Curriculum vitae of

Édouard ALPHANDÉRY (phd)

AlphaOnco

General information:

Last name: ALPHANDERY

First name: Edouard

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Loop Frontiers: loop.frontiersin.org/people/106081/overview

Lens (patent): lens.org/lens/search/patent/list?q=alphandéry

Positions Held:

From 2008 onwards: Founder and CEO of the company AlphaOnco (previously called Nanobacterie) created in 2008 (www.nanobacterie.fr).

2006-2024: Assistant professor at the University of Paris 6, Paris, France, working both in the physics and chemistry departments.

2018-2024: Visiting professor at the University of Zurich, Zurich, Switzerland (position financed by the Nomis foundation)

Education & Diploma:

2013: French accreditation to supervise PhD students.

2004-2006: Postdoc in biochemistry in the group of William Parson at the University of Washington, Seattle, USA.

2003-2004: Postdoc in biophysics in the group of John Donegan at Trinity College, Dublin, Ireland.

2002-2003: Teaching Physics in French University.

1997-2002: PhD in solid state physics in the group of Robin Nicholas at the University of Oxford, Oxford, UK.

October 2002: Award of the PhD degree in Solid state Physics from the University of Oxford.

1996-1997: Final undergraduate year at the University of Glasgow in Scotland.

1995-1996: Third year in physics (Magistère de physique fondamentale) at the University of Orsay, France.

1994-1995: Second year in math & physics at the University of Orsay, France.

June 1992: End of high school.

International ranking highlighting recognition of my work:

Edouard Alphandéry ranked first scholar in the specialty of iron oxide nanoparticles worldwide by Scholar GPS: https://scholargps.com/scholars/38135393643751/edouard-alphandery

Edouard Alphandéry ranked among the top 2% of the best scientists worldwide by Stanford University: https://topresearcherslist.com/Home/Profile/785623

Ranking: 23725 (2024); 25646 (2023); 14036 (2022); 27739 (2021); 95596 (2020)

The patent portfolio built by Edouard Alphandéry within AlphaOnco-Nanobacterie ranked 4th in Nanomedicine in terms of number of submitted patents in this field by the IP firm Mark and Clerck: Nanomedicine: a retrospective and a glimpse into the future

Summary of my research activities:

I have developed a cancer treatment consisting of two medical devices: a suspension of natural iron oxide nanoparticles, called magnetosome, and an ultrasound heating module. The treatment works through magnetosome administration in the tumor followed by moderate heating of the tumor to destroy it.

Compared with chemically synthesized nanoparticles, magnetosomes present the advantages of being purer in iron, more biocompatible, more magnetic, and arranged in chains enabling a more favorable distribution in the tumor. Concerning to the heating module, it is designed to heat and hence target the whole tumor using moderate heating temperatures to avoid damaging surrounding healthy tissues.cWe have recently published an article, showing that we can fully eradicate subcutaneous PC3 prostate tumors by introducing magnetosomes in these tumors and by heating them 6 to 10 times 10 minutes at 45 °C (DOI: 10.1002/adtp.202400281).

Since 2008, my efforts have essentially been articulated around three aspects:

1. The development of magnetosomes that can be injected to humans through the development of methods to yield: i) non-pyrogenic magnetosomes, ii) magnetosome production in the absence of toxic compounds, iii) stable magnetosomes that can be stored in powder form and re-suspended in water before injection (DOI: 10.1039/d4nr02284j)

2. The determination of an optimal hyperthermia treatment of solid tumors and glioblastoma tumors and by heating them under the alternating magnetic field, leading to full tumor disappearance.

3. The treatment of prostate tumors using an ultrasound heating source, which is more compact, less expensive, easier to use than the alternating magnetic field.

The overall aim of the project is to develop a treatment of solid tumors (starting with prostate ones), which is affordable, can be performed outside the operating theatre without necessitating general anesthesia, in an efficient and safe manner.

