

Article

Greetings from Foodland: Teaching Biochemistry to BS Students in Food-Related Courses in Italy^S

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Abstract

Biochemistry has always been a mandatory topic within BS courses aimed at food science students at the University of Milan, namely: Food Science & Technology and Catering Sciences. Addressing biochemistry topics in this peculiar setting requires: (i) specific focus on topics that are seldom considered in courses offered in bio-medical curricula; (ii) close integration with other area disciplines, such as food biotechnology; (iii) *ad hoc* design of laboratory classes; and (iv) an array of elective courses covering specific aspects of biochemistry. In this context, for example, protein chemistry is presented by using food proteins of known structure and discussed in terms of structural features in the raw materials and of structural and chemical modifications occurring upon processing. Along the same lines, metabolic pathways and their regulation are presented starting

from widespread metabolism-related issues and to issues related to food safety (including food allergies and intolerances). A similar “hands on” approach is used for laboratory classes, that cover about one third of total credits and are aimed at providing fundamental-type information by analyzing practical situations in the food chain. In spite of their inherent complexity and volume, biochemistry courses score very well with the students in mandatory anonymous surveys. Our approach to biochemistry courses seems to help the students in “visualizing” the practical implications of concepts acquired in other courses within their curricula. The students’ appreciation is confirmed by the sizeable attendance to elective and specialized biochemical-themed courses. © 2019 International Union of Biochemistry and Molecular Biology, 00(00):1–10, 2019.

Keywords: BS students; food and catering sciences and technology; food quality and safety; structural changes upon processing

Introduction

Italy has a worldwide reputation as being “foodland,” that is, the place where food is possibly most enjoyable and most revered. Food-related issues are at the heart of the Italian lifestyle, as somewhat certified by the Italian food-related legislation being the strictest (and the pickiest) on the whole planet. The typical Far-East salutation “Have you had your rice today?” surely cannot be used in Italy, as it likely will result in people discussing an incredibly elaborated listing of

dishes, followed by a heated argumenting on the appropriate ingredients and of the proper way to fix them.

As far as Universities are concerned, the growth of the food industry and the changes in lifestyle that accompanied transition from rural to urban living have generated a number of food-related courses. Many of these have their roots (pun intended) in the fertile soils of various Italian regions, take into account local specificity, and aim at providing information as for the “primary production” of goods (of plant or of animal origin) as the starting point for food-making. These courses will not be considered here.

The city of Milan—although best known as a fashion magnet and a financial hub—lies in the middle of the most fertile plains in Italy. Hard labor has transformed the surrounding swampy area into pastures and crops that thrive all year around. Rice paddies, cornfields, and ample extensions of other grains and legumes have also come to characterize the rural landscape around Milan, supporting an impressive population of farm animals. These by far outnumber humans in Lombardy, in spite of this being one of the most populated and industrialized areas in Europe.

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The farming background and creative entrepreneurship facilitated the emergence of Milan as the hotspot of the Italian agro-food business well before WWII and has been instrumental to the establishment of the first food science curriculum in the whole country. Until 1971, high-rank technical and management positions in most of the Italian food industries were the realm of graduates from a broad array of curricula. Chemists were then in charge of pre- and post-production controls, chemical engineers took care of processing and operations, and graduates from agricultural schools covered biology-related aspects of food production, including safety issues.

As the need for a new professional figure was evident, the Faculty of Agriculture at the University of Milan (UNIMI) launched in 1966 a five-year curriculum in “Food Preparation Sciences” [*sic*]. To undercore differences with existing agricultural schools, these forefathers thought of packing this course with “advanced” science. Exciting developments in fields as diverse as molecular biology or protein chemistry, were then making biochemistry looking like the “new frontier” of science, so that a healthy serving of mandatory biochemistry appeared in the menu.... Of course, integrating biochemical knowledge with the other disciplines required for completing the formation of a food scientist/technologist did not happen overnight, and remains an ongoing process, because of ever-evolving needs and knowledge, of increasing collaboration with scientists from other and diverse areas in the whole “food system,” and of structural changes occurring in the whole university system, including Italy adopting the three-level system of college education (BS, MS, PhD) in the early 1990’s.

The current situation of biochemistry courses in food-related BS programs at UNIMI is presented in what follows and is discussed both in terms of comparison with similar offerings in Italy and with respect to presenting “classical” biochemical topics to students with a different range of interests and coming from very different backgrounds. In other words, to remain faithful to the food theme that pervades this note: we have all the ingredients in our fridge/pantry, but the way to fix dinner is left to the cook. If interested, you’ll may find here below some recipes you may want to try.

