



Centro Università degli Studi di Milano - Scuola per la diffusione delle Bioscienze
Via Celoria 20 - 20133 Milano
Tel: +39 02.503.14054 Fax: +39 02.503.15040
www.cusmibio.unimi.it
cusmibio@unimi.it

CusMiBio - Centre of the University and School of Milan for Bioscience Education

CusMiBio was founded by the University of Milan in 2004 in close collaboration with the Lombardy Educational Office. The main goal of the project was to improve science education in the Italian school system by acting both on science teachers and high school students. Indeed, the centre represents a bridge between the High School and University educational systems, with the general aim to increase the perception of Science in society. CusMiBio organizes training activities and updating courses directed to school teachers and laboratory activities for high school students, to increase their STEM skills and their interest in biosciences with the final goal of ensuring a new generation of researchers. For the past 11 years, ~ 120,000 Italian students and ~ 700 school teachers participated in experimental activities organized by CusMiBio.

CusMiBio provides advanced CPD (Continuing Professional Development) courses and experimental laboratories mainly in the field of Biosciences, integrating the expertise of both researchers and professors from several Departments and Faculties of the University of Milan: Biological Sciences and Biotechnology, Medicine, Pharmacy, Veterinary, Agricultural Sciences, Informatics, Chemistry, Physics and Mathematics. Indeed, CusMiBio has been developed following the philosophy that interactions between the various levels of the educational system (school students, school teachers, university students and university researchers and professors) are fundamental to boost the interest in scientific careers as well as the public awareness of scientific priorities in Europe.

CusMiBio activities, in frame of IBSE support, include training courses in molecular biology and genetics combining cutting-edge science with research activities that are easily transferable to the classroom. Additionally, we include IBSE support modules in our Bioteach Web Project (<http://bioteacheng.ariel.ctu.unimi.it>) where science teachers can find a collection of molecular biology and bioinformatics teaching modules. The participation in International (Science on Stage, ESOF, World Science Conference Israel) and National Science Festivals (Genova Science Festival, Bergamo Scienza, Foligno Festa di Scienza e Filosofia) is an additional relevant way to disseminate our IBSE activities.

CusMiBio has its own laboratories within the university campus. The labs are fully equipped with cutting edge instruments, including 36 “wet” stations, and 28 bioinformatics stations, each with computer and internet connection. CusMiBio is directed by Professor Paolo Plevani and co-Directed by Professor Giovanna Viale, faculty members of the University of Milan; two high school teachers, both members of the Lombardy Educational Office, work full-time at CusMiBio, Cinzia Grazioli and Livia Pirovano. Additionally, about two dozen researchers and professors of the University of Milano collaborate with

CusMiBio in seminars, updating courses, and setting-up of new hands-on activities for students. Several Ph.D. students and post-docs act as tutors during the hands-on activities in the labs.

CusMiBio is a member of NYEX (Network of Youth Excellence) and has signed a collaborative agreement with the DNA Learning Center (DNALC) of the Cold Spring Harbor Laboratory for the development and implementation of lab activity on DNA barcoding in the Italian schools.

Aims of CusMiBio

The general philosophy underlying all the initiatives developed by CusMiBio is that High School Teachers are the key elements in the process of diffusion of knowledge. Consequently, all activities towards high school students are discussed and organized in close collaboration with the teachers. Therefore, CusMiBio aims to:

- a) provide constant scientific updating for High School Teachers together with new stimuli for doing their work in a more motivated, creative and effective way;
- b) promote a more participatory, inquiry-based approach in High School science education;

Activities for High School Students

CusMiBio seeks to increase the participation of students in biological research and to encourage them to prepare for careers in research in the broad spectrum of the biological sciences from medicine, to biotechnology, ecology and bioinformatics.