To develop such activity, I relied on my interdisciplinary background, having studied during my youth:

- enzymology, *i.e.* the stability of an enzyme called catechol-o-methyltransferase responsible for the inhibition of dopamine in the brain during my postdoc at the University of Washington, USA (DOI: 10.1016/j.bbapap.2008.04.006);

- physico-chemistry, *i.e.* Förster resonance energy transfer between nanocrystals and dyes during my postdoc at Trinity College, Ireland (DOI: 10.1016/j.cplett.2004.02.080);

- solid state physics, *i.e.* the growth conditions and photoluminescent properties of self-assembled InSb quantum dots during my PhD at the University of Oxford, UK (DOI: 10.1063/1.123750);

Publications

1. Self-assembled InSb quantum dots grown on GaSb: A Photoluminescence, magnetoluminescence and atomic force microscopy study,
E. Alphandéry, R. J. Nicholas, N. J. Mason, P. Möck, G. R. Booker, B. Zhang, Appl. Phys. Lett. V. 74, P. 2041 (1999).
DOI: 10.1063/1.123750 (H factor: 3.5)

2. MOVPE grown self-assembled Sb-based quantum dots assessed by means of AFM and TEM,
P. Möck, G. R. Booker, N. J. Mason, E. Alphandéry, and R. J. Nicholas, I.E.E. Pro. Optoelectron. V. 147, P. 209 (2000). (H factor: 1.7)

3. MOVPE grown self-assembled and self-ordered InSn quantum dots in GaSb matrix assessed by AFM, CTEM, HRTEM and PL, P. Möck, G. R. Booker, N. J. Mason, R. J. Nicholas, E. Alphandéry, T. Topuria and N. D. Browning, Materials Science and Engineering B. V. 80, P. 112 (2001).
DOI: 10.1049/ip-opt:20000615 (H factor: 3)

4. Photoluminescence of self-assembled InSb quantum dots grown on GaSb as a fonction of excitation power, temperature and magnetic field,
E. Alphandéry, R.J. Nicholas, N.J. Mason, S.G. Lyapin, and P.C. Klipstein, Physical Review B, V. 65, P. 115322 (2002).
DOI: 10.1103/PhysRevB.65.115322 (H factor: 3.7)

5. Tunable mid-IR emission using a novel quantum dot-quantum tell coupled system,
R.A. Child, R.J. Nicholas, N.J. Mason, E. Alphandéry, Physica E, V. 13, P. 241 (2002).
DOI: 10.1016/S1386-9477(01)00529-X (H factor: 3.2)

6. Properties of narrow gap quantum dots and wells in the InAs/InSb/GaSb systems,
RJ. Nicholas, PA. Shields, RA. Child, LJ. Li, E. Alphandéry, NJ. Mason, C. Bumby, Physica E, V. 20, P. 204 (2004).
DOI: 10.1016/j.physe.2003.08.004 (H factor: 3.2)

7. Highly efficient Förster resonance energy transfer between CdTe nanocrystals and Rhodamine B in solid films, E. Alphandéry, L. M. Walsh, Y. Rakovich, L. Bradley, J. F. Donegan, N. Gaponik, Chemical Physics Letters V. 388, P. 100 (2004).
DOI: 10.1016/j.cplett.2004.02.080 (H factor:2)

8. The V108M Polymorphism Decreases the Thermal and Chemical Stability of Human Catechol-Omethyltransferase, K. Rutherford, E. Alphandéry, A. C. Mc Millan, V. Daggett, W. W. Parson, Biochimestry Biophysics Acta, V. 7-8, P.1098 (2008).
DOI: 10.1016/j.bbapap.2008.04.006 (H factor: 3.7)

9. Difference between the magnetic properties of the magnetotactic bacteria and those of the extracted magnetosomes: Influence of the distance between the chains of magnetosomes, E. Alphandéry, C. Lefèvre, I. Lisiecki, A. T. Ngo, L. F. Wu and M. P. Pileni, Journal of Physical Chemistry C, V. 112, P. 12304 (2008).
DOI: 10.1021/jp800408t (H factor: 4.3)

10. Assemblies of Aligned Magnetotactic Bacteria and Extracted Magnetosomes: What Is the Main Factor Responsible for the Magnetic Anisotropy ?
E. Alphandéry, Y. Ding, A. T. Ngo, Z. L; Wang, and M. P. Pileni, ACS Nano, V. 3, P. 1539 (2009).
DOI: 10.1021/nn900289n (H factor: 13.9)

11. Different signatures between chemically and biologically synthesized nanoparticles in a magnetic sensor: A new technology for multiparametric detection,
E. Alphandéry, L. Lijeour, Y. Lalatonne, L. Motte, Sensors and Actuators B: Chemical, V. 147, P. 786 (2010).
DOI: 10.1016/j.snb.2010.04.009 (H factor: 6.4)

