Guidelines for the Structure of Public Health Entomology Laboratories

Pan American Health Organization
World Health Organization
Regional Office for the Americas

PAHO

GUIDELINES FOR THE STRUCTURE OF PUBLIC HEALTH ENTOMOLOGY LABORATORIES

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Preface

Vector-borne diseases (VBDs) put a significant burden on the health of affected populations and on the economy in Latin America and the Caribbean. Since drugs and vaccines are not available for a large number of VBDs, strategies to mitigate their impact on the population are based primarily on entomological surveillance and vector control tools.

The complex ecology of the transmitting vectors and the dynamics of VBD transmission in our Region pose additional challenges for countries striving to institute effective, high-quality prevention and control programs.

As part of its mission, the Pan American Health Organization (PAHO) has developed a set of activities to strengthen the capacity and practice of public health entomology in the countries of the Region.

For this reason, one of PAHO's key priorities is to help countries design their entomology laboratories. This initiative will help improve the conditions for them to develop capacities to properly support entomological monitoring and the evaluation of control activities.

Information on the minimum requirements for the construction and/or adaptation of entomology laboratory facilities and equipment is scattered throughout various official publications, but has not been compiled in a harmonious, systematic fashion.

The purpose of this document ("Guidelines for the Structure of Public Health Entomology Laboratories") is to give countries proper guidance on structuring their entomology laboratory networks.

The document is an attempt to give heads of vector control programs, entomologists, and laboratory and field operations staff the information they need to conduct a proper needs assessment, set priorities, and make decisions to strengthen their entomology lab networks.

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1 Introduction

Vector-borne diseases such as dengue, Zika, chikungunya, malaria, and leishmaniasis, among others, have a great impact on public health. This makes it necessary to step up entomological surveillance to guide prevention and control activities.

Entomological surveillance is the regular compilation of data on vectors and the analysis of defined entomological parameters, such as the composition of species and their abundance, resistance to insecticides, behavior, and infection rates. The collection and analysis of these and other indicators should generate evidence on which to base a selection of the most appropriate interventions and determine when and where to apply them.

To carry out these activities, countries need well-structured laboratories equipped to perform the required functions. Staff must also be trained in these activities.

Although it is important to consider the institutional arrangements in a country's health sector, an effective vector-borne disease control program depends on a public health entomology network with well-defined structures and responsibilities. This may be more complicated in a decentralized health system, but it is still necessary to have clear structures for implementing activities, as well as material and financial resources and entomology staff. To fulfill the various roles and responsibilities in a given country, regardless of where vector control is carried out, public health entomologists with different skills will be needed.

This document provides countries with recommendations for structuring a public health entomology laboratory network. The document will help countries to identify their areas of need and determine how the entomology network can be strengthened, especially in the context of a decentralized health system.

The recommendations also consider the different degrees of development and different entomological research needed to support disease prevention and control activities.

2 Organizational Structure of the Laboratories

To conduct entomological surveillance, infrastructure is necessary at different levels of the network. The network should include basic laboratories at the local level, as well as laboratories capable of performing more complex tests. Activities can range from identification of the collected specimens—through biological, biochemical, and molecular tests—to monitoring of insecticide resistance.

The organizational structure of a country's entomology laboratory network must be established in light of local policies, administrative structure, geography, and the health system (WHO, 2013).

As with other health services, the entomology laboratory network should be organized by administrative level:

- central or national reference laboratory with the capacity to carry out all the network's entomology activities and train personnel;
- intermediate laboratories that perform less complex activities;
- local laboratories, usually in municipalities or districts, that conduct more basic entomology activities.

In addition to the national network, it is important to have laboratories of excellence for referring samples or tests done outside the network.

2.1. National reference laboratories

A national reference laboratory is not usually managed within the national laboratory network as it is considered a national center of excellence. National reference laboratories are sometimes supported by external donors, such as universities and research centers that routinely provide the necessary resources. These laboratories perform highly skilled tests to complement tests conducted at the central laboratory. Services at this level are highly specialized and the techniques used are often complex and automated, including research and specialized tests (such as molecular assays to detect insecticide resistance and studies to detect virus in mosquitoes) (USAID, 2009).

The national reference laboratory can also provide training for technical personnel at the central laboratories and conduct external quality control evaluations.