The aim is to:

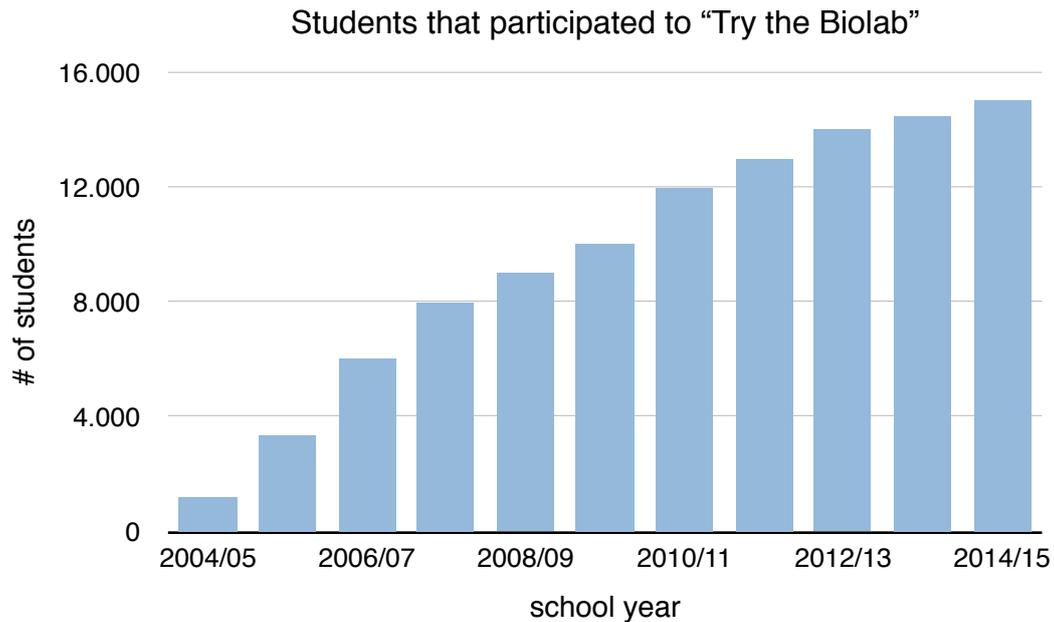
- a) support students in conscious planning of their future studies and to ensure a new generation of researchers;
- b) promote and favour the outgrowth of the most talented students.

Major initiatives directed towards High School Students are listed below.

Try the Biolab

Entire classes visit a fully equipped laboratory within the University campus where students can perform hands-on experiments in some hot topics of genetics and biotechnology under the supervision of a lead teacher and of young tutors.

The proposed activities take place in the CusMiBio lab and follow a daily schedule organized via a booking system that opens at the beginning of the school year. The chart below shows the number of students that attended during the past eleven years:



Listed here are the topics of the molecular biology and bioinformatics lab activities:

DNA profiling: DNA analysis performed to obtain molecular fingerprinting, i.e. for human genotypic identification.

Healthy or affected? A simulation of genetic counselling and prenatal diagnosis of genetic diseases by means of RFLP (Restriction Fragments Length Polymorphism) analysis.

DNA cloning: white or blue? recombinant or not? Two genetic engineering activities on DNA cloning in bacterial cells and on the identification of recombinant DNA molecules.

Chromosome analysis: preparation and optical microscope observation of healthy human metaphase chromosomes; cytogenetic analysis of human normal and pathological karyotypes.

Surfing among genomes: a bioinformatics module to discover how scientists use genetic information in databases and how to become familiar with the main tools available online used to ask (and answer) questions about the human genome.

Gene Hunting: online searching for genes, proteins and mutations associated with genetic disorders.

Invisible forms: lysozyme crystals can be obtained in short time and observed at light microscope; in a parallel bioinformatics module, students visit one of the major protein 3D structure database and experiment how 3D models of proteins are used to design molecules of medical relevance.

SOS environment: a reporter gene in transgenic plants (*Arabidopsis thaliana*) becomes an environmental bioindicator able to detect the presence of heavy metals in soil.