12. Heat production by bacterial magnetosomes exposed to an oscillating magnetic field, E. Alphandéry, S. Faure, L. Raison, E. Duguet, P. A. Howse, D. A. Bazylinski, Journal of Physical Chemistry C, V. 115, P. 18 (2011).
DOI: 10.1021/jp104580t (H factor: 4.3)

13. Cobalt doped magnetosomes: Impact of the organization in chains on the magnetic properties,
E. Alphandéry, C. carvallo, N. Menguy, I. Chebbi, Journal of Physical Chemistry C, V. 115, P. 6279 (2011).
DOI: 10.1007/978-3-642-38262-8_5 (H factor: 4.3)

14. Chains of Magnetosomes Extracted from AMB-1 Magnetotactic Bacteria for Application in Alternative Magnetic Field Cancer Therapy, E. Alphandéry, S. Faure, O. Seksek, F. Guyot, I. Chebbi, ACS Nano, V. 5, P. 6279 (2011)
DOI: 10.1021/nn201290k (H factor: 13.9)

15. The effect of iron-chelating agents on Magnetospirillum magneticum strain AMB-1: stimulated growth and magnetosome production and improved magnetosome heating properties, E. Alphandéry, M. Amor, F. Guyot, I. Chebbi, Applied Microbiology and Biotechnology, V. 96, P. 663-670 (2012).
DOI: 10.1007/s00253-012-4199-5 (H factor: 3.7)

16. Preparation of chains of magnetosomes, isolated from Magnetospirillum magneticum strain AMB-1 magnetotactic bacteria, yielding efficient treatment of tumors using magnetic hyperthermia,
E. Alphandéry, F. Guyot, I. Chebbi, International Journal of Pharmaceutics, V. 434, P. 444-452 (2012).
DOI: 10.1016/j.ijpharm.2012.06.015 (H factor: 4.2)

Publications (2/3)

17. Use of bacterial Magnetosomes in the magnetic hyperthermia treatment of tumours: A review, E. Alphandéry, I. Chebbi, F. Guyot, M. Durand-Dubief, International Journal of Hyperthermia, V. 11, P. 801-810 (2013). DOI: 10.3109/02656736.2013.821527 (H factor: 3.4)

18. Applications of Magnetosomes synthesized by magnetotactic bacteria in medicine, E. Alphandéry, Frontiers in Bioengineering and Biotechnology, V. 2, P. 1-6 (2014). DOI: 10.3389/fbioe.2014.00005 (H factor: 5.1)

19. Perspective of Breast Cancer Thermotherapies, E. Alphandéry, Journal of Cancer, V. 5, P. 472-479 (2014). DOI:10.7150/jca.8693 (H factor: 3.2)

20. Chemical signature of magnetotactic bacteria, M. Amor, V. Busigny, M. Durand-Dubief, M. Tharaud, G. Ona-Nguema, A. Galabert, E. Alphandéry, N. Menguy, M. F. Benedetti, I. Chebbi, F. Guyot, Proceedings of the National Academy of Science, V. 112, P. 1699 (2015). DOI: 10.1073/pnas.1414112112 (H factor: 9.4)

21. Cancer therapy using nanoformulated substances: scientific, regulatory and financial aspects, E. Alphandéry, P. Grand-Dewyse, R. Le fèvre, C. Mandawala, M. Durand-Dubief, Expert Review of anticancer therapy, V. 15, P. 1233-1255 (2015). DOI: 10.1586/14737140.2015.1086647 (H factor: 2.6)

22. Mass-dependent and-independent signature of Fe isotopes in magnetotactic bacteria, M. Amor, V. Busigny, P. Louvat, A. Gélabert, P. Cartigny, M. Durand-Dubief, G. Ona-Nguema, E. Alphandéry, I. Chebbi, F. Guyot, Science, V. 352, P. 705-708 (2016). DOI: 10.1126/science.aad7632 (H factor: 41)

23. Development of non-pyrogenic magnetosome minerals coated with poly-l-lysine leading to full disappearance of intracranial U87-Luc glioblastoma in 100% of treated mice using magnetic hyperthermia, E. Alphandéry, A. Idbaih, C. Adam, J-Y. Delattre, C. Schmitt, F. Guyot, I. Chebbi, Biomaterials, V. 262, P. 259-272 (2017). DOI: 10.1016/j.biomaterials.2017.06.026 (H factor: 10.2)