Materials and Methods

Course Description

The data reported here were collected in the frame of Biochemistry courses compulsory for MS curricula in Food Science and Technology (FST) and in Catering Science and Technology (CST) at the University of Milan, over the three academic years from 2016 to 2018. The average class size was 120 and 70 students (for FST and CST, respectively). In both cases, the teaching load was 10 Credit Forming Units (CFU), split between 80 hours in the classroom and 32 hours in practical laboratories.

The aims of the biochemistry courses are: (1) to make the students aware of the principles governing the structure

and function of biomacromolecules and of their relevance in determining food quality and in governing key steps in processing; (2) to provide the basis of how biochemical methods allow to gather information on food safety and quality; (3) to learn the principles of metabolic pathways and of their control, therefore to appreciate the food/nutrition/health relationships.

Evaluation of Students

Students’ assessment consists of mid-term tests during the course. A positive outcome of all mid-term tests is required to pass the exam. Failing one of the tests requires the student to undergo a comprehensive test after course completion. All tests have an open answer format.

Evaluation of Teachers

To have their scores registered, the students must complete an online course evaluation scoresheet, in a format provided by the University, that also has room for comments from the students. Results handling is outsourced, and data are communicated to the involved teacher and to the School Dean.

Results and Discussion

Biochemistry Credits within Food Science BS Courses in Italy

The amount of biochemistry credits in the different Food Science BS curricula in Italy ranges from 6 to 10 (Table I). In all courses, a minimum of six credits is devoted to basic concepts of biochemistry, namely, structure and function of biological macromolecules and fundamental metabolic pathways. However, the balance between these blocks of topics is far from even, as is the depth of focus on specific pathways and regulatory events.

In all schools where this minimum value is increased, the additional teaching effort is devoted to the fundamentals of food biochemistry. In particular, the additional 2–4 CFU are aimed at presenting the molecular determinants of process-induced modifications of food proteins and at introducing biochemical approaches used for assessing food safety and quality. Any further increase in the number of credits (up to 12/14, see Table I) is meant to cover biochemical aspects of nutrition or some molecular biology topics.

As shown in Table I, most teachers have biochemistry training and are active in biochemical research (Table I). However, some of the teachers have little familiarity with food-related issues, being associated with bio-medical schools, and are active in research fields that often are far away from the specific interests of a Food Science curriculum. In agricultural-themed schools, teachers have a background in plant physiology (Table I). This results in a bias toward biochemical events relevant to primary food production and in a phenomenological approach that minimizes molecular aspects.

TABLE I**Biochemistry in food science BS curricula in Italy**

<i>University</i>	<i>Curricula</i>	<i>Total enrollment, 2015</i>	<i>CFU, Biochemistry-related topics</i>	<i>Background of teacher</i>
Milan	Food Science & Technology	759	10	Biochemistry
	Catering Sciences	459	10	Biochemistry
Parma	Food Science & Technology	342	6	Biochemistry
	Gastronomy	121	5	Biochemistry
Naples	Food Technology	413	9	Biochemistry
Teramo	Food Science & Technology	323	12	Biochemistry
Foggia	Food Science & Technology	104	8	Biochemistry
	Gastronomic Sciences	73	5	Biochemistry
Florence	Food Technology	375	9	Biochemistry
Udine	Food Science & Technology	n.a.	6	Biochemistry
Basilicata	Food Technology	75	9	Biochemistry
Catania	Food Science & Technology	390	14	Biochemistry
Tuscia	Food & Oenological Technol.	302	6	Agricultural Chemistry
Sassari	Food & Oenological Technol.	71	6	Agricultural Chemistry
Bologna	Food Technology	n.a.	12	Biochemistry
	Viticulture & Oenology	n.a.	6	Biochemistry
Molise	Food Science & Technology	123	8	Biochemistry
Modena/Reggio	Agrifood Sci. & Technol	74	8	Biochemistry
Turin	Food Technology	n.a.	8	Agricultural Chemistry
Cattolica	Food Science & Technology	197	8	Agricultural Chemistry
Perugia	Food Science & Technology	198	6	Agricultural Chemistry
	Food Economics and Culture	80	8	Biochemistry
Bari	Food Science & Technology	133	6	Agricultural Chemistry
Messina	Gastronomic Sciences	63	None	Food Chemistry
Bra	Gastronomic Sciences	50	4	Food Chemistry
Marche	Food Science & Technology	75	12	Biochemistry
Pisa	Viticulture & Oenology	n.a.	6	Agricultural Chemistry
Palermo	Food Science & Technology	n.a.	6	Biochemistry
Reggio Calabria	Food Science & Technology	98	6	Agricultural Chemistry
Roma Tre	Oeno-gastronomic Sciences	52	None	None
Padova	Catering and Gastronomy Culture and Science	70	None	None
	Food Safety	65	4	Biochemistry
	Food Science & Technology	90	None	None



