

Stimulating Participation and Learning in Microbiology: Presence and Identification of Bacteria from Student's Hands

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Abstract: We proposed in the Basic Microbiology Subject for food science and nutrition students, a “hands-on” activity consisting on sampling student’s hands for bacterial presence and identification. This is a project to be implemented in multiple laboratory classes throughout the semester, allowing students to learn, and apply general microbiology techniques in mixed or isolated cultures obtained from their own samples in parallel with those from the laboratory collection proposed in the microbiology syllabus (as aseptic technique, hands sampling, streaking for single-colony isolation, culture medium analysis, bacterial morphology, and biochemical study, employ of dichotomous keys) This activity will allow them to understand the association between humans and microorganisms, to recognize the importance of personal hygiene (for example, hand-washing), and to know how hands can be an important vehicle for bacterial spreading in surrounding environments (for example, kitchen, health-care setting). The fact that the isolates for practical work were not only from laboratory collections, but also from the personal student’s hands, keeps them interested in discover and study their own bacteria to know their main characteristics and the potential importance to human health, through spread of hazardous isolates. This project also potentially contributed for student’s development of other skills such as autonomy and teamwork, planning and write, communication, and debate.

Teaching and Learning Tip

Teaching microbiology to food science and nutrition students is crucial, because of their future role in food safety education in the community, either as potential supervisors of food-handlers in food service (for example, schools, nursing homes, hospitals, canteens) or as health-care professionals (clinical nutritionists/dietitians). Since hands are a major vehicle for pathogens spreading, the improvement of safer food handling practices, including hand hygiene promotion, will result in clear benefits for public health. Food-borne diseases represent a global burden and a major public health threat, with social and economic impact (Kuchenmüller and others 2013). One of the major risk factors associated with food-handlers and meal preparation practices is poor personal hygiene, including the lack of hand-washing (FDA 2013), a preventable error linked to numberless food-related incidents (Byrd-Bredbenner and others 2013; EFSA and ECDC 2015). Moreover, proper use of hand hygiene is also critical to the prevention of health-care associated infections (WHO 2009). In addition, washing hands is crucial to be learned by all the community, especially kids, being more interesting and exciting

to develop practical activities about bacteria on hands using simple microbiological assays, as recently highlighted by popular press (<http://www.medicaldaily.com/germs-hands-8-year-old-boys-handprint-reveals-various-bacteria-after-playing-outside-337036>).

We proposed, for the food science and nutrition students, 5 y to date, in the Basic Microbiology Subject (2nd academic year of the Nutritional Sciences course) an activity consisting on sampling student’s hands for bacterial presence and identification. This activity will allow students to understand the essential association between humans and microorganisms and the consequence that spread of some bacteria could represent for human health, helping to recognize the importance of personal hygiene (for example, hand-washing), relevant issues for the Food Microbiology Subject. Bacterial detection and identification from human skin is a project to be implemented in multiple laboratory classes throughout the semester, allowing students to learn, and apply general microbiology techniques (for example, aseptic technique, hands sampling, isolation streak, culture medium analysis, Gram stain, biochemical identification, use of dichotomous keys) in isolates obtained from their own samples in parallel with those from the laboratory collection used for the laboratory classes proposed in the microbiology syllabus (Table 1).

Basic Microbiology laboratory classes have been organized in 4 groups of 4/5 students, once a week (2 h) during the 13 wk of the semester, involving special challenges in order to achieve,

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Table 1—Project inclusion in the syllabus of laboratory classes of the basic microbiology subject

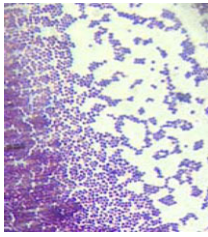






Week	Syllabus of laboratory classes	Project brief description	Project material description	Project Pictures
1	Safety standards and basic tools in the microbiology laboratory. Aseptic technique. Basic concepts of microscopy. Observation of previously prepared wet-mount and Gram stained slides.	Sampling and cultivation of hand skin microorganisms in different culture media plates.	Mannitol salt agar MacConkey agar Plate Count agar Blood agar	
2	Preparation of microorganisms from laboratory culture collections for bacterial morphology study. Preparation of wet-mount slides and smears for staining techniques: simple and differential staining, Gram stain.	Colony observation: growth rates in different media, morphology and subculturing of 1 colony per student/group.	Tryptone Soya agar slants and/or plates	

Selection of colony and subculturing on *Tryptone Soya agar (TSA)* - 37°C/48h



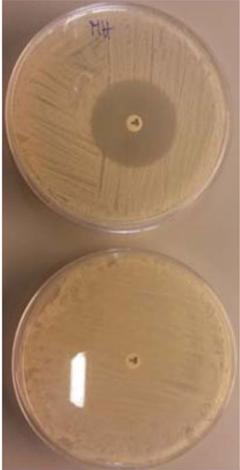
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Table 1–Continued