24. Chains of magnetosomes with controlled endotoxin release and partial tumor occupation induce full destruction of intracranial U87-Luc glioma in mice under the application of an alternating magnetic field, E. Alphandéry, A. Idbaih, C. Adam, J-Y. Delattre, C. Schmitt, F. Guyot, I. Chebbi, Journal of controlled release, V. 141, P. 210-222 (2017). DOI: 10.1016/j.jconrel.2017.07.020 (H factor: 7.9)

25. Enhanced antitumor efficacy of biocompatible magnetosomes for the magnetic hyperthermia treatment of glioblastoma, R. Le Fèvre, M. Durand-Dubief, I. Chebbi, C. Mandawala, F. Lagroix, J-P. Valet, A. Idbaih, C. Adam, J-Y. Delattre, C. Schmitt, C. Maake, F. Guyot, E. Alphandéry, Theranostics, V. 7, P. 4618-4630 (2017). DOI: 10.7150/thno.18927 (H factor: 8)

26. Biocompatible coated magnetosome minerals with various organization and cellular interaction properties induce cytotoxicity towards RG-2 and GL-261 glioma cells in the presence of an alternating magnetic field, Y. Hamdous, I. Chebbi, C. Mandawala, R. Le Fèvre, F. Guyot, O. Seksek, E. Alphandéry, Journal of nanobiotechnology, V.15, P. 1-18 (2017) DOI: 10.1186/s12951-017-0293-2 (H factor: 5.3)

27. Biocompatible and stable magnetosome minerals coated with poly-L-lysine, citric acid, oleic acid, and carboxy-methyl-dextran for application in the magnetic hyperthermia treatment of tumors, C. Mandawala, I. Chebbi, M. Durand-Dubief, R. Le Fèvre, Y. Hamdous, F. Guyot, E. Alphandéry, Journal of Material Chemistry B, V. 5, P. 7644 (2017). DOI: 10.1039/C6TB03248F (H factor: 5)

28. Nanoprobe Synthesized by Magnetotactic Bacteria, Detecting Fluorescence Variations under Dissociation of Rhodamine B from Magnetosomes following Temperature, pH Changes, or the Application of Radiation, E. Alphandéry, D. Abi-Haidar, O. Seksek, A. Trautmann, N. Bergovicci, F. Gazeau, F. Guyot, I. Chebbi, ACS Applied Materials and interfaces, V. 9, P. 36561 (2017). DOI: 10.1021/acsami.7b09720 (H factor: 8.5)

29. Iron uptake and magnetite biomineralization in the magnetotactic bacterium Magnetospirillum magneticum strain AMB-1: An iron isotope study, M. Amor, V. Busigny, P. Lovat, M. Tharaud, A. Gélabert, P. Cartigny, J. Carlut, A. Isambert, M. Durand-Dubief, G. Ona-Nguema, E. Alphandéry, I. Chebbi, F. Guyot, Geochimica et Cosmochimica Acta, V. 231, P. 225-243 (2018). DOI: 10.1016/j.gca.2018.04.020 (H factor: 4.7)

30. Magnetic-field induced rotation of magnetosome chains in silicified magnetotactic bacteria, M. Blondeau, Y. Guyodot, F. Guyot, C. Gatel, N. Menguy, I. Cebbi, B. Haye, M. Durand-Dubief, E. Alphandéry, R. Brayner, T. Coradin, Scientific Reports, 8:7699 (2018). DOI: 10.1038/s41598-018-25972-x (H factor: 4)

31. Glioblastoma treatments: An account of recent industrial developments, E. Alphandéry, Frontiers in Pharmacology, V. 9, Article 879 (2018). DOI: 10.3389/fphar.2018.00879 (H factor: 3.9)

32. Fluorescent magnetosomes for controlled and repetitive drug release under the application of an alternating magnetic field under conditions of limited temperature increase (<2.5 °C), E. Alphandéry, D. Abi Haidar, O. Seksek, F. Guyota, I. Chebbi, Nanoscale, V. 10, P. 10918 (2018). DOI: 10.1039/c8nr02164c (H factor: 7)

33. Biodistribution and targeting properties of iron oxide nanoparticles for treatments of cancer and iron anemia disease, E. Alphandéry, Nanotoxicology, V.13, P. 573 (2019). DOI: 10.1080/17435390.2019.1572809. (H factor: 6)