Teaching Biochemistry in Food Science BS Courses: The Specific Experience at UNIMI

Classes: Goals and Background

This section deals with the content of the biochemistry courses for BS degrees in Food Science and Technology (FST) and in Catering Sciences (CST) at the University of Milan (UNIMI). The two courses are similar for what relates to biochemistry fundamentals, whereas the selection of topics in the part focused on food biochemistry is—to some extent—adjusted to specific requirements.

The basic biochemistry part of the FST and CST courses (6 CFU) aims at understanding at the molecular level the structural features of biological materials, the interactions among components, the transformations occurring in metabolism, and some key regulatory issues of relevance to human nutrition and health. The other module (four credits) for FST students is focused on food biochemistry. Here, the aim is to provide basic knowledge on how individual food components—macromolecules, in particular—relate to food quality and safety, also with reference to the peculiar needs of specific consumers and to quality and safety issues.

In the case of CST students, the Food Biochemistry module (4 CFU) presents biochemical methods that provide information on process-induced modifications of food proteins with a focus on how biochemical methodologies are used for assessing food safety and quality. The main goal is to allow students the capacity of applying the principles of protein chemistry and enzymology as tools for assessing the quality of ingredients or of foods, including storage and shelf-life-related issues.

All the biochemistry courses are taught in the first semester of the second year, to students that have taken classes in general and physical chemistry and in organic chemistry. However, metaphorically speaking, having taken your meal does not necessarily imply you have digested it.... We have solid evidence that the familiarity of individual students with concepts as simple as pK_a or pH, or with other basic chemical concepts (such as redox events) may be extremely different, mostly because of the highly variegated background of our students, that may come from schools forming hotel/restaurants managers, from agricultural colleges, from elite technical institutes (providing endless hours in up-to-date laboratories), or from schools with their main focus on humanities. Even students from “science-oriented” schools have uneven backgrounds, as a consequence of the diverse quality/focus of the teachers and of available laboratory resources. We have also witnessed an increasing presence of students from other countries within and outside Europe, although foreign students remain in small numbers (<3–4%), and lectures are presented in Italian. English versions of classroom materials are available through a dedicated portal, if the originals were not in English already.

Turning a Generic Biochemistry Course into a “Food Specific” One: 1 – General Biochemistry

Because the first part of both the FST and CST courses cover aspects of basic biochemistry and taking into account the students’ interests and background, the content and organization of lectures need to: (1) underscore the relevance of biochemical concepts to food science at large; (2) use language and examples that relate to common (domestic, in most cases) experience in food handling; (3) avoid excessive technicalities, while striving to be scientifically correct; (4) stimulate their ability at finding “molecular” explanation for common food-related occurrences; (5) help them in using the knowledge they may acquire to spot common food-related misconceptions, nowadays running wild—very unfortunately—on the web or on TV.

For instance, the structuring role of water with respect to molecules and macromolecules is presented with reference to everyday life. Lectures on water as a solvent and as a structuring agent stress the role of water as the main component of many foods and in defining their textural properties. As an example, the role of water in the establishment of hydrophobic interactions is explained by discussing two “case studies.” Dishwashing is taken as an example of micelle formation, whereas the behavior of fat droplets (“eyes”) in bouillon is discussed as an example of the thermodynamic need for minimizing surface at interfaces.

The same “specificity” is also evident in the lectures dedicated to protein structure. Favorite examples of how various types of chemical interactions collaborate to stabilize the structure of proteins include proteins in cow milk whey (beta-lactoglobulin [BLG] and alpha-lactalbumin [ALA], see Fig. 1). These small proteins are extremely helpful in presenting concepts related to the formation and stability of high-order structures. All the interested interactions may be observed in these two proteins, including those depending on local charges, on disulfide bonds, on hydrophobic interactions, and of interactions with organic or inorganic non-protein components. Students are invited to analyze the native folding of these proteins by using simple and free online modeling tools, that are also used to describe the role of specific ions in stabilizing the tertiary structure using lactalbumin and lactoferrin (Fig. 1) as models of different complexity and stability. Our introduction to quaternary structure starts from BLG (a dimer stabilized by short-range hydrophobic interactions and long-range electrostatic bonds) and ends in discussing myoglobin and hemoglobin. These proteins are a “must” in any biochemistry course, but also have an essential role in defining the properties of meat products, thus making them “appealing” also from the standpoint of the food scientist.