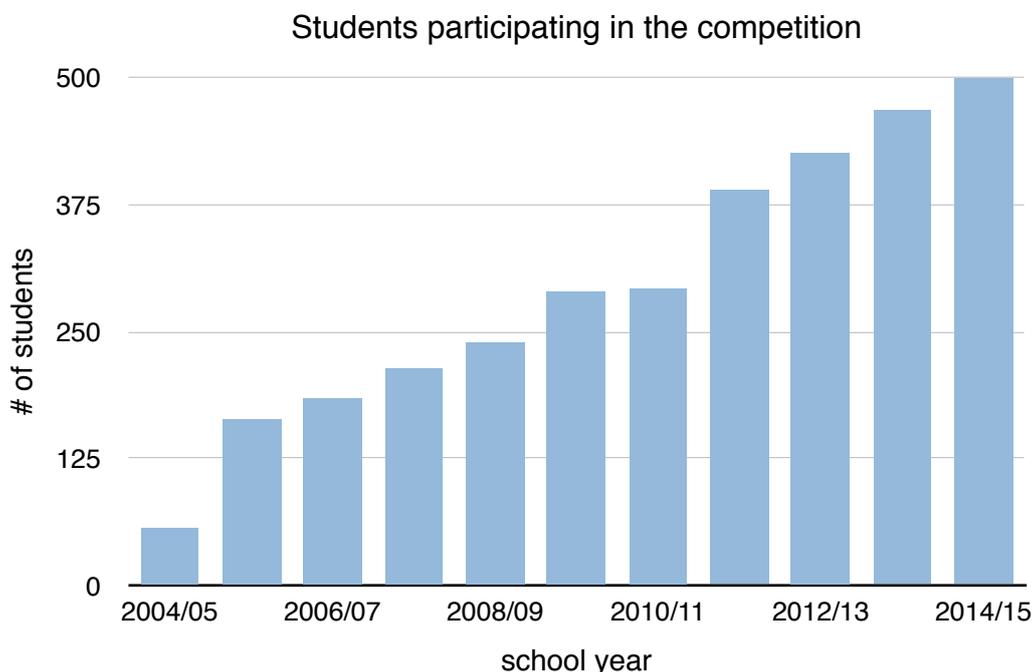
Identification of meat species: analysis of a mitochondrial gene, cytochrome b, to identify the species origin in a mixed-meat sample.

Genetically Modified Organisms: what, how and why: analysis of corn flour to detect the Bt transgene from the bacterium *Bacillus thuringiensis*, coding for a protein which confers the GM plant protection against most insects pests.

Which plant is this? How can we identify a plant species starting from its DNA? An introduction to DNA barcoding, a new method for the definition, cataloguing and monitoring of biodiversity.

A week as a researcher

Each year CusMiBio organizes a competition to select 20 excellent High School students who, at the end of their school-year, will spend *A week as a researcher* in a bioscience research lab in Italy or abroad. They can choose among the University of Milan, Scuola Superiore Sant'Anna of Pisa, University of Catania, International Lab Centres i.e. XLAB in Göttingen or Experimenta in Heilbronn. As an alternative, they can participate to international conferences i.e. Sustainergy Youth Conference and World Science Conference in Israel.



The number of students participating in the competition is growing every year, with students coming from different regions of Italy. Since 2012, besides Milano, the competition takes place simultaneously in 8 locations: Domodossola, Imperia, Pisa, Vasto, Foligno, Latina, Catania and Pachino.

Wannabe a tutor

From School to University, a round trip: become a tutor and teach your peers

Talented students and motivated teachers, under the supervision of CusMiBio staff, design and set-up kits and learning modules adapted to be transferred to their schools. Students and teachers are trained to become familiar with the kit activities (Chromosome analysis, DNA profiling, Genetically Modified Organisms, Healthy or affected?) and to be able to autonomously propose them to their peers.

