiamate ossimetri, che da molti anni vengono utilizzati nelle terapie intensive dell'adulto e del neonato e nelle camere operatorie di tutto il mondo. Industrie leader dell'ossimetria cerebrale sono attualmente quattro industrie americane (Medtronic, Edwards, Masimo, Nonin) e una giapponese (Hamamatsu Photonics). L'industria leader nell'ossimetria muscolare è Artinis (Olanda) con cui si è collaborato negli ultimi venti anni.
- **1986-1987** Soggiorno di studio presso il Dipartimento di Anestesiologia della Johns Hopkins University di Baltimora (USA).
  - Sviluppo e validazione di un algoritmo predittivo per la misura non invasiva della saturazione dell'emoglobina venosa cerebrale utilizzando una tecnica chemiometrica che sfrutta le proprietà delle derivate degli spettri nel vicino infrarosso.
  - Valutazione della sensibilità della misura del contenuto di emoglobina e del tempo di transito cerebrale, determinato dalla curva di clearance di un tracciante assorbente nel vicino infrarosso, a definire i limiti della dilatazione cerebrovascolare.

- Mediante spettri differenziali ottenuti su animali di laboratorio privi di emoglobina, evidenza della presenza di una larga banda attribuibile alla citocromo-c-ossidasi che può essere ossidata e ridotta al variare delle condizioni respiratorie. Individuati i rapporti fra la soglia di riduzione della banda della citocromo-c-ossidasi cerebrale, flussi ematici e potenziali evocati somatosensoriali.
- **1988-1992** Misure di spettroscopia risolta nel tempo per quantizzare il cammino ottico percorso dai fotoni in fantocci di diversa complessità, sul muscolo scheletrico e sulla testa di volontari in collaborazione con l'Università di Firenze.  
Per primi al mondo, abbiamo dimostrato che:
  - i cammini ottici, a parità di geometrie, sono diversi nel tessuto cerebrale e muscolare;
  - esiste una dipendenza temporale della forma dell'impulso trasmesso nel muscolo dell'avambraccio in condizioni di riposo e durante ischemia, occlusione venosa ed esercizio;
  - le inaccurately del cammino ottico influenzano le misure di consumo di ossigeno muscolare ottenute combinando i dati spettrali in continua con le misure di cammino ottico.
  - la modellistica Monte Carlo è indispensabile a verificare le modalità di propagazione dell'impulso nei diversi tessuti;
  - è possibile misurare i coefficienti di assorbimento e di scattering del muscolo dalla forma dell'impulso trasmesso;
  - il cammino ottico nel cervello varia durante ipossia ipossica.
- **1989-1997** Messa a punto di metodi NIRS per quantizzare il consumo di ossigeno ed il flusso nell'avambraccio durante il riposo e durante la contrazione muscolare massimale.
- **1994-1995** Studio dell'ossigenazione di diversi gruppi muscolari della gamba e dell'avambraccio in soggetti sani ed affetti da distrofie muscolari durante esercizi standardizzati e durante la fase di recupero post-esercizio. Studi in collaborazione con Fondazione Don Gnocchi Firenze.
- **1994-1997** Validazione di un prototipo di ossimetro tissutale operante nel dominio delle frequenze per la misura dell'ossigenazione cerebrale e muscolare. In collaborazione con una industria americana (ISS, Urbana, Illinois, USA).
- **1996-1997** Determinazione della relazione tra lo stato redox della banda del rame della citocromo-c-ossidasi e l'ossigenazione dell'emoglobina nel cervello di un modello sperimentale animale. Studio in collaborazione con University College di Londra.
- **1996-1998** Studi per migliorare ed espandere l'accuratezza dei dati NIRS. Ottimizzazione dell'interfaccia fibra ottica-tessuto monitorato. Valutazione dell'effetto delle variazioni di temperatura sugli spettri di assorbimento dell'emoglobina, metemoglobina ed acqua per implementare gli algoritmi di quantizzazione dei cromofori nei fotometri NIRS commerciali. Identificazione e quantificazione del contrasto ottico intrinseco della mammella mediante spettroscopia in derivata seconda per implementare le potenzialità diagnostiche della mammografia ottica. Studi in collaborazione con University College di Londra e I Università di Roma.
- **1996-1999** Studio del metabolismo aerobico ed anaerobico di diversi gruppi muscolari della coscia e della gamba sottoposti a esercizi di intensità diversa sia su soggetti allenati che non allenati. Studio della correlazione tra la cinetica di deossigenazione muscolare e la produzione di lattato. L'inizio della deossigenazione muscolare è correlato con l'inizio dell'accumulo di lattato (effetto Bohr *in vivo*). Studi in collaborazione con CNR di Milano.
- **1997-1999** Valutazione della reattività cerebrovascolare in pazienti cerebrovascolari.
- **1996-presente** Studi di NIRS funzionale (fNIRS). La fNIRS è una tecnica di imaging cerebrale di tipo vascolare che, mediante strumentazione multicanale, riesce a mappare le variazioni di ossigenazione della corteccia cerebrale a seguito di stimoli di diversa complessità. È stata studiata la funzione della corteccia cerebrale prefrontale/frontale in risposta a stimoli cognitivi e motori di diversa complessità su volontari sani e pazienti.  
Sono stati utilizzati prototipi fNIRS sviluppati da Politecnico di Milano e da Università di Nijmegen, e strumenti commerciali della Artinis (Olanda) e dell'Obelab (Corea).
- **2000-2004** Studio, mediante strumenti NIRS multicanale, della eterogeneità del consumo di ossigeno e del flusso nei muscoli dell'arto inferiore durante flessione plantare ed esercizio isometrico del quadricipite. Studi in collaborazione con l'Università di Nijmegen (Olanda) e di Tuft (USA).
- **2000-2008** Studio della correlazione della componente lenta del consumo di ossigeno sistemico con la deossigenazione del muscolo vasto laterale durante la corsa ed altre modalità di esercizio. Studi in collaborazione con CONI Roma.
- **2011-2020** Review su invito. Pubblicazione di sei review in importanti riviste internazionali. Gli articoli riguardano le tecniche e le diverse applicazioni dell'ossimetria NIRS e fNIRS. Queste review hanno avuto oltre 1800 citazioni.

