

## Modern design concepts and principles of biology laboratory

1. Maximum respect to the base environment to express respect to the environment - ecological building design

In the full analysis of the current situation, basing on the idea making the building as the background of the environment, making the single building inclusive in the environment.

2. Forward-looking design concepts

Biology Laboratory has the following characteristics:

- Flexibility: Each laboratory can have enough space to place instruments and equipment. Individual sections can independently control their respective purposes in order to ensure that the laboratory does not affect the relevant circumstances and need not change the module configuration.
- Economy: laboratory takes into account the protection work and the efficiency of the allocation of the use of regional division, in order to avoid the waste of area and space.
- Scalability: To set the laboratory system which based on the structure of modules which can be added to the form and reusable operating system , can make the necessary contraction and expansion without sacrificing features and doing not affect certain laboratory circumstances .
- Safety: Laboratory is divided many area according to their potential allocation risk. The space for Smoke shield , acid substances and flammable substances and the space distributed for the bio-security warehouse will be configured at a higher risk in the laboratory with the rear (away from the exit). Some waste of space and adequate access will be used to form a second layer with a higher risk of protection. Each laboratory will be used for low-risk arrangements of a variety dry benches such as the table, computer and instruments and so on. Wet tables are placed in middle-danger area.

Patency: Laboratory aisle and entrance channel will provide easy operation and provide the corresponding line access to relevant norms.

### 3. Adapt to the trends in biotechnology development

The safety of laboratory personnel and preventing pollution is the prerequisite to carry out pathogenic microorganism experimental study. Because the laboratory is the result of high risk of infection of laboratory personnel or the environment. In the design, not only to meet the functional requirements, but also must be in accordance with national standards and professional standards for the industry, and learn and consul design standards and related specifications of biology laboratory at home and abroad, to achieve common security standards of microbiology and biomedical laboratories.

### 4. Promote the best available scientific research capacity

Modern laboratory stress personnel to exchange each other, especially study exchanges and team spirit. Taking into account the characteristics of research activity, the building must be able to adapt to the changes in all aspects in technology, equipment, processes and skills, and can quickly and easily to respond ,and it can promote knowledge sharing and transferring between researchers and visiting scholars, and thus forming a kind of interaction and information exchange academic atmosphere.

### 5. The rational use of space, take full account of the flexibility and adaptability

In the design of modern laboratory adopting uniform columns network, and the division of cells with different levels of security modules to suit different process requirements. This modular layout not only absorb the foreign advanced process CDC, but also the actual situation, so it make the laboratory layout more versatility, flexibility, and to meet the possibility of future reform.

### 6. humanity processing for the environment Indoor and outdoor,

In the advanced design concepts guidance, taking the humanity design concepts to layout indoor and outdoor environment , to provide efficient and

comfortable environment for laboratory staff in the workplace and leisure space.

## 7. Biology laboratory safety and security

Most laboratories are 2-class bio-security laboratory, they are suitable for moderate research of potentially harmful micro-organisms for staff or the environment; some experimental area are 3-class bio-security laboratory, which suitable for pathogenic microorganisms and toxins research which primarily through the respiratory pathway to make people infect with severe or even fatal diseases. Preventing the microbial hazards, bio-safety 2-class and bio-safety 3-class laboratory design is the key.

## 2. Modern biology laboratory process design contents and requirements

### 1. The design report for modern biology laboratory

The design report for modern biology laboratory includes requirements of each department and the requirement of area and functional; To develop the design requirements of each room of the building, decoration elements, doors and windows, climate control, power (lighting, communications and network), gas pipelines, water supply and drainage, air conditioning, fire control, and structure in Biology Laboratory; to develop the required fixed equipment list in each room of Biology Laboratory.