34. A discussion on existing nanomedicine regulation: Progress and pitfalls, E. Alphandéry, Applied Materials Today, V. 17, P. 193 (2019). DOI: 10.1016/j.apmt.2019.07.005. (H factor: 8)

35. Iron oxide nanoparticles as multimodal imaging tools E. Alphandéry, RCS Advances, V. 9, P. 40577 (2019). DOI: 10.1039/C9RA08612A. (H factor: 3)

36. Biodegraded magnetosomes with reduced size and heating power maintain a persistent activity against intracranial U87-Luc mouse GBM tumors, E. Alphandéry, A. Idbaih, C. Adam, J-Y. Delattre, C. Schmitt, F. Gazeau, F. Guyot, I. Chebbi, Journal of Nanobiotechnology, V. 17: 126 (2019). DOI: 10.1186/s12951-019-0555-2. (H factor: 5)

Publications (3/3)

37. Iron oxide nanoparticles for therapeutic applications
E. Alphandéry, Drug Discovery Today, V. 25, P. 141 (2020).
DOI: 10.1016/j.drudis.2019.09.020 (H factor: 6.9)

38. Nano-therapies for Glioblastoma treatment,
E. Alphandéry, Cancers, V. 12, P. 242 (2020).
DOI: 10.3390/cancers12010242 (H factor: 6.2)

39. A method for producing highly pure magnetosomes in large quantity for medical applications using magnetospirillum gryphiswaldense MSR-1 magnetotactic bacteria amplified in minimal growth media,
Clément Berny, Raphael Le Fèvre, François Guyot, Karine Blondeau, Christine Guizonne, Emilie Rousseau, Nicolas Bayan, and Edouard Alphandéry, Frontiers in Bioengineering and Biotechnology, V. 8, Art. 16 (2020).
DOI: 10.3389/fbioe.2020.00016 (H factor: 5.1)

40. Bio-synthesized iron oxide nanoparticles for cancer treatment, Edouard Alphandéry, International Journal of Pharmaceutics, V. 586, P. 119472 (2020).
DOI: 10.1016/j.ijpharm.2020.119472 (H factor : 6.5)

41. Applications of magnetotactic bacteria and magnetosome for cancer treatment: A review emphasizing on practical and mechanistic aspects,
Edouard Alphandéry, Drug Discovery Today, V. 25, P. 1444 (2020).
DOI: 10.1016/j.drudis.2020.06.010 (H factor : 8.4)

42. Natural Metallic Nanoparticles for Application in Nano-Oncology, Edouard Alphandéry, International Journal of Molecular Science, V. 21, Art 4412 (2020).
DOI: 10.3390/ijms21124412 (H factor : 6.2)

43. Light-Interacting iron-based nanomaterials for localized cancer detection and treatment,
Edouard Alphandéry, Acta Biomaterialia, V. 124, P. 50 (2021).
DOI: 10.1016/j.actbio.2021.01.028. (H factor: 10.6)

44. Nano dimensions/adjuvants in COVID-19 vaccines,
Edouard Alphandéry, J. Mater. Chem. B, V. 10, P. 1520 (2022)
DOI: 10.1039/d1tb02408f. (H factor: 7)

45. Ultrasound and nanomaterial: an efficient pair to fight cancer, Edouard Alphandéry, Journal of Nanobiotechnology, 20:139 (2022).
DOI: 10.1186/s12951-022-01243-w. (H factor: 11.5).

46. Nanomaterials as Ultrasound Theragnostic Tools for Heart Disease Treatment/Diagnosis,
Edouard Alphandéry, International Journal of Molecular Science, V. 23, art 1683 (2022).
DOI: 10.3390/ijms23031683. (h factor: 6.2).

47. Non-pyrogenic highly pure magnetosomes for efficient hyperthermia treatment of prostate cancer,
Tieu Ngoc Nguyen, Imène Chebbi, Raphaël Le Fèvre, François Guyot, Edouard Alphandéry, Applied Microbiology and Biotechnology (2023).
DOI: 10.1007/s00253-022-12247-9. (h factor: 5.6).