2.2. Central or Level I laboratories

The central laboratory occupies the highest level within the national laboratory services network and is usually connected with the ministry of health. The central laboratory usually conducts the broadest range of specimen identification. It also has the capacity to carry out all the tests required by the entomology network. The central laboratory usually serves as the laboratory to which the basic or intermediary level laboratories can refer samples for identification or for more complex tests. Laboratories within a network typically send samples to a higher level when they lack the capacity, technology, or equipment to perform tests. For example, basic or intermediary laboratories can carry out biological tests to determine insecticide resistance and forward material to the central laboratory to confirm resistance mechanisms using biochemical or molecular assays.

The central laboratory usually maintains an insectarium with colonies of mosquito species and other insects of public health concern.

The central laboratory should have the capacity to carry out all the activities of the entomology network, including at least the following:

- collect insects of public health concern in their different stages (egg, larva, pupa, nymph, and adult);
- identify the specimens collected;

- raise and maintain insect colonies;
- examine specimens to confirm natural infection and physiological age;
- conduct biological tests to evaluate the effect of insecticides on simulated and field situations;
- determine the size of insecticide droplets produced by space-spraying equipment;
- perform biological, biochemical, and molecular tests to evaluate insecticide resistance;
- maintain entomological collections;
- participate in the investigation of vector-borne disease outbreaks;
- train human resources in the network;
- supervise and do quality control on Level II laboratories.

2.3. Intermediate or Level II laboratories

These laboratories are at the secondary level of a country's health structure and usually fall under the authority of provinces or states. If the health system is still centralized they may be under the ministry of health at the regional level. They usually perform almost all network activities. Level II laboratories generally serves as a reference for receiving samples for identification or for making more complex tests not performed at level III.

A Level II laboratory should maintain an insectarium with colonies of mosquito species and other insects of public health concern in the region.

A Level II laboratory should have the capacity to do at least the following:

- collect insects of public health concern in their different stages (egg, larva, pupa, nymph and adult);
- identify the collected specimens;
- raise and maintain insect colonies;
- examine specimens to confirm natural infection and physiological age;
- conduct biological tests to evaluate the effect of insecticides on simulated and field situations;

- determine the size of insecticide droplets produced by space-spraying equipment;
- perform biological tests to evaluate insecticide resistance;
- maintain entomological collections;
- participate in the investigation of vector-borne disease outbreaks;
- train Level III human resources;
- supervise and do quality control on Level III laboratories.

2.4. Basic or Level III laboratories

These laboratories are at the basic level of a country's health structure and are generally under municipalities or districts. If the health system is still centralized they may be under the local authority of the ministry of health. They usually perform the most basic and routine activities of the entomology network.

A Level III laboratory should be able to do at least the following:

- collect insects of public health concern at their different stages (egg, larva, pupa, nymph and adult);
- triage and prepare samples and specimens for shipment to Level II laboratories;
- identify the collected specimens;
- perform biological tests to evaluate the effect of insecticides on simulated and field situations;
- determine the size of insecticide droplets produced by space-spraying equipment;
- investigate outbreaks of vector-borne diseases.

To carry out the various activities, consideration must be given to biosafety, infrastructure that provides suitable physical space for each activity, furniture, and miscellaneous equipment.

3 Biosafety in Public Health Entomology Laboratories

Laboratory activities expose workers to a variety of risks, depending on the materials and methods used. To minimize or eliminate risks, it is essential to establish a laboratory biosafety program.

Public health entomology laboratories should be designed to comply with biosafety requirements in accordance with the risk classification of the organisms and agents they handle. An assessment should be done to ensure that the required biosafety measures are clearly identified, since each laboratory has its own combination of risks. The person in charge of the laboratory and the internal biosafety committee are responsible for evaluating the risks and properly implementing recommended biosafety measures. The country's prevailing standards for risk assessment should be applied. Recommendations from the Centers for Disease Control and Prevention (CDC, 2009) and the World Health Organization (WHO, 2005) can also be followed.

Risk groups are defined in terms of the biological agents and chemicals that will be handled, using a biosafety scale from 1 to 4. Entomology laboratories are usually at biosafety levels 1 and 2, although activities that involve infection may require biosafety level 3.

The biosafety level of insectariums and for infectious activities will usually be determined by the risk classification of the agent being studied or by the risk assessment. Nevertheless, some additional special precautions are needed:

- different areas must be available for infected and uninfected invertebrates and for those exposed and not exposed to insecticides;

- those areas must be sealable when required for fumigation;
- cooling facilities must be available when needed to reduce the activity of the invertebrates;
- access should be gained through a vestibule outfitted with mosquito nets in the doors and insect traps;
- all ventilation openings and windows that can open must be outfitted with mosquito-proof screens (WHO, 2005).