### 2. Modern biology laboratory process design / equipment planning

Modern biology laboratory process design / equipment planning include the requirements in accordance with international the project mission statement process and standard, to complete the biology laboratory capital equipment planning, process layout, the enlarged floor plans of a typical biology laboratory technique, major Stereogram, and major profile; to complete information of fixed equipment manufacturers for biology laboratory and engineering design data.

### 3. The design requirements for modern biology laboratory building

Modern biology laboratory building design includes:

- Base Environmental Design - in the full analysis of the current situation, based on the background of the building as an environmental design concepts, make the single building included in the environment.

- construction process design requirements - mainly contains biology laboratory building design, interior decoration materials requirements.

Basic laboratory work of the regional scale (ELM) is to ensure the safety of biomedical research to run to set a regional scale. Laboratory ELM generally include console, laboratory equipment (including storage cabinets), table, chemical exhaust cover and the length requirement of biology safety cabinets. The current trend in laboratory design planning has already begun moving in the direction of Planning regional spatial scale, but not limited to the length of the regional scale. This trend is originated in the form of modular laboratory use.

As the construction area including circulation areas, building core area, wall area and public area, certainly in the whole it is greater than the use of specific functional area. Reference the AIA ,using the conversion method between the area and construction area, The basic conversion factor of laboratory (including the internal circulation and function of distribution area) area is from 1.7 to 2.2. The total area conversion out will also be required to adjust in actual planning.

Laboratory Construction materials should select the type of durable and easy to clean and they can help to create a comfortable and safe working environment. The key factor for the material is easily to clean, easily to maintain, easily to storage and to minimize the virus spreading. Selected material for the wall and the floor must also be taken into account to ensure the safety of laboratory personnel.

- structural design process requirements - including biology laboratories

structural design, structural load requirements. As the vibration would interfere with the sensitivity of laboratory instruments, designers must consider to control the proper vibration and the vibration source should be placed away from the sensitive equipment, and must do careful analysis for vibration response of the building structure, in order to control the spreading of vibration in the laboratory area, engineers need to consider earlier structural design factors.

When set the size of Laboratory rooms (high, wide), the laboratory module, function allocation, Vibration Standard and late development etc should be considered, the width should be correspondingly changed in size based on laboratory modules, so not only ensure to design flexibility, but also meet the conventional doors and windows design and laboratory support connection is formed a unified whole. Not allow to set the column in laboratory module to avoid prejudicing to the laboratory's internal circulation and space use, structural system and air conditioning system should be closely coordinated to prevent interference.

- HVAC design process requirements - including biology laboratory space HVAC system design, air filtration, exhaust systems, biology safety cabinet exhaust system requirements.

HVAC systems must meet laboratory requirements. Not only to strictly control temperature and humidity, but also to need adequate ventilation to handle the dust, odor, air contaminants, ventilation hoods and lab, so as to meet the requirements for heat. And we must take full account of system reliability and as well as the well-off amount. Different nature of the region need to ensure that different relative pressure, and according to relevant standards to consider long-term saving energy. NC of Cover mouth among laboratory operation should not exceed the maximum 50dB, unless the device itself allows, NC generally should not exceed 60 dB.

HVAC, water, electricity, lighting equipment must be in accordance to the principle of efficient use of energy to choose, as well as easy to control and manage. Anti-condensation insulation thickness is required to meet minimum energy efficiency standards and recommended reference value of domestic-related. Building material must ensure the health and safety of residents, suggest to make use of the environmentally friendly and energy-saving materials. All energy systems and components should be fully controlled and managed, whether taking heat recovery or not should be more appropriate evaluation.

By laboratory equipment maintenance costs of economic analysis, make use of different HVAC systems. Economic analysis should depend on enough data to take a overall energy efficiency calculations for sufficient economy. Economic analysis includes the initial investment for the project, energy consumption, operating costs, system reliability, adaptability, and to compare them. The choice of each system is required to meet the flexible operation, reliable, easy to maintain and reserve margin, the total investment includes maintenance costs.

- drainage system process design requirements - including laboratory building drainage system design, equipment requirements.