- **2018-2020** Validazione di sensori per elettromiografia (EMG) indossabili e dell'ossimetria per il monitoraggio wireless integrato dell'attività del quadricipite femorale durante esercizi di forza e resistenza. Il sensore EMG è realizzato con tessuti "intelligenti". Studio in collaborazione con Ohmatex (Danimarca).
- **2019-presente** Utilizzazione di sistemi fNIRS wireless multicanale per l'imaging della corteccia prefrontale di soggetti anche in movimento (mobile neuroimaging). Studi in collaborazione con l'Università di Roma "Foro Italico" e industria Artinis (Olanda).
- **2020-presente** COVID-19. Pubblicazioni relative alla standardizzazione ed il corretto uso dell'ossimetria pulsata e dell'ossimetria cerebrale in particolare per i pazienti COVID-19.

## PUBBLICAZIONI SU RIVISTE INTERNAZIONALI CON REVISORI

### ANNO 2022

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2. **Ferrari M**, Quaresima V, Scholkmann F. Letter to the Editor: Pulse oximetry, racial bias and statistical bias: further improvements of pulse oximetry are necessary. *Annals of Intensive Care* (2022) 12: 19.
3. Silverston P, **Ferrari M**, Quaresima V. Pulse oximetry in primary care: factors affecting accuracy and interpretation. *British Journal of General Practice*. (2022) 72 (716): 132-133.
4. **Ferrari M**, Quaresima V. Racial discrepancies in oximetry: where do we stand? The gold standard choice. *Anaesthesia* (2022). First published: 07 January 2022 doi.org/10.1111/anae.15661

### ANNO 2021

5. Belluscio V, Casti G, **Ferrari M**, Quaresima V, Sappia M, Horschig J, Vannozzi G. Modifications in prefrontal cortex oxygenation in linear and curvilinear dual task walking: a combined fNIRS and IMUs study. *Sensors* (2021) 21(18): 6159.
6. **Ferrari M**, Quaresima V. The future of noninvasive neonatal brain assessment: the measure of cerebral blood flow by diffuse correlation spectroscopy in combination with near-infrared spectroscopy oximetry. *Journal of Perinatology* (2021) 41(11):2690-2691.
7. Scholkmann F, Restin T, **Ferrari M**, Quaresima V. The role of methemoglobin and carboxyhemoglobin in COVID-19: A Review. *Journal of Clinical Medicine* (2021) 10:50.

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8. Quaresima V, **Ferrari M**. More on pulse oximetry for monitoring patients with COVID-19 at home. *Annals of the American Thoracic Society* (2020) 17:1496.
9. **Ferrari M**, Quaresima V. Hypoxemia in COVID-19: cerebral oximetry should be explored as a warning indicator for mechanically ventilated adults with COVID-19. *Respiratory Research* (2020) 21: 261.
10. Di Giminiani R, Cardinale M, **Ferrari M**, Quaresima V. Validation of a fabric-based thigh wearable EMG sensors and oximetry for monitoring quadriceps activity during strength and endurance exercises. *Sensors* (2020) 20: 4664.
11. Quaresima V, **Ferrari M**. COVID-19: efficacy of prehospital pulse oximetry for early detection of silent hypoxemia. *Critical Care* (2020) 24: 501.

### ANNO 2019

12. Quaresima V, Farzam P, Anderson P, Farzam PY, Wiese D, Carp SA, **Ferrari M**, Franceschini MA. Diffuse correlation spectroscopy and frequency-domain near-infrared spectroscopy for measuring microvascular blood flow in dynamically exercising human muscles. *Journal of Applied Physiology* (1985). (2019) 127: 1328-1337.
13. Quaresima V, **Ferrari M**. A mini-review on functional near-infrared spectroscopy (fNIRS): Where do we stand, and where should we go? *Photonics* (2019) 6 (3): 87.
14. Quaresima V, **Ferrari M**. Functional near-infrared spectroscopy (fNIRS) for assessing cerebral cortex function during human behavior in natural/social situations: A concise review. *Organizational Research Methods*. (2019) 22: 46–68.