More detailed biosafety recommendations for insectariums and infectious activities can be found in the guidelines for arthropod vector containment published in the *Journal of Vector-borne and Zoonotic Diseases* (2003). The Oswaldo Cruz Foundation (Fiocruz) has also published an excellent guide on the subject (Adegas *et al.*, 2005).

4 Laboratory Infrastructure

As part of its functions, a public health entomology laboratory responds to the need to keep and handle insects, perform chemical analysis, and keep animals to supply blood for the insects. A physical, administrative, and technical structure must be established that is compatible with the activities to be carried out. The main aspects of laboratory planning are: personal safety, sample protection, accurate results, efficient workflow, environmental protection, and protection from the risks of the laboratory activities.

Laboratories should be constructed with materials that are easy to maintain and clean, are impermeable to the chemical products used, and do not allow the insects to escape.

Spaces outside the laboratory itself should be designated for holding the clothing and personal belongings of the staff. There should also be places to eat, drink, and rest outside the laboratory work areas. Space should be provided for the storage of long-term use items, conveniently situated outside the work areas. Items for immediate use should be kept inside the rooms where they will be used (WHO, 2005).

Some basic rules should be followed: a) the rooms should have enough space to perform laboratory tasks safely, and should be easy to clean and maintain; and b) lighting must be adequate for all activities, while undesirable reflections and glare should be avoided (WHO, 2005).

4.1. Laboratory design and facilities

All physical spaces (walls, floors, ceilings, etc.), as well as electrical installations and plumbing, benches, and furniture should be arranged in accordance with the activities to be carried out in the different areas of the laboratory. Below are some recommendations based on guidelines prepared by the Ministry of Health of Brazil (Funasa, 2004).

Walls and panels: Use partitions in areas where flexible space is required; partitions or panels should be covered in sturdy, washable material in light colors with a matte finish that is non-porous and smooth.

Floors: Floors should be level, non-porous, and covered with non-slip, washable, chemical-resistant, smooth material. They should also have a good drainage system (see plumbing).

Ceilings: Continuous, properly sealed, waterproof ceilings with no sagging (including suspended ceilings) should be coated with washable materials that are non-porous to gases and chemical products.

Suspended ceilings: Removable panels can be used in hallways and administrative and support areas, including acoustic tiles (Figure 1).

Framing: Framing should be made of easily cleaned and maintained materials.

Viewing panels: Viewing panels are recommended for partitions between rooms and hallways. Their use is mandatory at doors.

Doors:

- doors to access laboratory, washing, sterilization, and storage areas should have a minimum width of 1.10 m;
- doors to all other laboratory areas should have a minimum width of 0.80 m;
- all access doors to spaces where large equipment is installed must have removable panels, at a width determined by the size of the equipment, to allow for entry and exit from the room;
- the direction in which doors open should be determined based on work flows in the laboratory areas to prevent accidents;
- lever door handles should be used to facilitate hands-free opening;

- doors that prevent entry by unauthorized persons into risk areas should be used, opening automatically with use of a card or other security system;
- lab entry doors should be clearly marked with signs.

Windows: windows that can open should have insect-proof screens. In biosafety Level 3 laboratories, the windows should be kept closed with safety glass and properly sealed.

Benches, sinks, and furniture:

- bench height of 0.90 m for standing tasks and 0.75 m for seated tasks, with a minimum depth of 0.70 m for both;
- bench dimensions suitable for specific equipment;
- upper shelves, racks, and wall cabinets for small, lightweight materials;
- bench surfaces consistent with intended uses, considering such factors as moisture, weight of the materials, and use of liquids and chemicals;
- bench surface covered in non-porous, smooth, seamless materials without grooves;
- sinks deep enough for the intended use, 25 cm minimum;
- ergonomic furniture built with non-porous, chemical-resistant surfaces, without crevices and corners. Latches and handles should be easy to clean and maintain;
- easily moved, flexible use, modular furniture.

Water installation: should meet the country's regulatory standards and provide

- a tank with enough water for laboratory activities and reserves in case of fire; check need for prior water treatment;
- water tank with at least two compartments to allow clean-up and maintenance operations;
- water supply and outlet points at construction waste dumps;
- secondary wastewater treatment if there is no public wastewater collection network;
- no use of greywater from laboratory areas;

- water intake points for at least two sinks in each laboratory area;
- water intake for emergency eyewash devices and showers near strategic points in the laboratory area;
- water intake for a hands-free automatic washstand in the laboratory area, near the exit;
- water intake for the deionizer, the still, the autoclave, and other special equipment that uses water.