48. Magnetic and structural properties of biogenic magnetic nanoparticles along their production process for use in magnetic hyperthermia, Claire Carvallo, Alain Fondet, Raphael Le Fèvre, Dario Taverna, Yoann Guyodo, Imène Chebbi, Vincent Dupuis, France Lagroix, M. Khelfallah, Jean-Michel Guigner, François Guyot, Edouard Alphandéry, Amélie Juhin, Journal of Magnetism and Magnetic Materials, V. 575, P. 170726 (2023).
DOI: 10.1016/j.jmmm.2023.170726 (H factor: 3).

49. Set-up of a pharmaceutical cell bank of Magnetospirillum gryphiswaldense MSR1 magnetotactic bacteria producing highly pure magnetosomes,
Theo Chades, Raphael Le Fevre, Imene Chebbi, Karine Blondeau, Francois Guyot and Edouard Alphandery, Microbial Cell Factories, 23:70 (2024).
DOI: 10.1186/s12934-024-02313-4. (H factor: 5)

50. Stable pharmaceutical composition of cryo-protected non-pyrogenic isotonic chains of magnetosomes for efficient tumor cell destruction at 45 ± 1 °C under alternating magnetic field or ultrasound application,
Tieu Ngoc Nguyen, Imène Chebbi, Raphaël Le Fèvre, François Guyot and Edouard Alphandéry, Nanoscale, V. 16, P. 18984 (2024).
DOI: 10.1039/d4nr02284j (H factor: 5)

51. Full Disappearance of PC3-Luc Prostate Tumors Mediated by Hyperthermia Under Low Intensity Ultrasound Application in the Presence of Magnetosomes,
Cynthia El Hedjaj, Eric Barret, Imène Chebbi, Raphaël Le Fèvre, Caroline Maake, Franco Guscetti, François Guyot, Jean-Francois Aubry, Olivier Seksek, and Edouard Alphandéry, Adv. Therap., 2400281 (2025).
DOI: 10.1002/adtp.202400281 (H factor: 3)

52. Multivariate Screening and Automated Clustering of Macrophage Immunoreactome to Nanoparticles and Photothermal Therapy,
Sonia Becharef, Léa Jabbour, Nassima Bekaddour, Giulio Avveduto, Nathalie Luciani, Gautier Laurent, Rana Bazzi, Edouard Alphandery, Stéphane Roux, Amanda K. A. Silva, Kelly Aubertin, Jean-Philippe Herbeuval, and Florence Gazeau, Adv. Sci, 2405860 (2025).
DOI: 10.1002/advs.202405860 (H factor: 15)

Patents

I have made inventions leading to the following patents listed below:

1st family protecting chains of magnetosomes for medical applications: *Treatment of cancer or tumors induced by the release of heat generated by various chains of magnetosomes extracted from magnetotactic bacteria and submitted to an alternative magnetic field,* int. publ. number: WO2011061259A1, first priority US61/262,260 filed on 18/11/2009, inventors: **E. Alphandéry**, S. Faure, I. Chebbi.

Patents : SE10781494-9, NL10781494-9, IT502015000022641, IE10781494-9, GB10781494-9, FR10781494-9, ES10781494-9, DE10781494-9, CH10781494-9, RU2012122639, IL219745, CN201080060420-9, CA2780851, BR112012011767-0, AU2010320918, US16/292662, JP2016-031157, US15/433018, US13/510416, JP2012-539330.

2nd family protecting the introduction of chelating agents in the medium of magnetotactic bacteria to boost bacterial growth: *Use of at least one chelating agent introduced into the culture medium of magnetotactic bacteria in order to stimulate the growth thereof,* int. publ. number: WO2012/153247, first priority FR1153938 filed on 06/05/2011, inventors: **E. Alphandéry**, I. Chebbi.

Patents: US9359589, EP12722893

Patents (2/2)

3rd family protecting non-pyrogenic magnetosomes for medical applications: *Apyrogen preparation containing nanoparticles synthesized by magnetotactic bacteria for medical or cosmetic applications*, int. publ. Number WO2016203121, first priority FR1501267 filed on the 17/06/2015, inventors: **E. Alphandéry**, M. Durand-Dubief. Granted in Europe, Israel, Japan, South Corea, USA, Canada, and Australia.

Patents: SE16744434-8, NL16744434-8, LU16744434-8, IT502021000045962, IE16744434-8, GB16744434-8, FR3037581, ES16744434-8, DE16744434-8, CH16744434-8, BE16744434-8, IL255435, KR10-2017-7034555, JP2017-561730, CN201680032820-6, CA2985163, AU2016277897, FR1501267, US16/506104, US17/198645, US15/510048.