Week	Syllabus of laboratory classes	Project brief description	Project material description	Project Pictures
3	Other examples of staining techniques (endospore and capsule visualization).	Bacterial morphology study: preparation of wet mount and Gram stained slides from the obtained pure cultures.	Microscope Oil immersion Glass slides / coverslips Gram stain reagents Inoculation loops Pipettes with pipettor Saline solution	 
4	Culture techniques. Microbiological culture media. Isolation procedures: streak plate method.	Selection of the appropriated flowchart identification scheme.		
5	Culture techniques. Plate counts: spread plate and pour plate methods. Observation of the obtained cultures: colony morphology and other features.	Selection of the appropriated flowchart identification scheme. First written report.		
6	Culture techniques. Biochemical identification tests (e.g., broth media, slant and stab tubes). Observation of the obtained cultures and colony counts.	Beginning of bacterial identification by biochemical tests.	Biochemical tests: selected by student groups (e.g. catalase, glucose fermentation, coagulase, DNase, oxidase, urease, novobiocin susceptibility)	  
7-9	Bacterial identification: biochemical tests	Biochemical identification tests	Biochemical tests and reagents selected by student groups	 

(Continued)

Table 2–Continued

Week	Syllabus of laboratory classes	Project brief description	Project material description	Project Pictures
10-12	Antimicrobial susceptibility assays. Antibiotics and Biocides. Fungi identification. Preparation of mold culture slide.	Biochemical identification tests	Biochemical tests and reagents selected by student groups	Novobiocin susceptibility test 
13	Microbial identification and typing: molecular methods. Bioinformatics tools.	Final written report. Discussion of the obtained results and conclusions.		

and organize interesting and dynamic classes. The experimental project and its goals and how they will be integrated in the Basic Microbiology Subject syllabus (Table 1) are explained to the students in the 1st laboratory class. Also, one of the addressed topics included microbiology laboratory safety guidelines and how to put them into practice (Harley 2011). Every week, the activities and the required material for the experimental project are:

Week 1: In order to have their own material, students make a sample of their hands (fingers, fingertip, and/or nails), using aseptic technique and touching 4 different agar media: Plate Count Agar, Mannitol Salt Agar, MacConkey Agar, and Blood Agar. Some groups were free to choose make the sampling after hand-washing. After the sampling, all students should wash their hands. The plates are identified with their names, incubated 48 h at 37 °C and transferred to a refrigerator after the incubation period.

Week 2: The composition and goals of the 4 culture media should be studied before the class, allowing students to be more skilled to observe different types of colonies (for example, color, number, size and shape, biochemical reactions) and growth rates in each culture medium. Different types of microorganisms (bacteria, yeasts, and molds) will be observed and counted, if possible, using Plate Count agar and Blood agar, which will allow understand the different nutritional composition of these culture media. Mannitol Salt agar and MacConkey agar, 2 selective/differential media, will allow the observation and analysis of different types of bacterial colonies (Gram positive and Gram negative, respectively) and their fermentation reactions. In this class, each group of students must choose 1 isolated colony from 1 selective media, where it will be expected to find interesting and significant isolates for the project (for example, on Mannitol Salt agar we found Gram positive cocci mostly from *Staphylococcus* species; on MacConkey agar it is expectable to found Gram negative hygiene indicators). After recording the colony morphological features (they can take photos of the plates), students streaked it on Tryptone Soya agar plates/slants and incubate them 48 h at 37 °C. These plates/tubes were then transferred to a refrigerator after the incubation period.

Week 3: Students start the project laboratory work performing Gram stain and wet-mount slide (for testing motility) (Harley 2011), using their own previously obtained bacteria. Preparation of smears and Gram stain were learned in previous classes (week 2) using pure cultures from the laboratory collection (Table 1). After microscopic observation (Gram stain and motility features), students must proceed to the bacterial identification using Gram positive or Gram negative flowchart identification schemes (dichotomous keys).

Weeks 4 and 5: Students should search and plan bacterial identification approaches, selecting the most suitable flowchart identification scheme. As an additional task, they must hand a written report containing a proposal of diagram with the selected colony features (including photos), and the required material for the further steps of bacterial identification.

Weeks 6 to 12: Inoculation and recording of Gram positive or Gram negative biochemical identification tests (Harley 2011), based on the flowchart identification schemes selected for each case, should be performed. Biochemical tests principles (enzymes activities, carbohydrates, proteins, and amino acids metabolisms; Harley 2011) are discussed during these weeks (Table 1).

Week 13: In the last class, each group of students should present to the classmates their results (type of sample and colony studied; family, genus, and specie presumptively identified), encouraging

the discussion about hand colonization with resident or transient human hand skin flora (for example, related with improper hand hygiene) and the importance of hand-washing in safe food handling practices and/or health-care settings. In addition, students must delivery to the teacher a final written report (including photos and diagrams).

Education of future health professionals, such as nutritionists/dietitians, about the importance of hand hygiene for the prevention of food-borne and/or health-care associated infections is a mandatory strategy. Since food science and nutrition students will have an important role in food safety education and as health-care professionals, the proposed laboratory activity in the Basic Microbiology Subject is helpful to understand how hands are colonized by diverse microorganisms, including resident and transient flora, and how they could be an important vehicle for bacterial spreading in surrounding environments (for example, kitchen, health-care setting). Moreover, this “hands-on” activity, focused in the study of skin bacteria, provided the opportunity to apply several microbiological techniques throughout the semester in a real context. Since the implementation of this project, final written reports and oral discussions have demonstrated student’s interest and involvement in discovering their own bacteria, knowing its main characteristics and the potential importance to human health. Besides the opportunity to apply several microbiological techniques in a real context, this project potentially stimulated and contributed for student’s development of other skills such as autonomy, planning, communication, and teamwork.

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