Along the same lines, the functional and structural relevance of post-translational modifications is presented by using peculiar proteins—such as collagen and casein—that allow to discuss in molecular terms what makes calf meat so tender or Mozzarella softer than Parmesan. The section on proteins is

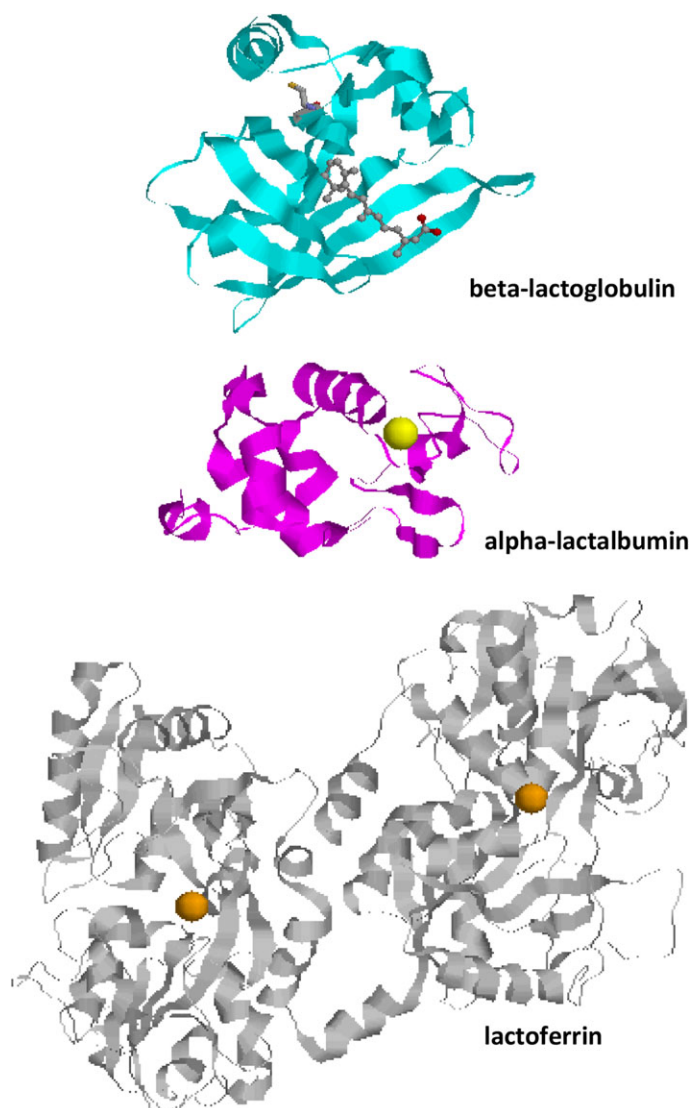


FIG 1

Schematic view of the structural features of food proteins used for teaching purposes. Representations of individual proteins (not to scale) where generated by using RASMOL [1], and the PDB files given below for each protein. Top: bovine beta-lactoglobulin (1GX9), a predominantly beta-barreled lipocalin, with a cavity lined with hydrophobic residues and suitable for binding of hydrophobic species (such as retinol, shown here as balls-and-sticks in CPK colors); the tertiary structures of beta-lactoglobulin is stabilized by two intramolecular disulfide bonds (66–160 and 106–119), leaving a single free cysteine residue (Cys 121, shown here as sticks in CPK colors) hidden below the largest alpha-helix in the structure. Middle: Alpha-lactalbumin (1B9O), the second most abundant protein in bovine milk whey, involved in regulation of lactose biosynthesis in the mammary gland. In yellow is the calcium ion bound to side chain Asp and Glu carboxylates in a specific helix-turn-helix element of tertiary structure and relevant to pH-dependent stabilization of the whole protein structure. Bottom: lactoferrin

complete by studying enzymes and enzymatic catalysis, with an emphasis on the regulation of enzyme activity (for its relevance in metabolic control), and on the inactivation of enzymes by the physical or chemical treatments used in food processing).

