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Health Building Note 15

Facilities for pathology services

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Executive summary

The Department of Health, in its good practice advice 'Modernising Pathology Services' (published 2004), recommends that NHS trusts form pathology networks to deliver NHS pathology services across so-called "natural health communities". The nature of each network and size of community served should be determined locally, but the latter may be based on an area served by a strategic health authority (SHA) or part of it, or, in some circumstances, may cross SHA boundaries.

This document gives best practice advice on the planning and design of accommodation for NHS pathology services. It focuses on laboratory-based facilities within acute hospitals (on-site or stand-alone) serving acute and primary care needs across a pathology network. It also touches upon point-of-care testing facilities in acute and primary care settings.

It recommends that each laboratory space, whether a general or specialised laboratory or support laboratory, should be based on a standard module size in order to maximise the flexibility and adaptability of facilities. It supports a multidisciplinary approach to pathology working by categorising laboratory spaces based on function rather than discipline and encouraging disciplines to share facilities wherever possible.

Schedules of accommodation are provided for three examples: a full pathology service on an acute site serving a whole network; urgent and emergency service only on an acute site; routine, specialised and non-urgent service on a stand-alone site covering several acute sites.

This document replaces the existing HBN 15 – 'Accommodation for pathology services' (1991 edition).

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Clinical science centre, Wythenshawe Hospital (Photo: Bob Collier)

1 Introduction

PURPOSE AND SCOPE OF DOCUMENT

1.1 This Health Building Note (HBN) gives best practice advice on the planning and design of accommodation for pathology services. It covers laboratory-based facilities in acute hospitals (on-site or stand-alone) and point-of-care testing (POCT) facilities in acute and primary care settings.

1.2 In order to maximise capacity, efficiency and economies of scale it suggests that pathology services should be organised around pathology networks.

1.3 'Modernising Pathology Services' (DH) sets out the steps that can be taken locally to develop pathology modernisation strategies, including setting up managed pathology networks. It also describes the actions that will be taken nationally to support developments. This HBN should be read in conjunction with this publication.

1.4 This HBN adopts standard module sizes for both laboratory and POCT facilities in order to increase their flexibility in use.

1.5 It replaces the existing HBN 15 – 'Accommodation for pathology services' (1991 edition).

1.6 This HBN does not cover mortuary and post-mortem room facilities. These are covered in HBN 20 – 'Facilities for mortuary and post-mortem room services'

TOPICS COVERED

Planning considerations

1.7 This chapter deals with general planning considerations, including:

- the function of pathology services;
- the increased demand for pathology services;
- the network approach to pathology services;
- the modular approach to pathology services.

1.8 It also sets out other aspects of planning for pathology accommodation, such as upgrading or adapting existing buildings.

General functional and design considerations

1.9 This chapter covers the broader issues that are relevant to the design of pathology accommodation.

1.10 This chapter also addresses particular issues such as safety, security, finishes and IT.

Specific functional and design considerations

1.11 This chapter provides detailed design guidance for pathology facilities including the layout and planning of the specimen reception area, storage and support spaces, associated offices, staff facilities and laboratory requirements, including:

- non-laboratory support spaces;
- automated laboratories;
- general laboratories;
- support laboratories;
- specialised laboratories;
- histopathology and cytopathology facilities;
- point-of-care testing facilities.

Other chapters

1.12 Chapters 5–8 provide detailed guidance about engineering services. Chapter 9 provides cost information.

2 Planning considerations

THE FUNCTION OF PATHOLOGY SERVICES

2.1 NHS pathology services should provide a high-quality, timely analytical and interpretative service to assist in clinical diagnosis, preventative medicine (for example screening programmes), research, teaching and training, and epidemiological studies.

2.2 Currently, 60–70% of diagnoses are based upon pathology.

2.3 Specimens dealt with in acute general hospitals will arrive from a number of sources, including:

- wards;
- out-patients departments;
- A&E departments;
- operating theatres;
- critical care areas;
- post-mortem rooms;
- ambulatory care;
- GPs;
- community clinics;
- treatment centres (TCs);

Clinical science centre, Wythenshawe Hospital (Photo: Bob Collier)

- other hospitals/trusts;
- other pathology facilities;
- social services;
- dentists.

2.4 NHS pathology services also provide support for national screening programmes, public health, communicable disease surveillance, local authority environmental services, and national medical research programmes.

2.5 The wide range of clinical services offered, and the variety of investigations available, in both number and type, must be taken into consideration when planning and designing pathology facilities.

INCREASED DEMAND FOR PATHOLOGY SERVICES

2.6 Demand for pathology services continues to grow year by year. There are several reasons for this, including the increase in demand for tests from the primary care sector.