International Activities

CusMiBio students in Europe and the world

CusMiBio, together with several international organisations, promotes events aimed to select excellent young people in science:

- 2012-14: CusMiBio selected 2 students to participate to the annual international conference *Eilat-Eilat International Renewable Energy Conference* in Israel. The students presented a project that was awarded with the second prize, both in 2012 and 2014 (<http://renewable-energy-eilat.org/conference/>)
- 2010-12: CusMiBio students won the first prize at the international DNA DAY organized by the American Society of Human Genetics
- 2009 3 students took part to the Summer School organized by the Freie Universität of Berlin
- 2008 Based on the agreement between Glaesernes Labor di Berlin (part of the BBB-Management GmbH Campus Berlin-Buch) and CusMiBio, 2 students participated to the Bio-Olympiade Summer Academy in Berlin
- 2008 At the NYEX (Network of Youth Excellence) annual meeting in Göttingen, 3 students from the *Wanna be a researcher* project were chosen by a european committee to take part in an international biotechnology stage, held both at EXPLO in Heidelberg and at XLAB in Göttingen
- 2007 The winners of the first two edition of *A week as a researcher* obtained a FEBS (Federation of European Biochemical Societies) fellowship to participate to the 7th Young Scientist Forum in Vienna

City DNA Barcode Project

In 2012 CusMiBio has introduced a new activity, The *City DNA Barcode Project*, that wants to engage high school students to explore urban biodiversity using DNA technology. A DNA sequence that defines univocally a living organism is called its genetic barcode. Just as a unique pattern of bars in a universal product code (UPC) identifies each item for sale in a store, a DNA barcode is a DNA sequence that uniquely identifies each species of living thing. In the *City DNA Barcode Project*, student teams use DNA barcoding to explore biodiversity in their own city. Participants are introduced to cutting edge biological and bioinformatics techniques while implementing a personally selected “authentic” research project from experimental design stages to data analysis and interpretation.

DNA barcoding is widely used in ecological studies, food traceability, and other basic and applied scientific research, is well established, theoretically and practically robust, and well supported by the existence of public databases containing sequence and taxonomic information. From a science education perspective, DNA barcoding represents an intriguing experimental paradigm. Groups of students can decide on a biological question requiring species identification (how many species of mosquito are present in my area? Is the fish in my sushi really tuna?), pursue an open-ended practical activity requiring multiple steps that illustrate various biological disciplines (experimental design, sample collection, molecular biology and bioinformatics) and interpret data to answer the initial question.

This projects offers a unique approach to developing STEM skills and an appreciation of both the societal roles of science and the nature of the scientific method. The main objective is to provide teachers with the opportunity to use DNA barcoding as a non-intimidating tool to teach biological disciplines such as genetics, taxonomy, ecology, molecular biology and its applications in a new and engaging way.

The first pilot project was supported through funds obtained from the Italian Ministry for Research and Education (<http://www.cusmibio.unimi.it/urbanbarcodeproject/inglese/barcodeengl01.html>). The program of the activity was derived, with the help of the DNA Learning Center (DNALC, Cold Spring Harbor Laboratory), from the model developed for the New York City Urban Barcode Project (<http://www.urbanbarcodeproject.org/>). The DNA subway bioinformatics platform (<http://dnasubway.iplantcollaborative.org/#>), developed for DNALC activities, was used for bioinformatics data analysis. A simple website providing background, protocols and tutorials, in both Italian and English was implemented (<http://www.cusmibio.unimi.it/urbanbarcodeproject/inglese/barcodeengl01.html>).

Presentation of results as a poster encourages participants to revisit the entire process undertaken and provides a discrete conclusion to the activity.

Posters have been presented at various public events including Science Festivals, the 2013 Milan *Researchers Night*, Fascination of Plants day (2014 and 2015 editions) and in some cases, at “end of year” activities in school. In these events, participants are encouraged to explain the work to interested members of the public, promoting the skills of presentation and communication of scientific information.

Summer School: diving into molecular Biology

CusMiBio organizes International Summer School through which students receive training and research experience in a university setting.

The admitted students spend a week doing intensive hands-on experiments and attending seminars at the CusMiBio laboratories on the University of Milan campus.

Lab activities are supervised by scientists of Milan University, post-doc tutors and CusMiBio teaching staff. Seminars are given by University faculty members or affiliated research organizations active in the fields of Biotechnology and Biomedicine.

At the end participants will have gained a broad up-to-date and experimental overview of nowadays biological research and they could be inspired and encouraged to take an interest in research and to consider careers in bioscience and technology.