Electrical facilities: should meet the country's regulatory standards and provide

- stabilized electric power for electronic equipment;
- outlets, lighting, signage, and data and voice communications suitable for every activity;
- marked 110- and 220-volt outlets;
- special >600-watt outlets for equipment such as stoves, heating plates, and stills. These should operate on separate, marked circuits;
- marked circuit breaker boxes specific to each area of laboratory placed near the exit;
- electrical feed to circuit breaker boxes that can handle 30% more than currently forecast needs, for possible future circuit extension;
- grounding for all outlets;
- installation of a back-up generator to run emergency lighting and power equipment;
- reinforced lamps in the waste disposal area;
- electrical socket near automatic washstands.

Air treatment: should meet the country's regulatory standards.

- The chambers of the chemical extractor should have ducts leading outside the building, with their ends at the highest point of the building and nearby buildings, far from residential structures and the air vents for the climate control system;

- for insect colony areas, air treatment must consider the humidity level required for them to thrive.

Safety equipment:

- emergency eyewash devices and showers at strategic spots in the laboratory (Figure 2);
- automatic washstand at the laboratory exit;
- place near entrance to the laboratory for keeping lab coats and other personal protective equipment (PPE); (*Note:* There must be a space for gown-hanging area - Figure 3);
- pressurized chamber (air lock) through which technical personnel can enter and exit an insectarium and put on or remove lab coats and other PPE.

4.1.2. Special recommendations for insectariums

The main insects raised in public health entomology laboratory insectariums are mosquitoes of the genuses *Aedes*, *Anopheles*, and *Culex*, which are involved in the transmission of the arboviral diseases—dengue, Zika and chikungunya, malaria, and filariasis—respectively. Phlebotomine sand flies that transmit leishmaniasis and triatomine bugs that transmit Chagas disease are also bred. Different species, even of the same genus, may have different requirements; for example, *Anopheles albitarsis* larvae can be kept in clean, unchlorinated water, while *An. aquasalis* requires salt or brackish water.

Before installing an insectarium, there must be a good understanding of the insect's biology and the length and characteristics of its life cycle, nutritional requirements, and physical parameters such as temperature, relative humidity, and brightness. All requirements should be considered when determining the physical space and appropriate environmental comfort, as well as the biosafety standards to be followed to minimize or eliminate the risks inherent in this type of activity (Adegas *et al*., 2005).

When defining the physical space and conditions of an insectarium, it is necessary to consider, in addition to the specifications described above, the following additional specifications (ACME/ASTMH, 2003; Adegas *et al*., 2005; Mexico, 2015):

- wood is not recommended as a building material due to its flammability; concrete is most suitable;
- the insectarium should be physically separated from traffic areas within the building and other laboratory areas, preferably away from the entrance;
- the insectarium should have only one entrance;
- the insectarium should be physically separated from public passageways by at least two automatically closing doors;
- visible signage at the entrance to the insectarium should indicate the biosafety level and the organism;
- the entrance to the insectarium should have a double door vestibule, known as an air chamber, to separate the external area from the internal area, equipped with an exhaust fan to trap any free mosquitoes and minimize the risk of their release (Figure 4);
- the two contiguous doors should not open at the same time;
- the internal doors can either open out or slide, but they should close automatically and remain closed when insects are present;
- the insectarium must have at least two areas, one for keeping adult specimens and another for larvae and pupas;
- it is recommended that triatomine bugs be kept in a separate environment from the mosquitoes;
- there should be a handling room inside the insectariums, which should be located inside the double door system;
- any windows should use fixed glass to prevent insects from escaping. For triatomine bugs, Phlebotomine sand flies, and *Aedes*, no windows are needed. However, *Anopheles* mosquitoes benefit from the light of dawn and dusk;
- there should be a lavage room near the insectarium;
- the walls, ceiling, and floor of the insectariums should be white;
- ceilings should be at least 2.5 meters high;

- bench tops should be smooth and easy to clean; the best material is stainless steel, but other materials can be used;
- the furniture should be far from the walls and its bases protected against entry of ants or other insects;
- there should be minimal furniture in the breeding rooms, preferably easily moved with open shelves;
- electrical wiring and plumbing should be sealed off, encased in the walls, and have no cracks that could become hiding-places;
- at least one large sink is needed in the breeding area, with hot and cold running water, and a water mixer to regulate the temperature.