The drainage system should be consistent with the laboratory module, a flexible drainage system should be designed and set aside part of the laboratory facilities to ensure reliable and continuous operation, try to avoid doing going through the wall treatment in the laboratory area .

Sewage, waste water system should be set to divert sewage and waste water drainage network, sewage treatment to water reuse standards standby and back again to supply water for landscaping and water features. Research and production waste to local treatment after disinfection with the focus on a combination. Being poisonous and radioactive waste contaminated water, the

nearest set inactivation and attenuation processing unit, strict control, treatment compliance after discharge.

Ground water through rainwater pipes organizing collection ,then filtered through the gravel layer ,at last to storage and reuse, margin and flood drain off the channel nearby.

- Strong and weak power design requirements - including biology laboratory power system design, room distribution system design, lighting design, intelligent design, security system design, communication system design requirements.

- Fire Process design - the main means of biology laboratory fire system design requirements.

The special requirements of laboratory fire protection should be considered in accordance with relevant local standard laboratory settings and in accordance with the regional laboratory using standardized building set on fire for fire rating materials, setting fire dampers, automatic sprinkler system, fire signal system, flue gas duct detection system, fire hydrant and fire pump and other fire facilities.

Biology laboratory furniture and equipment requirements, including health appliances, countertops, chemical hoods and biology safety cabinets, laboratory equipment requirements.

- bio-technology laboratory safety design requirements - includes conventional security process design, radiation safety, process design requirements.

Health and safety guidelines requires on construction projects as far as security staff to effectively control the formation, thus to minimize the potential occupational hazards in the workplace. These guidelines must also be submitted with the engineering content of the specific building design documents ,so as to the security in the building construction can be reflected. Although the healthy and safe policy and the requirements of many

engineering content can be unified, it is impossible to contain all the factors. Therefore suggest the health and safety experts as part of architectural design team.

All laboratories must ensure safely and reliably reserving radioactive materials. The capacity and type of radioactive material depends on the type and number of laboratory research function. Therefore, designers need to determine the necessary the region for radioactive material depending on the functional requirements of the laboratory. All laboratories must have the appropriate general level of disposal of storage containers for radioactive substances. The storage location of each laboratory waste must be standardized ,so that the emergency protection staffs take prompt measures when fire or accident happen.

- Environmental Protection process design requirements - includes wastewater and sewage treatment, noise protection, radiation protection, bio-security requirements.

Pay attention to environmental protection and proper disposal of waste , ensuring the laboratory staffs, visiting scholars and the well operation of the surrounding facilities and the maintenance of construction academic atmosphere is very important. Therefore, it is necessary to control strictly the laboratory's hazardous materials, hazardous waste reserving and processing, distributed storage facilities, wastewater discharge, solid waste management and recycling, gas distribution .

4. BSL3 biology laboratory, animal laboratory planning, process design / equipment planning and engineering design requirements - notably the completion of BSL3 biology laboratory, animal laboratory plane technology floor plan, elevation and profile design; complete the requirements and introduction of P3 biology experiments rooms, animal laboratories engineering design.



Bio-safety 3-class laboratory must be set to clean equipment (recommended autoclave). Autoclave area shall meet the corresponding requirements. Bio-safety 3-class laboratory vacuum system must be set protective filters. When the airflow in Bio-safety 3-class laboratory does not match the design, there should have images and sound alerts Taking actual situation and considering the safety of personnel and materials set the high efficiency filter. Exhaust entrainment will have steam inside, the filter of the ventilation must be set the appropriate filter (0.2 micron filtration filter or equivalent) --high efficiency filter installation, it must meet the appropriate special testing requirements.

#### 4. Examples of Modern biology laboratory building design

##### 1. China Disease Prevention and Control Center

###### Design Concept:

- maximum respect for the bases natural environment, protect the environment
- forward-looking design
- Modular International Biology Laboratory Design
- Development and flexibility