2.7 Although traditionally most pathology services have been based within acute hospital trusts, an increasing number of tests are being requested by clinicians who are managing patients in the primary care setting. Primary care diagnostic requests currently constitute around 40% of the work performed in pathology departments.

2.8 There has also been an increase in the demand for POCT facilities, not only on acute hospital sites but also in GP surgeries, out-patient clinics and TCs. This has implications for pathology services in terms of communications systems and quality control requirements.

2.9 As part of the 'NHS Plan', clinical guidelines have been published, for example for cancer networks. These have prompted an increase in the number of specimens requested from individual patients together with an increase in the complexity of tests and for more detailed reports.

2.10 New scientific and technological developments are leading to the expansion of clinical specialties and to an associated increased demand for pathology services.

2.11 Such developments, in particular the increase in the use of molecular diagnostic techniques, has led to an increase in the use of shared equipment across pathology disciplines and to the development of closer working relationships between pathology staff. Therefore, during the planning phase, consideration should be given to the desirability of pathology disciplines sharing laboratory facilities.

CHALLENGES FACING THE PLANNING OF PATHOLOGY SERVICES

2.12 Particular challenges that will influence the planning and building of pathology accommodation in the future include:

- the advent of pathology networks in order to maximise capacity, efficiency and economies of scale;
- the need for standardised and sophisticated IT systems across pathology networks;
- the EU Working Time Directive, which will affect how and where pathology services are organised and delivered.

NETWORK APPROACH TO PATHOLOGY SERVICES

2.13 When new pathology facilities are being planned, it is important to consider whether a network approach is appropriate to service needs and whether it would lead to improvements in the following:

- capacity;
- turnaround time;
- multidisciplinary working;
- service standardisation across the health community.

2.14 There is no single preferred model for the organisation of pathology services. However, where a network is in place or is being developed, one approach could be for a "lead" trust to lead/manage the service on behalf of other trusts.

2.15 An effective network should cover a "natural" health community. This community will need to be determined locally. It may be based on a strategic health authority (SHA) or part of it, or in some circumstances, a natural health community may cross SHA boundaries.

2.16 During the initial planning phase, the design team must consider whether it is more appropriate to use existing pathology facilities or to build new facilities in order to provide the optimum level of service. It is unlikely that one facility will provide pathology services for an entire network; a combination of pathology accommodation across different sites may serve a network more effectively.

2.17 Possible planning options may include a combination of the following:

- the provision of all pathology services on one site associated with an acute hospital trust and serving the needs of the whole pathology network including other acute hospitals, TCs and primary care services;

- the provision of pathology accommodation across several acute sites within a pathology network. Where there is sufficient demand, several facilities might cater for urgent and emergency specimens such as haematology (including cross-matching) and chemical pathology, whereas routine, non-urgent and specialist testing might only be justified on fewer sites or even one site;
- the provision of "standalone" pathology facilities, not located on an acute hospital trust site but providing a service for a pathology network covering several acute hospitals, TCs, GP surgeries and primary care trusts (PCTs). These facilities may cater for routine, non-urgent, and specialised investigations;
- the provision of smaller facilities for POCT within acute hospitals, TCs, and the primary care setting as part of the service provided by a pathology network.

MODULAR APPROACH TO PATHOLOGY SERVICES

2.18 Whatever combination of services is most appropriate, a flexible modular approach to planning, designing, and building pathology facilities can be used. The modular approach allows:

- each laboratory facility, whether it is a general laboratory, automated laboratory, specialised laboratory or POCT facility, to be based on a standard module size;
- each module to be scaled to accommodate the demand for investigations;
- each module to be scaled to accommodate the configuration and size of the equipment required;
- laboratories to adapt as technologies develop;
- pathology networks to respond to local requirements.

EVALUATING SERVICE REQUIREMENTS

2.19 During the initial option appraisal and planning stages of pathology accommodation, all key stakeholders, including people commissioning work on behalf of PCTs, should be consulted and involved in evaluating the service requirements. Establishing a good relationship, at the earliest stages of the project, between the different disciplines and user groups involved will help problem-solving throughout the planning and design process.

2.20 The key stakeholders should consider the range of diagnostic services required to support existing clinical services and planned developments within the pathology network. The pathology accommodation must be able to provide a fully adequate service for the acute and non-acute sectors.

2.21 The planning team must also take into account other clinical services such as cancer networks, preventative screening programmes and epidemiological studies undertaken within the area, and any requirements for specialised pathology services.[1]

2.22 Local planning teams should consult with laboratory clinicians to assess the range of pathology investigations to be provided. There may be situations when a network does not provide certain types of investigation, for example highly specialised tests only carried out in a small number of laboratories.