4.2. Arrangement of physical spaces, furniture, and equipment

The physical spaces, equipment, and furniture in each laboratory room should be suitable for the activities performed in it.

The furniture should be sturdy and leave space between tables, cabinets, and other items, as well as underneath them, for easy cleaning. There should be enough space to store immediate-use items so they do not clutter the work benches and hallways. It is important to have small drawers in the furniture and receptacles for storing reagents, disposable materials, and cleaning supplies (WHO, 2005).

It is advisable to first precisely determine what activities will be carried out in the laboratory before configuring the laboratory space.

The spaces must have an arrangement of furniture and equipment necessary for the development of activities. It is important to take care of biosecurity by separating the clean environments (without the use of insecticides or without the use of pathogens) from the spaces with material exposed to insecticides and materials from the field.

Some spaces may be the same, for example, the reception and sample registration room and the administration room.

Next are detailed guidelines for the arrangement of physical spaces, furniture, and equipment according to the activity to be carried out and the laboratory level. Some spaces are needed only in more complex laboratories.

Area for reception and registration of samples

This should be before the entryway to the other laboratory spaces and should be the only place that non-laboratory personnel are allowed, for the sole purpose of delivering samples and picking up results. Laboratories of all levels should have such an area.

Activity: receive samples and insects collected in the field, make notes, and conduct triage. When insects collected are alive, they should be immediately taken to the environment designated for that purpose.

Table 1 describes the equipment and materials for this area according to laboratory level.

Table 1. Equipment and furnishings for the reception and triage area

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
File cabinet	1	1	1
Trash bin	1	1	1
Manual counter	1	1	1
Printer	1	1	1
Microcomputer table	1	1	1
Microcomputer	1	1	1
Chair	1	1	1
Stool	1	1	1

Administrative office

Activity: administrative activities of the laboratory.

For Level I laboratories, this should be a separate room. In Level III laboratories, this space may be adjacent to where samples are received and registered.

Table 2 describes the equipment and materials needed in this room according to laboratory level.

Table 2. Equipment and furnishings for the administrative office

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
File cabinet	2	1	1
Cabinet or closet	2	1	1
Trash bin	2	1	1
Printer	2	1	1
Meeting table with chairs for 4 people	1	1	1
Printer table	2	1	1
Microcomputer table	2	1	1
Microcomputer	2	1	1
Chair	6	5	2

Meeting/training room

Activity: training of laboratory personnel; meetings to adjust procedures. Level I and II laboratories should have such a space. Level III laboratories can use the administrative office.

Table 3 describes the equipment and materials needed for this room according to laboratory level.

Table 3. Equipment and furnishings for the meeting/training room

Equipment	Level I Laboratory	Level II Laboratory
Split air conditioner	1	1
Support table	1	1
Conference table with chairs for 10 people	1	1
Microcomputer table	1	1
Microcomputer	1	1
Multimedia projector	1	1
Chair	12	12

Preparation and identification room

Activity: receive samples and insects collected in the field, do triage, and identify the insects collected. Prepare insects for further study.

Table 4 describes the equipment and materials needed for this room according to laboratory level.

Table 4. Equipment and furnishings for the preparation an identification room

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
Bench with two sinks (Figure 5)	1	1	1
Pedal trash bin[1]	2	2	2
Movable drawers	1	1	1
Chemical extraction hood (Figure 6)	1	1	1
Electric current stabilizers	4	2	2
Above-bench shelving	1	1	1
Oven	1	1	1
BOD incubator[2] (Figure 7)	2	1	1
Refrigerator	2	1	1
Cold light source	3	2	2
Refrigerated table	1	1	1
Bacteriological microscope (Figure 8)	2	1	1
Stereoscopic microscope (Figure 9)	2	1	1
Chair	4	2	2
Stool	1	1	1

[1] Refuse holder with pedal to open.
[2] BOD (biochemical oxygen demand).

Cleaning room

Activity: clean the materials used for preparation of the insects and in the tests.

The laboratory should have a cleaning room and the insectarium should have its own cleaning room.

Table 5 describes the equipment and materials needed for this room, according to laboratory level.

Table 5. Equipment and furnishings for the cleaning room

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
Cabinet or closet	2	1	1
Bench	1	1	1
Bench with two sinks	1	1	1
Pedal trash bin	2	1	1
Above-bench shelving	1	1	1

Entomological collection room

Activity: keep collected insect specimens in the different stages for reference and training.

