2-2: Laboratory design

Access

When designing a laboratory or organizing workflow, ensure that patients and patient samples do not have common pathways. Circulation paths should be designed in such a way that contact between the public and biological materials can occur only in the rooms where patient samples are collected. The reception desk where incoming patients register should be located as close as possible to the entry door.

Access to rooms where manipulation or analysis of samples takes place, or where hazardous chemicals or other materials are stored, must be restricted to authorized persons, usually laboratory technical staff and maintenance staff. Restriction of access may be accomplished using signs on doors, locks when appropriate and staff identification badges.

Circulation pathways

To identify where improvements in laboratory design may be needed in order to prevent or reduce risks of cross-contamination, follow the path of the sample as it moves through the laboratory during the pre-examination, examination and post-examination phases of testing. Pathways to assess include:

- Sample collection areas—a laboratory layout with both the reception and the sample collection room located at the entrance saves time and energy.
- Sample processing areas—here, samples are centrifuged as needed, allocated for different examinations and dispersed to the appropriate sections of the laboratory for analysis. If possible, the sample processing area should be separated from, but nearby, the testing areas.
- Start with changes that can be easily accomplished and have the biggest impact.
- Circulation pathways of biological samples between different sections of the laboratory—These pathways should be assessed for the purpose of minimizing contamination risks. If possible, circulation pathways of clean and dirty laboratory materials should never cross, and circulation pathways of contaminated waste should be isolated.
- Post-examination pathways—After the analysis of the samples, the results must be accurately recorded, properly filed, and delivered on time to the right person. Communication systems appropriate to the size and complexity of the laboratory, including the efficient and reliable transferring of messages, should be part of the laboratory design.

For the most efficient design, all related services should be located in close proximity.

2-3: Geographic or spatial organization

Distribution of activities

When organizing laboratory work space, divide the laboratory into areas with different access control in order to separate patients from biological samples. Where samples are actually processed, plan for spatial organization that ensures the best service.

For optimal organization of the laboratory, consider:

- Delineation of laboratory activities—Care should be taken to either group related activities in a single room, or to clearly delineate bench space for specific activities. Measures must be taken to prevent cross-contamination of samples.
- Location of service rooms—Service rooms to accommodate autoclaves, sinks for cleaning glassware, preparation and sterilization of culture media, and so on, should be located in a central area to minimize distances and facilitate circulation paths of materials, samples and goods. A responsible staff member should be designated to oversee cleaning and maintenance of the service rooms.
- Location of activities with specific requirements, such as:
  - molecular biology—needs to be located in a separate space, with at least two rooms, so that preparation of DNA extracts is not performed in the same room as where the subsequent steps (preparation of reagent mixes and DNA amplification) are performed;
  - fluorescence microscopy—requires a dark room with proper ventilation which must not be used for storage of stock materials and other chemicals;
  - ultraviolet illumination systems for DNA gel photography—requires a dark room and appropriate eye protection equipment.

Spatial provision for equipment

The laboratory director and safety officer must consider special needs for equipment when designing laboratory space. Some things to consider are:

- Access to equipment for entry and maintenance—Make sure that there are no physical restrictions for access, such as door and elevator size, that could pose a problem for the delivery and maintenance of new machines and equipment.
- Power supply—Consider the need for a stable power supply for sensitive equipment and a backup power supply or emergency generator for times when the laboratory's primary power source is down.
- Managing disposal of liquids from equipment—Disposal of liquid reagents, by-products and wastes from laboratory equipment and procedures is a major concern for laboratories. When placing equipment in the laboratory, be sure to consider how liquid wastes will be handled. It is important to be aware of, and comply with, local and national requirements for liquid waste disposal, in order to prevent contamination of community sewage systems with pathogens or toxic chemicals.

2-4: Physical aspects of premises and rooms

Facilities

The laboratory must be designed to ensure proper ventilation throughout, with an active ventilation system and adequate space for circulation of people, laboratory carts and trolleys.

Rooms should have a high ceiling to ensure proper ventilation, and walls and ceilings should be painted with washable, glossy paint or coated with a material suitable for cleaning and disinfection. The floor must also be easy to clean and disinfect, and have no edges between the walls and floor.

Work benches

Laboratory work benches should be constructed of materials that are durable and easy to disinfect. If the laboratory's budget allows, ceramic tiles are good materials to use for benchtops, as they are easy to clean and are resistant to deterioration from harsh disinfectants and aggressive cleaning products. However, be aware that the grout between them can sometimes harbour contaminating microorganisms, so must be disinfected regularly.

Wood should not be used, as it is not easy to clean or disinfect, and will deteriorate over time when repeatedly exposed to disinfectants and detergents. Wood also support the growth of contaminants when wet or damaged.

The disadvantage of using steel for benchtops is that steel will rust when washed with chlorine.

It is advisable to organize work benches according to the type of analysis that is performed, with adequate space for benchtop equipment and enough space to place a standard operating procedure while in use and display job aids. In areas where microbiology procedures are performed, work benches should be separated according to the different types of samples or pathogens that are analyzed, in order to minimize risks of cross-contamination.

Cleaning

It is very important that all areas of the laboratory are cleaned and maintained on a regular basis. Examples of areas that need daily attention are:

- Benchtops—clean and disinfect benchtops after completing examinations, and after any spills of samples or reagents. This responsibility is generally assigned to the technical staff performing the tests.
- Floors—these are usually cleaned by cleaning staff, unless restricted access allows only technical staff to disinfect the floors at the end of the day.

Other areas of the laboratory should be scheduled for cleaning on a weekly or monthly basis, depending on laboratory conditions. For example, ceilings and walls may require cleaning weekly, whereas items such as refrigerators and storage areas might be scheduled for a monthly cleaning.

Cleaning and disinfection of laboratory areas should be recorded, including the date and name of the person performing the maintenance.