LOCATING AND SIZING PATHOLOGY FACILITIES

2.23 Local circumstances will need to be taken into account during the planning stage, and will influence decisions on the location and size of the facilities. These local circumstances may include the network's population and size, staffing levels, current equipment and existing facilities, the topography, and location of service users.

2.24 Any option appraisal must examine the advantages and disadvantages of the various planning proposals in relation to patients' needs and include a balanced assessment of all the major factors affecting capital and revenue costs for each proposal.

2.25 Whatever the most appropriate planning option, all pathology facilities on any one site should be linked together in one complex to ensure that common services can be shared.

OTHER PLANNING CONSIDERATIONS

2.26 Other planning considerations may include:

- the cost versus benefit of standardising IT systems across multiple sites to ensure efficient, effective, quality reporting;
- the cost versus benefit of standardising equipment across multiple sites;
- local traffic conditions and the necessity for an efficient transport system if specimens are to be analysed at another site;
- travel distances and the importance of delivering certain specimens to the laboratory without delay to ensure analytical and clinical validity;
- consideration of staff travelling time between departments;
- the availability of car parking or good local public transport systems;

1 'Guidance on Commissioning Arrangements for Specialised Services', DH

- the financial implications of providing efficient transportation of specimens to “standalone” facilities. This must be weighed against the costs of duplication of equipment, accommodation, staff, and running costs.

UPGRADING OR ADAPTATION OF EXISTING BUILDINGS

2.27 Before a decision is made to upgrade or adapt an existing building, consideration must be given to the long-term strategy for the service, the space required for the new service, and the size of the existing building. Regard must also be paid to the orientation and aspect of the building, and whether key requirements can be met, for example the need for accommodation with suitable access for large pieces of equipment and sufficient space for the location of all necessary support services.

2.28 If the most appropriate planning option is to upgrade or adapt existing facilities, the functional and physical condition of the building should be thoroughly examined. The assessment of the physical and other aspects of existing buildings should include:

- availability of space for alterations and additions, including office space and staff facilities;
- type of construction;
- insulation;
- age of the buildings and condition of fabric, for example external and internal walls, floors, roofs, doors and windows, which may be determined by a condition survey;
- life expectancy and adequacy of engineering services, ease of access and facility for installation of new wiring, pipework and ducts, if required;
- the height of ceilings – high ceilings do not necessarily require installation of false ceilings, which are costly and often impair natural ventilation;
- changes of floor level that may be hazardous;
- fire precautions;
- physical constraints to adaptation, such as load-bearing walls.

2.29 When comparing the cost of upgrading or adapting an existing building to that of a new building, due consideration should be given, in addition to the building cost, to the cost of relocating staff, demolition, salvage costs, disruption of services in a phased project, and the temporary effects on running costs of any impaired functioning of areas affected by upgrading.

2.30 The advice set out in this guidance essentially applies to new-build facilities. However, the principles are equally valid, and should be applied, when existing accommodation is being upgraded or new accommodation is being constructed within an existing building that may previously have been used for other purposes.

3 General functional and design considerations

CLINICAL PATHOLOGY ACCREDITATION

3.1 Consideration should be given to the criteria required for pathology laboratories to receive Clinical Pathology Accreditation (CPA). The key issue with regard to premises is that they should provide a working environment in which staff can perform their required functions in accordance with national legislation and guidelines. See 'Standards for the Medical Laboratory', Clinical Pathology Accreditation UK, for details.

FLEXIBILITY AND ADAPTABILITY

3.2 Like their research and teaching laboratory counterparts, routine NHS diagnostic laboratory facilities are increasingly subject to changing requirements. This is due to the rising use of automated testing equipment and the trend towards multidisciplinary working.

3.3 The terms "flexible" and "adaptable" are often used interchangeably to describe accommodation that can respond to changing user needs.

3.4 A "flexible" design enables different activities to be accommodated in a given space without physical rearrangement taking place.

3.5 An "adaptable" design allows physical rearrangement of building elements, services and furniture.

3.6 When designing pathology facilities, consideration should be given to the need to allow for growth and change, irrespective of the scale of work and scientific disciplines involved. To avoid being constrained by initial requirements, a flexible and/or adaptable design should be adopted.

3.7 The flexibility of pathology facilities depends on the provision of generic laboratory spaces that can accommodate a defined range of pathology functions within an essentially unchanging spatial and services framework. New needs and organisational changes are met by moving people and their equipment.

3.8 With a flexible design, an assessment is made at the design stage of the widest range of work that may take place in the foreseeable future, and a generalised – but fixed – arrangement is made.