Level I laboratories should have three separate cabinets: one for pin-mounted insects, one for insects preserved in liquid, and one for storing microscopic preparations. More modest laboratories can get by with one or two cabinets if they have a small collection (Ortiz, 1979).

Table 6 describes the equipment and materials needed for this room according to laboratory level.

Table 6. Equipment and furnishings for the entomological collection room

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
Cabinet	2	1	1
Cabinet with sliding drawers	3	1	1
Bench	1	1	1
Bench with two sinks	1	1	1
Pedal trash bin	2	1	1
Electric current stabilizers	2	1	1
Above-bench shelving	1	1	1
Cold light sources	2	1	1
Bacteriological microscope	2	1	1
Stereoscopic microscope	2	1	1

Insectarium support room

Activity: procedures with the insects upon arrival, before they enter the insectarium; and procedures with specimens removed from the insectarium and destined to other areas, e.g., resistance testing rooms.

Table 7 describes the equipment and materials needed for this room according to laboratory levels.

Table 7. Equipment and furnishings for the insectarium support room

Equipment	Level I Laboratory	Level II Laboratory
Split air conditioner	1	1
Cabinet	2	1
Bench	1	1
Bench with two sinks	1	1
Pedal trash bin	1	1
Acrylic box for handling of winged insects (Figure 10)	1	1
Heater	1	1
Air curtain	1	1
Still	1	1
Above-bench shelving	1	1
BOD incubator	2	1
Humidifier	2	1
Household refrigerator	2	1
Lab bench work chair	2	1

Insectariums

Activity: raise and keep insects of public health concern. Level I and II laboratories should have insectariums, although there will be variations in the complexity and quantity of species bred.

Different insects require different temperatures, humidity levels, and other climatic

conditions. Table 8 describes the materials required for a multipurpose insectarium. If insects with different climatic requirements are kept, different breeding rooms are needed.

There should be separate rooms for larvae and adult mosquitoes, infected and uninfected insects, and those that have and have not been exposed to insecticides.

Juvenile mosquitoes are sometimes bred in BOD incubators (Figure 11). In insectariums where winged mosquitoes are bred it is important to have light traps to collect any mosquitoes that try to escape.

Table 8 describes the equipment and materials needed for this room according to laboratory level.

Table 8. Equipment and furnishings for the insectarium

Equipment	Level I Laboratory	Level II Laboratory
Split air conditioner	1	1
Bench with two sinks	1	1
Pedal trash bin	1	1
Acrylic box for handling of winged insects	1	1
Heater	1	1
Air curtain	1	1
Shelves for cages and trays	2	2
BOD incubator	2	1
Humidifier	2	1
Thermo-hygrometer	1	1
Light traps to capture adult insects	1	1

Biochemical testing room

Activity: perform biochemical tests to determine insecticide resistance mechanisms.

Table 9 describes the equipment and materials needed for this room according to laboratory level.

Table 9. Equipment and furnishings for the biochemical testing room

Equipment	Level I Laboratory	Level II Laboratory
Split air conditioner	1	1
Magnetic agitator	1	1
Precision laboratory balance	1	1
Bench	2	1
Above-bench shelving	1	1
Bench with two sinks	1	1
Vacuum pump	1	1
Refrigerator	1	1
Vertical freezer -80ºC	1	1
Cooler	1	1
Printer	1	1
ELISA (Enzyme-Linked Immunosorbent Assay) microplate reader	1	1
Pedal macerator	1	1
Manual macerator	1	1
Ice machine	1	1
Micro centrifuges	1	1
Microcomputer	1	1
pH meter	1	1
Mono-channel pipette	2	2
Multichannel pipette	2	2
Chair	2	2
Lab bench chair	2	2
Milli-Q water ultra-purification system	1	1
Vortex mixer	2	1

Room for procedures and triage of materials and insects exposed to insecticide in the field

Activity: read magnesium oxide slides to count and determine the size of the droplets produced for space spray equipment. Remove mosquitoes from the exposure cages and transfer them to clean containers.

Table 10 describes the equipment and materials needed for this room according to laboratory level.

Table 10. Equipment and furnishings for the room for procedures and triage of materials and insects exposed to insecticides in the field

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
Bench with two sinks	1	1	1
Electric current stabilizers	2	1	1
Sources of cold light	2	1	1
Platinum plate and eyepiece for measuring droplet size	2	1	1
Bacteriological microscope	2	1	1
Stereoscopic microscope	2	1	1
Chair	2	2	2

Internal room for simulated field tests and dilution of insecticides

Activity: dilute the insecticides used in the biological tests and simulated field tests. Perform biological tests.