Program Activities:

- 10 experimental activities among those run in the *Try the Bioloab* project
- 2 seminars given by faculty members
- 4 visits to labs or facilities equipped with large and sophisticated research instruments (confocal microscopy, X-Ray crystallography, botanical garden)
- concluding seminar moderated by a faculty member in which participants (groups of 5) present one of the program activity, and discuss, in the frame of state of the art, research and future perspectives/applications. Internet access are provided during the program for the preparation of the seminar
- social & cultural program according with the Municipality of Milan.

Major initiatives directed towards High School Teachers

Workgroups

High School Teachers attend education groups that meet regularly under the supervision of university professors and provide them with constant scientific and cultural updating. The practical products of these education groups are handbooks and “tools and tips” that can be used by the teachers during their work at school and the development of laboratory activities that will be offered to the students. Here is a list of the workgroups planned for the current year, with relative seminars on the four topics:

- *Use of antibodies and ELISA test in various fields of applications*, prof. Antonio Siccardi
- *SNPs identification by restriction enzymes*, prof. Giovanna Viale
- *Triplet repeat expansion disorders*, prof. Chiara Zuccato
- *Sequencing techniques used to reveal genetic disorders*, prof. David Horner

Workshops on advanced topics in biosciences

Training courses in molecular biology and genetics combining cutting-edge science with simple activities easily transferable to the classroom.

Sep 2014	<i>Biotechnology theoretical and practical course</i>
Aug 2014	<i>Microscopy and multimedia course</i>
2013	Bioinformatics and <i>multimedia course</i>
Jun-Oct 2013	<i>Microscopy course</i> (in collaboration with CIMA and CTU, University of Milan)
2011	<i>Proteins: where, when and why</i> (held both in Milan and Genoa)
2010	<i>Colors of molecules and cells</i> (in collaboration with ELLS and EMBO)
2006-07-08	<i>From organisms to genes</i> (in collaboration with EMBL, Heidelberg)
2006	<i>Genes and diseases</i> (in collaboration with EMBL, Heidelberg)
2005	<i>From organisms to genes: what Zebrafish can tell us</i> (in collaboration with EMBL, Heidelberg)
2004	<i>Genetic engineering and its applications</i>

Theoretical courses

Happy Science: short conference cycles followed by brain storming and aperitif:

2009/10	Neurodegenerative diseases <i>Study models of a neurodegenerative disease, Amyotrophic Lateral Sclerosis (ALS)</i> , Prof. S. De Biasi, University of Milan <i>The cerebellum and movement disorders: Hereditary ataxia</i> , Prof. F. Taroni, University of Milan <i>Are we all going to get Alzheimer? A scientific problem with great social implications</i> , Prof. M. Mazzanti, University of Milan
2008/09	Model organisms <i>Yeast, honorary mammal</i> , Prof. P. Plevani, University of Milan <i>Zebrafish: a model system to study vertebrates biology and genetics</i> , Prof. F. Cotelli, University of Milan <i>C. elegans: a millimeter model system to study cancer</i> , Prof. G. Cassata, IFOM, Milan
2007/08	DNA damages <i>DNA repair workshops</i> , Prof. P. Plevani, University of Milan <i>DNA repair and onset of tumors</i> , Prof. M. Muzi Falcone, University of Milan <i>Children of the moon</i> , Prof.ssa M. Stefanini, CNR, Pavia

New Frontiers of Biology

2015	<i>Plants perception of stimuli and the magic of Photosynthesis - Fascination of Plants Day</i> University of Milan for EXPO'
2014	<i>Neuroscience school</i>
2014	<i>Animal testing in biological research</i>
2013	<i>Plants and health - Fascination of Plants Day</i>

2012	<i>Molecular biology of plants today and tomorrow - Fascination of Plants Day</i>
2011	<i>Life sciences: training and communication</i>
2010	<i>New applications of bio- and nano-technologies in biomedicine</i>
2009	<i>Epigenetics, the unknown</i>
2008	<i>microRNAs world</i>
2007	<i>Stem cells: from bench to bedside</i>

Conferences for Teachers and excellent and motivated students within the project:

From school to University, round-trip

23 Apr 2015	Happy Biotech in Brera
13 Mar 2014	<i>Tecniche di Citogenetica</i> . Dr. E. Martinoli, University of Milan
24 Feb 2014	<i>About GMOs</i> . Dr. P. Morandini, University of Milan
13 Feb 2014	<i>The importance of preconception period in the prevention of birth defects</i> , Dr E. Gavazzi, UOS Genetica Medica. <i>Infertility</i> , Dr P. Panina, DIBT San Raffaele
30 Jan 2014	<i>Biology and population genetics in forensic, from biological evidence to innovative techniques to study STR's polymorphisms</i> Dr. Giorgio Portera, Forensic biologist

Conferences and workshops in biotechnology for teachers in schools

Feb 2015	3 hours course at High School Taramelli, Pavia
Nov 2014 - May 2015	15 hours course at High School Natta, Bergamo

Training courses for science teachers and “Try the Biolab” activities for students held in Sicily

11-13 May 2014	High School Volta, Caltanissetta
20-22 Mar 2014	High School Bartolo, Pachino
17-19 Mar 2014	High School Galileo Galilei, Catania
28-30 Nov 2013	High School Volta, Caltanissetta
25-27 Nov 2013	High School Galileo Galilei, Catania

E-learning activities

A web space called *Bioteach: tools and tips for biology teachers* has been created, where didactic material is published (in Italian and English). Registration is free and all materials are downloadable; in this e-learning platform there are two modules dedicated to bioinformatics and its use for teaching Bioscience with new technologies.

<http://bioteacheng.ariel.ctu.unimi.it>

Lead teachers

Selected science teachers were trained to run *Try the Biolab* activities by themselves and can now coordinate students groups and give the introductory lecture supporting the lab activities.

Festivals and Scientific Events

- 2014 Milan: *ESHG- SIGU Scuola Workshop* conference of the European Human Genetics Society. Workshops for 180 students from Lombardy and Liguria
- 2014 Milan: *Unimi_Under18: The Importance of Being DNA*, open lab
- 2014 Bollate: *Science in Piazza: Evidence, clues and DNA...who is the culprit?* Science Fair with workshops for general public
- 2014 Milan: *Aperitif for Expo*, 90 events for the 90th anniversary of University of Milan and to introduce Expo 2015. Workshops for general public
- 2012-15 Foligno: *Science and Philosophy Festival*, Molecular biology workshops and conferences for general public
- 2012-14 Milan: *The White Night of Researchers*, Molecular biology and bioinformatics workshop, exhibit of electron microscopy and confocal photographs in collaboration with CIMA (Interdepartmental Centre Of Advanced Microscopy)
- 2010, 2012 Milan: *Science Adventure*, Molecular biology and bioinformatics workshop organized by University of Milan for the city of Milan
- 2010 Cagliari: *Cagliari Science Festival*
Introducing CusMiBio and its activities
- 2010 Turin: *ESOF (European Science Open Forum)*
Bioinformatics lab *Surfing among genomes*
- 2008 Paris: *La Ville Européenne des Sciences*
Bioinformatics for general public

Science Festival in Genoa

- 2015 *Our genes on the balance* Cytogenetics workshop for schools and general public
- 2014 *The magical world of protein crystals* Molecular biology and bioinformatics workshop for schools and general public
- 2013 *Micron? I like it!* Molecular biology and bioinformatics workshop for schools and general public
- 2012 *City Barcode* Use of DNA barcode sequence to identify animals and plants species
- 2011 *Models on the catwalk* Use of model organisms in basic research

- 2010 *Our genes on a microchip* Microarray workshop
- 2009 *The invisible forms* Workshops on protein crystallization and bioinformatics, for schools and general public
- 2008 *From DNA to biodiversity* bioinformatics workshops
- 2007 *Bioteach: tools and tips for science teachers*
Presentation of the the e-learning project