The “macromolecular” part of the course is completed by a structural overview of the simplest polysaccharides (amylose and amylopectin) and by the various features of glycoproteins. Structural and functional features of food fats and of lipid-based surfactants and surface-active agents are finally used to discuss the structure/function relationship in triglycerides, in phospho- and glycolipids, in biological membranes, and in lipoproteins.

The second part of the basic biochemistry module is dedicated to metabolism. Starting from basic concepts (energy interconversion, high-energy bonds, coupled reactions), lectures go through the catabolic routines, accompanied by their anabolic counterparts. Stress is placed on the molecular bases of diseases or metabolic conditions that are strongly related to food. This bird-eye view tries to provide glimpses of various health-relevant issues: from ketosis to lactose intolerance, from diabetes to gout, from phenylketonuria to hypercholesterolaemia. The relationships among these conditions and food are dealt in the context of the appropriate pathway. All of this leaves little room for presenting the biochemical aspects of the information flow in biological systems (i.e., nucleic acids and protein synthesis) that are treated very concisely.

Turning a Generic Biochemistry Course into a “Food Specific” One: 2 – Food Biochemistry

The Food Biochemistry module (4 CFU) is meant to offer students some information on how and why food components—macromolecules, in particular—relate to food safety and quality. The focus is on changes in the structural and functional properties of proteins and on how protein denaturation may be controlled and adapted to specific goals. The molecular approaches used for investigating food macromolecules and their process-induced modifications are described by presenting various examples of physical and enzymatic treatments. These lectures and the accompanying laboratory activities relate to our own research experience in addressing the molecular determinants of the behavior of food macromolecules, including the development of novel and advanced methodologies (that, dealing with BS students, are often left behind the scenes).

(1BLF), a large protein ubiquitous iron carrier in milk from all mammals, with similar but totally independent sites for pH-dependent binding of ferric iron (in rusty brown) on each lobe of the protein. [Color figure can be viewed at wileyonlinelibrary.com]



Addressing controlled protein denaturation by physical treatments starts from protein modification induced by heating in the presence of water. Structural and chemical modifications of whey proteins (BLG and ALA, see Fig. 1) as related to milk sanitization are convenient examples, given the nutritional and technological relevance of these proteins and given that the same proteins were used to introduce students to protein structure [2–4]. The same proteins and egg albumin are used to exemplify why other treatments that modify the structure of water (freezing or high-pressure treatments) may affect protein unfolding in a way controlled by both the treatment conditions and by the presence of other food components [3, 5, 6].

Mechanical stresses and shear forces are considered next. Case studies presented in this frame consider the rearrangement of disulfide bonds and hydrophobic interactions that accompanies basic steps in the production of grain-derived foods in pasta- and bread-making [7, 8]. Lectures also deal with the changes in protein structure that affect protein partition among phases, as these events are relevant to the formation and stability of food foams and of food emulsions (from mayonnaise and salad dressings to ice cream and homogenized milk) [9]. Given the difficulties to find textbooks or non-specialist reviews covering these subjects, we typically draw classroom material from our own studies, analyzing the effects of structural modifications on the interaction among proteins [2, 4, 10, 11] or among proteins and other food components [12–15].

Cheese making and the ripening of cheese represent the main case studies used for describing the effects of selective proteolysis. This includes formation of the so called “bioactive peptides” and the role of their structural organization. We emphasize that structural features are relevant not only in large proteins, but even in relatively small chemical species, so that their simple identification or quantification is often not enough to associate their presence to specific biological effects [16, 17].

The last part of the Food Biochemistry module is devoted to properties of macromolecules that are relevant to food quality and food safety issues. “Bad guys” are considered first, by discussing proteins acting as anti-nutritional factors, as allergens, or as potential sources of intolerance reactions. Management of the associated risks is also discussed, discriminating between “*bona fide*” allergens and proteins or peptides responsible for other pathologies, such as coeliac disease. As for this latter condition, several of the molecular issues related to gluten-free foods are discussed, again by presenting specific case studies. Lectures on residual gluten content in beer or in grain-derived syrups are much appreciated: you may expect one third of the audience to be interested in booze, whereas one third only drinks soda (and the remaining third very likely enjoying both...).