Table 11 describes the equipment and materials needed for this room according to laboratory level.

Table 11. Equipment and furnishings for the internal room for simulated field tests and dilution of insecticides

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Split air conditioner	1	1	1
Agitator	1	1	1
Precision laboratory balance	1	1	1
Bench with two sinks	1	1	1
pH meter	1	1	1
Thermo-hygrometer	1	1	1
Thermometer	1	1	1

External area for simulated field tests

Activity: conduct simulated field tests to confirm the effectiveness of the insecticides used in vector control programs. This area should be as isolated as possible from the insectarium areas. It should have enough space to distribute water and panels in containers to be impregnated with insecticides.

The materials can be kept in separate containers to be used only in the testing period. There must be plumbing for water supply, covered areas and areas exposed to the sun, and at least the following materials: 70-liter barrels, 300-liter water containers, tires, panels made of different materials (wood, masonry, etc.).

Laboratories at all levels can have areas for simulated field tests. However, this area is essential for the Level I and II laboratories.

Room for clean field material

Destination: store material to be used in the field for insect collection and other tests. Only truly clean material—free of insecticides and other contaminants—is kept here.

Table 12 describes the equipment and materials needed for this room according to laboratory level.

Table 12. Equipment, furnishings, and main traps for the clean field material room

Equipment	Level I Laboratory	Level II Laboratory	Level III Laboratory
Cabinet	2	1	1
Shelf	2	1	1
Ovitraps	1,000	500	200
BG sentinel trap	30	10	6
CDC trap	20	20	10
Shannon trap	3	2	1

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6 Annex - Figures

Figure 1. Suspended ceiling

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

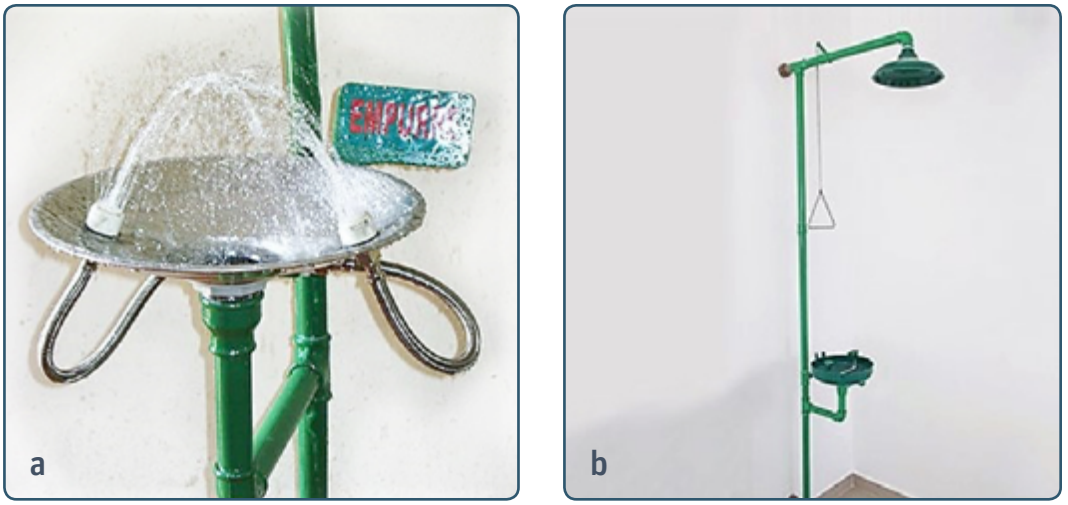

Figure 2. Emergency eye-washing station (a) and shower (b)
Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

Figure 3. Gown-hanging area

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

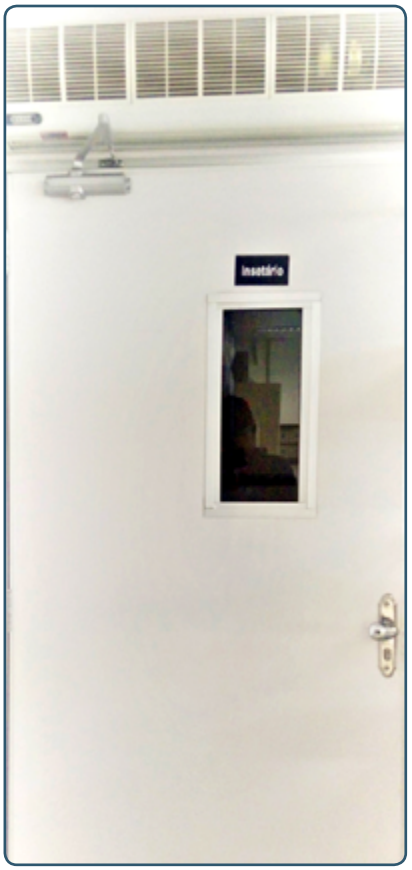

Figure 4. Insectarium door with air curtain, viewing window, and hydraulic arm for automatic closing