4th family protecting a fluorescent iron oxide nanoparticle used as probe: *Particle containing at least one ferrimagnetic iron oxide nanoparticle associated to at least one component for a medical or cosmetic use,* int. pub. number: WO/2017/068252, first priority FR150228 filed on 21/10/2015, inventors: **E. Alphandéry**, I. Chebbi.

Patents: EP3292409, GB16805165-4, CH16805165-4, IL257998, CA2996378, JP2018534271, CN201680056670-2, FR1502228, US17/245504.

5th family protecting a method to carry out magnetic hyperthermia treatment at several frequencies of oscillations of the magnetic field: *Magnetic field oscillating at several frequencies improve efficacy and/or reduce toxicity of magnetic hyperthermia,* first priority EP17290023 filed on 16/02/2017, int pub number WO2018150266, inventor: **E. Alphandéry**.

Patents: SE18711153-9, NL18711153-9, LU18711153-9, IT18711153-9, IE18711153-9, GB18711153-9, FR18711153-9, ES18711153-9, DE18711153-9, CH18711153-9, BE18711153-9, JP2019-539244, IL268627, CN201880007642-0, CA3030632, AU2018220863, CN202310862829-1, US18/147952, EP21020196-8, US16/325486.

6th family protecting a method to destroy a tumor at some distance from the regions of injection of the nanoparticle and application of radiation: *Magnetic nanoparticles associated to immunogenic entities for destroying pathological cells in an individual.* First priority EP16290202, filed on 21/10/2016, inventor: **E. Alphandéry**.

Patents: US16/845412, EP17305666-4, US15/615206.

7th family protecting a method to destroy a tumor through the sequential application of an acoustic wave: *Nanoparticles exposed sequentially to low intensity acoustic waves for medical treatment.* Int pub number WO2019106428, First priority EP17020555.3, EP17020556 filed on 30/11/2017, inventor: **E. Alphandéry**.

Patents: JP2020-528904, CA3050088, AU2018374564, IL267760, CN201880076134-8, EP18827221-5, US18/422687, US16/486574.

8th family protecting a method to fabricate pure magnetosomes in iron by using a minimal growth medium: *Cellular production of pure iron oxide nanoparticles,* first priority FR1801034 submitted on 02/10/2018, inventor: **E. Alphandéry**.

Patents: JP2019-181697, KR10-2019-0121517, CN201910962115-1, US16/589227, IL269755, CA3057346, EP19020545-0, AU2019240579, IN201914039721, FR1801034, US18/340297.

9th family protecting a method to purify magnetosomes through combustion: *Method for removing impurities from nanoparticles,* first priority FR1801033 submitted on 02/10/2018, inventor: **E. Alphandéry**.

Patents: FR2303049, US16/589394, US18/895634, EP19020544-3, FR1801033

10th family protecting a method of treatment by cryo-therapy in the presence of nanoparticles: *Nanoparticle for use in a method of treating a body part of an individual by non-predominant ice-ball cryotherapy,* first priorities EP19020359.6, EP19020360.4 submitted on 03/06/2019, inventor: **E. Alphandéry**.

Patents: JP2024-126004, US18/298801, KR10-2023-0106432, CA3082149, IL275020, CN202010490811-X, US16/887179, EP20020253-9, KR10-2020-0066909, AU2020203591, IL305397.

11th family protecting a method to release a compound from a nanoparticle in two separate steps: *Method for increasing the release of medical compounds from nanoparticles after an alteration step and physico-chemical disturbance step*, int pub number WO2020217205A1, first priority FR1904404 submitted on 25/04/2019, inventor **E. Alphandéry**.

Patents: CA3136792, US17/605383, EP20721811-6, FR1904404.

12th family protecting a method of treatment using sequential laser application applied on magnetosomes: *Magnetic nanoparticles sequentially irradiated by laser radiation for medical or biological or cosmetic applications*, first priority EP18020211.1 submitted on 16/05/2018, inventor: **E. Alphandéry**.

Patents: JP2024-178350, US16/412933, IL266645, CA3043592, AU2019203410, EP19020331-5.

13th family protecting a method to maintain the chain arrangement of magnetosomes after lyophilization using a magnetosome formulation containing a cryo-protectant: *A method to enable nanoparticles stored with a specific type of assembly to maintain this type of assembly upon reconstitution*, first priority EP22020559.5 submitted on 15/11/2022, inventors: **E. Alphandéry**, I. Chebbi.