The Food Biochemistry module (4 CFU) for CST students aims at providing an overview of the biochemical methods useful for addressing quality and safety issues along the food

chain, presenting examples of their application to food-related issues. For instance, enzyme activity is presented in terms ranging from the specific detection of food components to using enzymes as markers of process intensity (or of product spoilage). Methodologies for protein quantitation and identification are discussed with a focus on proteins considered markers of origin/genuineness or relevant to human health. Ample space is given to the fundamentals and the application of various immunochemical techniques and to the caveats intrinsic to performing and interpreting the results of immunochemical assays in food systems (the presence of insoluble proteins or of process-modified proteins). Lectures also deal with separation techniques and with some notions on how mass spectrometry may be useful in assessing the nature of reacting species or the kinetics and the outcome of their interactions.

Practical Laboratories

Practical laboratories are set up to provide: (1) a hands-on experience on topics presented during classroom lectures; (2) some understanding on how much labor is required to gather experimental data; (3) a quantitative vision of science (results are seldom black and white, and data often have to be “tortured” before they speak out). Students work in groups no larger than four people, using dedicated facilities, under the supervision of one supervisor every two groups.

Laboratory activities start with protein quantification by colorimetric methods, that are subsequently applied on real food matrices (i.e., in the presence of interfering materials), followed by assessing the activity of food-related enzymes. Once familiar with the basic aspects of enzymatic activity measurements, students are challenged to analyze the thermal inactivation of enzymes. Each group of students runs an inactivation experiment at a different temperature, and results are collected and analyzed in a group discussion at the end of the day. Here and elsewhere, no attempt is made at “normalizing” the results, so that heated discussions may arise when trying to make sense out of the data. Often, students ask to come back to the laboratory to repeat measurements that—in their first attempts—produced scattered and unreliable data...

The practical laboratories associated with the food biochemistry modules in both courses address controlled thermal unfolding of BLG, that is approached by monitoring the reactivity of the thiol on Cys 121 (see Fig. 1, top) toward Ellman’s thiols reagent [2, 3]. This approach is used to address both the extent of temperature-induced denaturation and its kinetics, again with individual groups working at different temperatures.

Next is the detection of specific compounds (such as glucose, fructose, and sucrose) in juices and vegetable extracts. These activities are carried out by using cheap commercial enzymatic kits according to the supplier’s instructions.