BergamoScienza

- 2015 *Our genes on the balance* Cytogenetics workshop for schools and general public
- 2014 *The magical world of protein crystals*
Molecular biology and bioinformatics workshop for schools and general public
- 2013 *Micron? I like it!*
Molecular biology and bioinformatics workshop for schools and general public
- 2012 *City Barcode* Use of DNA barcode sequence to identify animals and plants species
- 2011 *Models on the catwalk* Use of model organisms in basic research
- 2010 *Our genes on a microchip* Microarray workshop
- 2009 Bioinformatics workshops and *DNA fingerprinting*
Experiments, for schools and general public
- 2008 *DNA fingerprinting* experiments, for general public

Science on Stage

- 2015 London: workshop on *DNA barcoding project*
- 2011 Copenhagen (Science on Stage): *The invisible forms* workshop for teachers
- 2010 Berlin (Science on Stage Deutschland): *Gene hunting for cystic fibrosis gene*
Bioinformatics networks for teachers from Brandenburg
- 2008 Berlin (Science on Stage Deutschland): *Gene hunting for cystic fibrosis gene*
Bioinformatics networks for european teachers
- 2008 Grenoble: *Surfing among genomes* Bioinformatics networks

National and international meetings

- 2015 Jerusalem: CusMiBio, with 6 students and 1 teacher as head of delegation, represents Italy at the *World Science Conference Israel*. Conference with students representatives from 70 countries with 15 Nobel prizes attending
- 2015 Galati, University of Bucarest (Romania): Presentation of the project *From School to University a round trip* at the *Science Education in School*, within the project *Inquiry-Based Science and Technology Education – iBEST*. Member of the international jury at the Science Fair *Stars of Science*
- 2014 Civic Museum of Treviglio: Oral presentation entitled *The Importance of Being DNA* at the Aperitif with science *Esplorazione*
- 2013 Florence: Oral presentation entitled *From school to University: a round trip* at the International Workshop *Science Education And Guidance In Schools: The Way Forward*
- 2013 LITA Segrate: *60th anniversary of the discovery of DNA structure* Conferences and workshops with about 280 students and 25 teachers
- 2012 Porec, Slovenia: Presentation of the project *City Barcode* at the NYEX (Network of Youth Excellence) Annual conference
- 2010 Jerusalem: Presentation of the project *From School to University: a round trip* at the NYEX Annual conference
- 2010 Dortmund: *ECSITE*. DNA barcoding for risk assessment
- 2010 Havana: Presentation of the CusMiBio activities at the *7th International Congress on Higher Education. The University for a Better World*
- 2009 Naples: Presentation of the project *Have a nice journey Mr Darwin!* at the *VIII National SISSA meeting on Science Communication*
- 2008 Forlì: Presentation of the project *Wanna Be a Researcher* at the *VII National SISSA meeting on Science Communication*
- 2008 Goettingen: Presentation of the project *Wanna be a researcher* at the Annual NYEX conference
- 2007 Bucarest: Presentation of the CusMiBio activities and the project *Wanna be a researcher* at *The International Workshop-Science Education in School*.
- 2007 Balatonfured (Hungary): Presentation of the CusMiBio activities at the *3rd NATO-UNESCO Advanced Research Workshop on Talent Recruitment and Public Understanding for Science Education*
- 2007 Porto: Presentation of the CusMiBio activities at *EMBO* course
- 2006 Heidelberg: Presentation of CusMiBio activities at the *EMBO Workshop From school to University*

Publications in the educational field:

- *Pavesi G, Siccardi A, Viale G, Grazioli C, Calciolari T, TENCHINI ML, Plevani P (2008) Hedgehogs, humans and high-school science. The benefits of involving high-school students in university research. EMBO Rep. 2008 Mar;9(3):208-11. doi: 10.1038/embor.2008.25.*
- *Grazioli C, Plevani P, TENCHINI M.L , Viale G (2007) CusMiBio: an opportunity for talented young people in biosciences. Proceedings of the NYEX Conference on Science Education of Gifted Students, Petnica 2007 ; Editor: Srdjan Verbić. - [s.l.] : Valjevoprint Co., Valjevo, Serbia, october 2007. - ISBN 978-8ti-78ti1-039-4. - p. 73-77.*
- *Grazioli C, Gritti C, Plevani P, Viale G. (2012) "Studenti in laboratorio" ed. Zanichelli, Italy*