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

Figure 5. Counter with two sinks

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

Figure 6. Chemical extractor

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

Figure 7. BOD incubator

Source: Personal collection of Katia M. L. Braga (General Coordination of Public Health Laboratories of the Ministry of Health, Brazil)

Figure 8. Bacteriological microscope

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

Figure 9.
Stereoscopic microscope

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

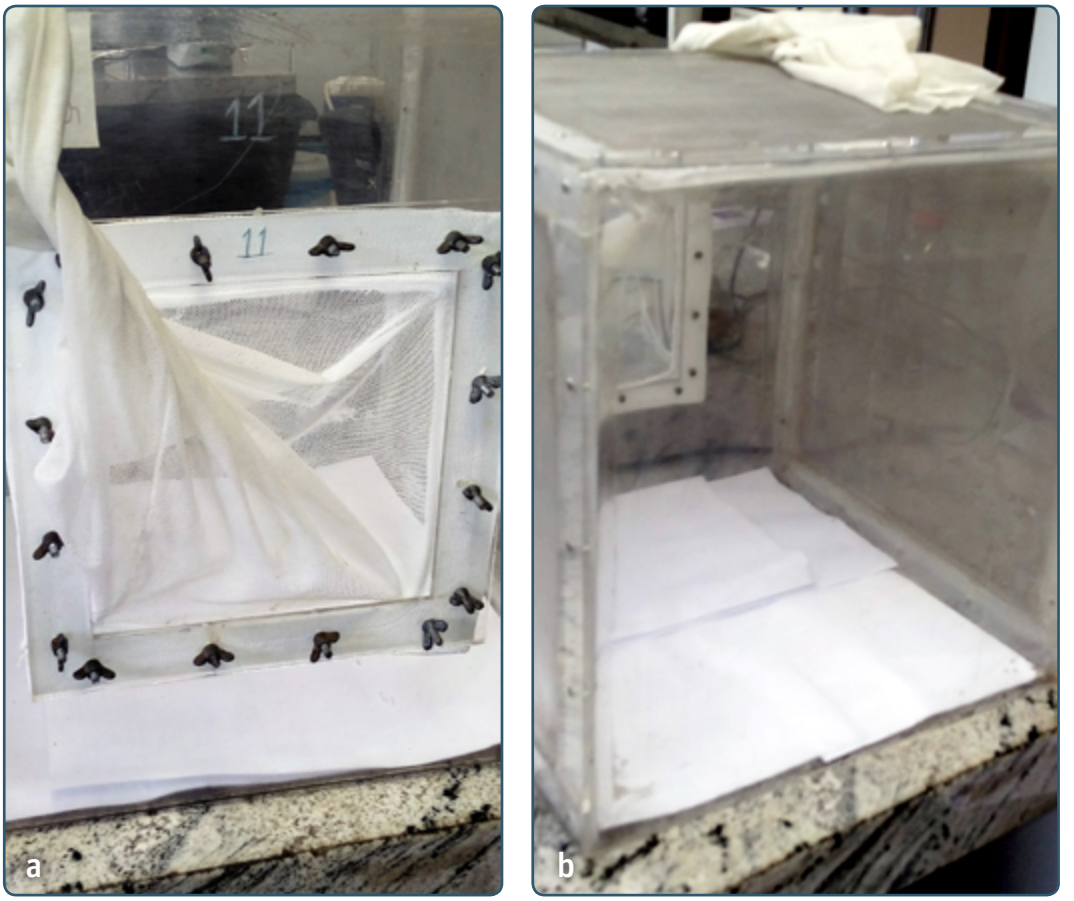

Figure 10. Acrylic box for handling winged insects (a. front, b. back)

Source: Entomology Laboratory, Ministry of Health of Minas Gerais, Brazil

Figure 11. Breeding mosquitoes larvae in BOD incubator

Source: Personal collection of Katia M. L. Braga (General Coordination of Public Health Laboratories of the Ministry of Health, Brazil)

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