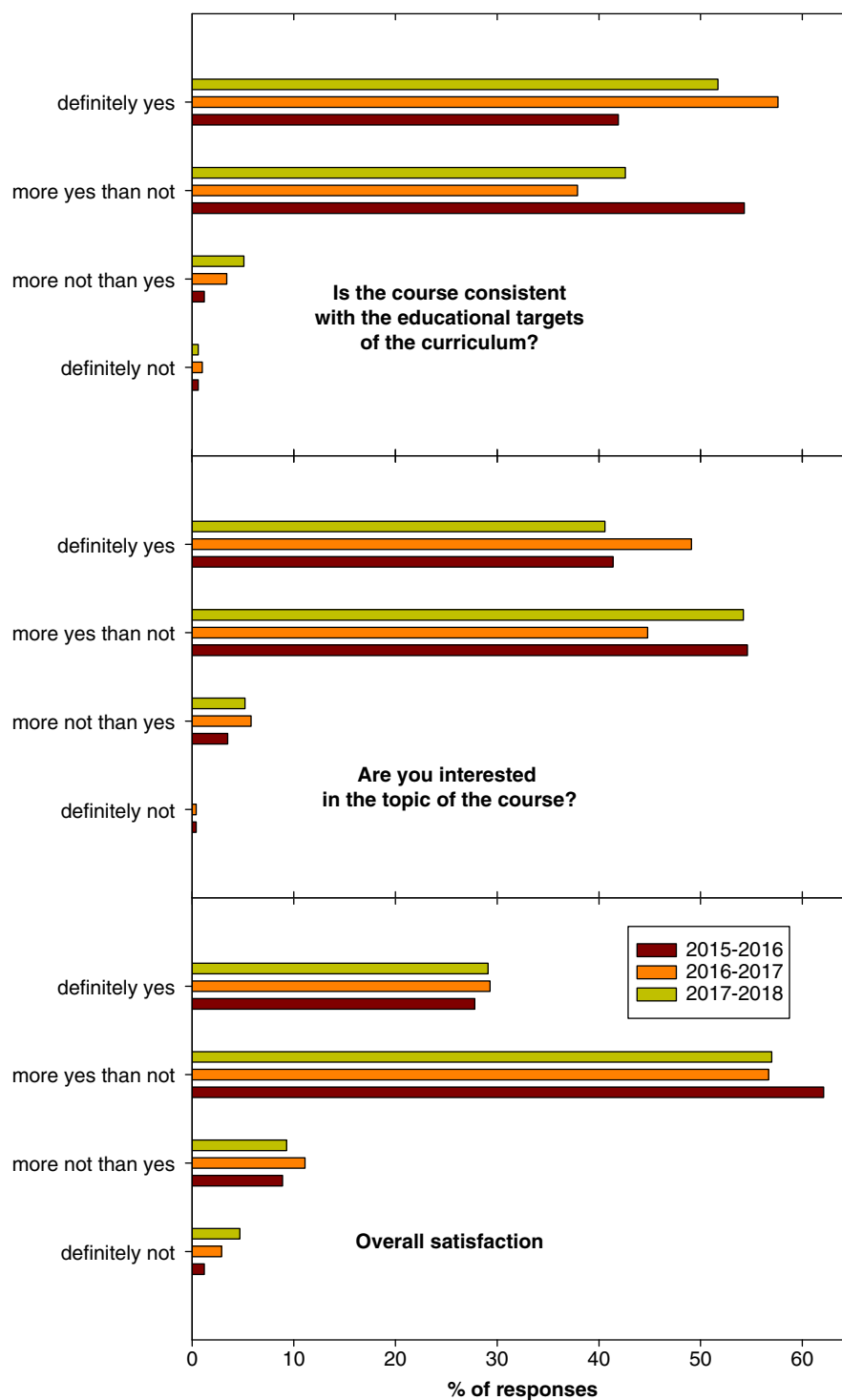
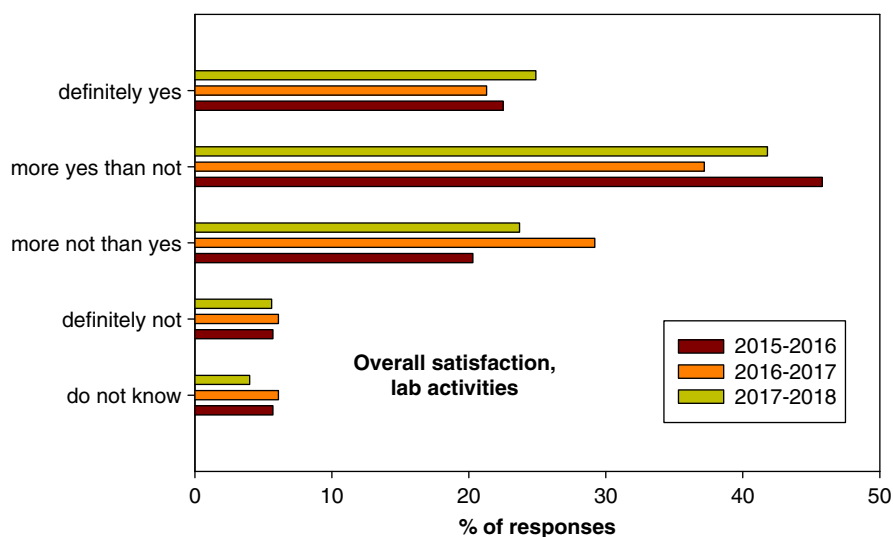


FIG 2

Students' appreciation, classes. [Color figure can be viewed at wileyonlinelibrary.com]

The final block of activities implies the use of commercial “quick format” ELISA kits for the detection of a food contaminant (aflatoxins in dairy products) or of a protein

food allergen (ovalbumin). These activities are a good occasion for discussing the pros and cons of immunochemical methodologies at large.



Students' appreciation, laboratories. [Color figure can be viewed at wileyonlinelibrary.com]

FIG 3

Analyzing the students' Response: 1—Performance and Feedback

As stated under M&M, FST students are tested at the end of each conceptual block of the course: (1) macromolecules; (2) metabolism; (3) food biochemistry. Rate of failure is below 20% for individual tests, with about 70% of the students receiving final positive marks through these intermediate tests. The latter figure increases to 85% when considering the students that attend classes and laboratories on a regular basis (about 70% of the students nominally enrolled). Overall success rate is similar in the case of CST students, that undergo only two intermediate tests.

To formalize their scores, students must complete a mandatory survey, providing information on their background and of the extent courses were responding to their needs and expectations. Relevant results from these surveys for the last three academic years are condensed in Figs. 2 and 3. For the sake of simplicity, the data presented here refer only to the FST curriculum, because very similar figures were obtained for CST students.