Patents: CA3220038, FR2212910, US18/509901, CN202311512346-5, EP23020495-0.

Financing:

2010: A grant of 60 000 euros awarded by OSEO to Nanobacterie.

2011: A refundable aid of 100 000 euros awarded by OSEO to Nanobacterie.

2012: An ANR P2N grant of 120 000 euros to Nanobacterie, in collaboration with CEA.

2015: A Eurostars grant (Nanoneck-2, E!9309) from Europe/BPI to Nanobacterie, in collaboration with EPFL & Univ. of Zurich.

2017: A Eurostars grant (Nanoglioma, E! 11778) from Europe/BPI to Nanobacterie, in collaboration with the Univ. of Zurich.

2020: A Eurostars grant (Nanoprostate, E!114157) from Europe/BPI to Nanobacterie, in collaboration with the Univ. of Zurich.

Teaching:

I have been teaching at university optics, solid state physics, quantum mechanics, general physics, thermodynamics and history of drugs and drug development.

Supervision of PhD Students through the French CIFRE program:

2014-2017: Thesis of Chalani. Mandawala (CIFRE 2014/0359): *"Optimization of magnetosomes for cancer treatment"*. Collaboration between Museum of natural history and Nanobacterie.

2015-2018: Thesis of Yasmina Hamdous (CIFRE 2015/0976): *"Formulation of magnetosomes for cancer treatment"*. Collaboration between University Paris Saclay and Nanobacterie.

2013-2016: Thesis of Raphael Le Fèvre (CIFRE 364/2013): *"Production in large quantity of magnetosomes for medical applications"*. Collaboration between Institute of physics of globe and Nanobacterie.

2016-2019: Thesis of Clément Berny (CIFRE 2016/0747): *"optimizations of the condition of fermentation of magnetotactic bacteria for medical applications of magnetosomes"*. Collaboration between Institute for Integrative Biology of the Cell and Nanobacterie.

2018-2021: Thesis of Tieu Ngoc Nguyen (CIFRE 2018/0468): *"Use of nanoparticles of biological origin (magnetosomes) for the treatment of prostate tumors: Preparation of clinical trials"*. Collaboration between Museum of natural history and Nanobacterie.

2018-2021: Thesis of Christine Guizonne (CIFRE 2018/0922): *"Physiological approach of the production of magnetosomes by magnetotactic bacteria Magnetospirillum Griphiswaldense"*. Collaboration between University Paris Saclay and Nanobacterie.

2018-2021: Thesis of Cynthia El Hedjaj (CIFRE 2018/0985): *"In vitro, ex vivo, in vivo studies of fluoresent magnetosomes produced by the company Nanobacterie to develop a fluorescent local probe working under the application of a radiation"*. Collaboration between University Paris Saclay and Nanobacterie.

2020-2023: Thesis of Théo Chades (CIFRE 2019-0032): *"Optimization/automatization of the culture conditions (oxygenation) of magnetotactic bacteria"*. Collaboration between Institute for Integrative Biology of the Cell and Nanobacterie.

2020-202: Thesis of Sonia Bécharef (CIFRE 2020-0996): *"Study of the immune mechanisms triggered by magnetosomes under exposure of various radiations"* Collaboration between University Paris Descartes and Nanobacterie.

Recruitment & supervision of a research team within AlphaOnco:

I have recruited and supervised the following researchers within AlphaOnco:

2008: téphanie Faure (PhD), carrying out the proof of concept of magnetic hyperthermia treatment with magnetosomes on mice bearing subcutaneous breast tumors.

2010: Imène Chebbi (PhD): working on all aspects of the development of the therapy developed by Nanobacterie (magnetosome production and formulation, toxicity and efficacy assessment of magnetosomes using various sources of excitation (magnetic field, laser) on animals (mice/dogs) bearing tumors).

2012: Mickaël Durand-Dubief (PhD), studying magnetosome formulation.

2017: Raphaël Le Fèvre (PhD), optimizing bacterial growth to obtain magnetosomes in sufficiently large quantities without impurities/toxic products.

2018: Sha Li (PhD), developing tumor cell destruction by cryo-therapy in the presence of magnetosomes.

Supervision of Master Students:

I have supervised ~ 30 master II students (6 months internship) coming from various Universities and fields (biology, chemistry, physics).