### ANNO 2018

15. Lancia S, Choi J, Baek J, Mammarella S, Bianco D, Quaresima V, **Ferrari M**. Trail making test induces prefrontal cortex activation as revealed by a CW wearable-wireless fNIRS/DOT imager. *Advances in Experimental Medicine and Biology*. (2018) 1072: 139-144.
16. Perrey S, **Ferrari M**. Muscle oximetry in sports science. *Sports Medicine*. (2018) 48 (3): 597–616.
17. Lancia S, Cofini V, Carrieri M, **Ferrari M**, Quaresima V. Are ventrolateral and dorsolateral prefrontal cortices involved in the computerized Corsi Block Tapping test execution? An fNIRS study. *Neurophotonics*. (2018) 5(1): 011019.
18. Muthalib M, **Ferrari M**, Quaresima V, Kerr G, Perrey S. Functional near-infrared spectroscopy to probe sensorimotor region activation during electrical stimulation-evoked movement. *Clinical Physiology and Functional Imaging* (2018) 38: 816–822.
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### ANNO 2016

20. **Ferrari M**, Culver JP, Hoshi Y, Wabnitz H. Special Section Guest Editorial: Clinical near-infrared spectroscopy and imaging. *Journal of Biomedical Optics*. (2016) 21 (9): 091301.
21. **Ferrari M**, Culver JP, Hoshi Y, Wabnitz H. Special Section Guest Editorial: Clinical near-infrared spectroscopy and imaging of the brain. *Neurophotonics* (2016) 3 (3): 031401.
22. Basso Moro S, Carrieri M, Avola D, Brigadoi S, Lancia S, Petracca A, Spezialetti M, **Ferrari M**, Placidi G, Quaresima V. A novel semi-immersive virtual reality visuo-motor task activates ventrolateral prefrontal cortex: a functional near-infrared spectroscopy study. *Journal of Neural Engineering*. (2016) 13(3): 036002.
23. Carrieri M, Petracca A, Lancia S, Basso Moro S, Brigadoi S, Spezialetti M, **Ferrari M**, Placidi G, Quaresima V. Prefrontal cortex activation upon a demanding virtual hand-controlled task: a new frontier for neuroergonomics. *Frontiers in Human Neurosciences*. (2016) 10: 53.

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24. Muthalib M, Re R, Zucchelli L, Perrey S, Contini D, Caffini M, Spinelli L, Kerr G, Quaresima V, **Ferrari M**, Torricelli. Effects of increasing neuromuscular electrical stimulation current intensity on cortical sensorimotor network activation: a time domain fNIRS study. *PLoS ONE* (2015) 10(7): e0131951.
25. Val-Lailliet D, Aarts E, Weber B, **Ferrari M**, Quaresima V, Stoeckel LE, Alonso-Alonso M, Audette M, Malbert CH, Stice E. Neuroimaging and neuromodulation approaches to study eating behavior, prevent and treat eating disorders and obesity. *NeuroImage: Clinical*. (2015) 8: 1-31. doi: 10.1016/j.nicl.2015.03.016

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26. **Ferrari M**, Bisconti S, Spezialetti M, Basso Moro S, Di Palo C, Placidi G, Quaresima V. Prefrontal cortex activated bilaterally by a tilt board balance task: a functional near-infrared spectroscopy study in a semi-immersive virtual reality environment. *Brain Topography*. (2014) 27: 353-365.
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28. Basso Moro S, Bisconti S, Muthalib M, Spezialetti M, Cutini S, **Ferrari M**, Placidi G, Quaresima V. A semi-immersive virtual reality incremental swing balance task activates prefrontal cortex: a functional near-infrared spectroscopy study. *Neuroimage*. (2014) 85: 451-460.
29. Placidi G, Avola D, **Ferrari M**, Iacoviello D, Petracca A, Quaresima V, Spezialetti M. A low-cost real time virtual system for postural stability assessment at home. *Computer Methods and Programs in Biomedicine* (2014) 117: 322-33.

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30. Basso Moro S, Cutini S, Ursini ML, **Ferrari M**, Quaresima V. Prefrontal cortex activation during story encoding/retrieval: a multi-channel functional near-infrared spectroscopy study. *Frontiers in Human Neurosciences*. (2013) 7, 925.
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33. Quaresima V, Bisconti S, **Ferrari M**. A brief review on the use of functional near-infrared spectroscopy (fNIRS) for language imaging studies in human newborns and adults. *Brain and Language*. (2012) 121: 79-89.
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37. **Ferrari M**, Quaresima V. A brief review on the history of human functional near-infrared spectroscopy (fNIRS) development and fields of application. *Neuroimage*. (2012) 63: 921-935.
38. Bisconti S, Di Sante G, **Ferrari M**, Quaresima V. Functional Near-Infrared Spectroscopy reveals heterogeneous patterns of language lateralization over frontopolar cortex. *Neuroscience Research*. (2012) 73:328-332.

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