Students' attendance data in Table II distinguish between "active" and "inactive" students (i.e., those taking classes on a regular basis and those allergic to sitting in a classroom). Attendance to classes is not compulsory at UNIMI. Inactive students have been decreasing constantly, down to <10% in the 2017–2018 cohort. About 70% of the active students attended more than 90% of lectures, and an additional 28% attended between 70 and 90% of the lectures. Good attendance is a relief for teachers but is also important for the credibility of data commented in what follows.

As shown in Fig. 2 and Supporting Information Table 1S, more than 90% of students think that biochemical courses are appropriate, and that topics and their presentation are

fit. Problems relate to the absence of textbooks covering all the course topics. Most of the graphic material is rearranged from scientific papers or from seminar slides: language and the format of these materials make it difficult for students (in particular, if not attending classes) to grasp the message we are trying to provide.

Fig. 3 and Supporting Information Table 2S analyze the students' attitude and opinion as for practical activities. More than 60% of the students think that practical activities are useful. As a matter of facts, many students were complaining about time dedicated to practical laboratories being too scarce. However, laboratory activities involve huge efforts in terms of materials, time, and human resources and—given the current numbers—any expansion seems currently unfeasible.

Analyzing the students' Response: 2 – Elective Courses

Another way of verifying the response of students to biochemical topics and activities comes from analyzing enrollment of students in "elective" courses. We are only offering two elective courses (4 CFU) for BS students. Both courses have 16 hours being devoted to laboratory activities.

One course deals with "Food Enzymology." Starting from basic enzymology concepts, the course then focuses on the enzymatic activities used in various fields of food biotechnology. Attendance remained constant at 15–20 students/yr, with several students from abroad and from other curricula at UNIMI.

Recently, we started offering a course devoted to "Biochemical Methodologies." Being targeted to BS students of variegated background, the course does not insist on the fine points of methodological advancements or on the latest technological innovations. We rather guide the student to understand

TABLE II

Attendance to lectures

Attendance to lectures	Academic year		
	2015/2016	2016/2017	2017/2018
Total nominal enrollment	339	363	342
Inactive students (attended less than 50% of classes)	112*	86*	93
51%–60%	5 (2.2) [†]	11 (4.0)	5 (2.0)
61%–70%	12 (5.3)	17 (6.1)	15 (6.0)
71%–80%	10 (4.4)	20 (7.2)	35 (14.1)
81%–90%	29 (12.8)	49 (17.7)	48 (19.3)
91%–100%	171 (75.3)	180 (65.0)	146 (58.6)

*Students not having acquired first year credits were: 102/112 (2015–2016); 0/86 (2016–2017); 2/93 (2017–2018).

[†]Percentages (in *Italics*) refer to “active” students (i.e., those attending more than 50% of lectures).

what makes a given approach better than others when it comes to practical applications, be that choosing appropriate starting materials, monitoring production lines, or controlling potential shelf life issues. Attendance is in the 10–15 students/yr.

We have no current plans for expanding attendance to elective courses, mostly because of the laboratory activities load. No financial support is provided for teaching assistants in elective courses, that also hardly fit into the packed schedule of dedicated students’ laboratories. This places a heavy burden on the teachers and on their research groups, as most practical activities within these courses are carried out by using the same laboratory facilities used by our own research teams. This results in long faces, congestion, conflicts among team members, and—most importantly—raises a number of laboratory safety issues.

Conclusions

Integrating biochemical knowledge and the underlying concepts in food science BS curricula may be challenging, as all of this must be framed in a context different from that of “standard” courses in bio-medical schools. Classes need to keep the students’ interest alive, presenting topics in a way that relates to the students’ interests while allowing them to “get what it takes” for their further pursues.

Our approach to biochemistry courses—as outlined here—has been honed over several decades and aims at making the students “visualize” the practical implications of concepts that may be useful in their future careers. In this frame, a strong accent is placed on laboratory activities. These represent an efficient way for “seeing” biochemistry at work and to demonstrate the usefulness of biochemical approaches and molecular knowledge in the general field of food sciences.

In spite of their inherent complexity and intimidating volume, and of difficulties associated with the efficient running of laboratory classes, biochemistry courses at Milan score very well in surveys within BS students. The students’ appreciation of the relevance of molecular-based approaches in this general area is circumstantially confirmed by the sizeable attendance to elective and specialized biochemical-themed courses.

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