3.9 A flexible design may incorporate:

- modular repetitive bays of laboratories – each laboratory having a locally agreed standard pattern of benches and services;
- service outlets arranged in a regular grid or pattern, with service runs in floor ducts, above ceilings or in vertical ducts. This will ensure that any work position is able to make use of the full range of services provided.

3.10 The adaptability of pathology facilities depends on the detailing, design and specification of building and service elements, as well as furniture and equipment, so that the facilities may be conveniently and cost-effectively altered.

3.11 An adaptable design allows tailored accommodation for each changing need by making physical adjustment of the facilities. The way in which this is done will vary depending upon how easy it is to make the adjustment.

3.12 An adaptable design may incorporate:

- removable partitions between laboratory spaces;
- laboratory furniture that can be added to, subtracted from, or rearranged as required.

LABORATORY ACCOMMODATION – GENERAL PRINCIPLES OF DESIGN AND LAYOUT

Laboratory modules

3.13 Laboratories planned on a modular concept allow maximum flexibility and future adaptation as well as the standardisation of mechanical and electrical systems.

3.14 A pathology laboratory may be based on a 3.3 m x 9.9 m module (as shown in Figure 3.1). The minimum module size should be the ⅓ module. Modules may be added together to accommodate a range of facilities from individual support laboratories to general laboratories.

3.15 The module width may vary from 3.0 m to 3.6 m. Reference should be made to BS EN 14056 to determine the correct aisle width between benches. Consideration should also be given to the bench depth

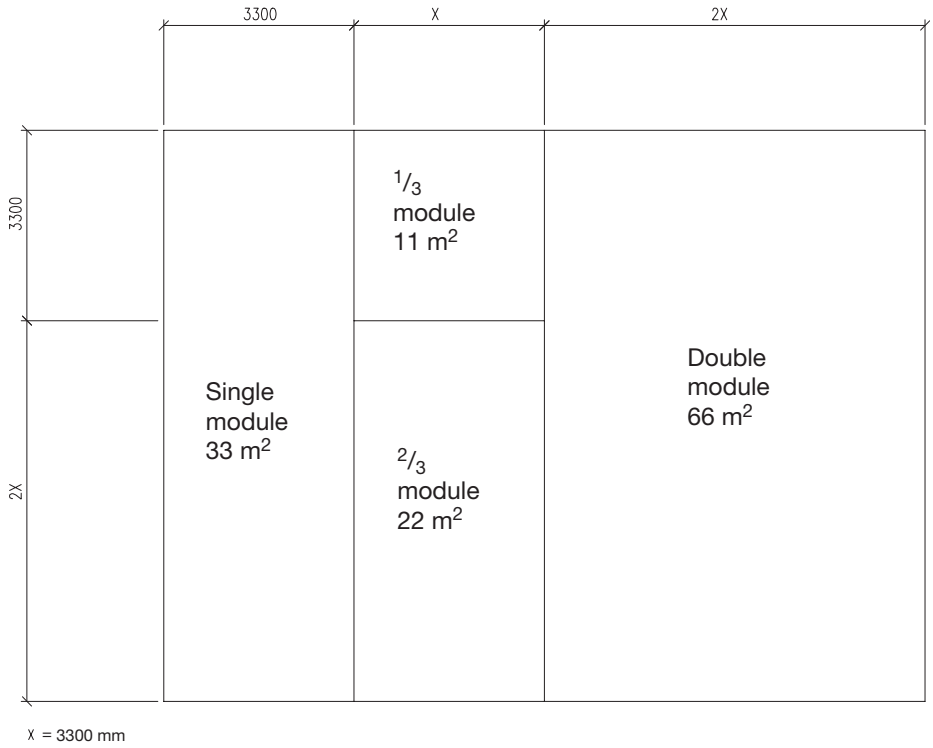


Figure 3.1 Laboratory modules

(between 750 and 900 mm) and the wall construction between rooms.

3.16 The number of modules required and their final configuration should be determined by pathology users based on workload and type of work carried out.

Entry to the laboratory

3.17 A lobby at each laboratory exit should form the boundary between the laboratory and non-laboratory space. This will allow for the hygienic, safe and secure passage of users between non-laboratory and laboratory spaces.

3.18 Clinical hand-washing facilities and coat pegs for hanging laboratory protective clothing should be provided in the lobby, together with colour-coded linen bags for storing dirty protective clothing.

Safety

3.19 In order to arrive at a satisfactory and economical design solution that will minimise the risks from potential hazards, users should be consulted at an early stage of the project.

3.20 The design and layout of the facilities is important in encouraging safe working practices. Guidance on design features that contribute to safety (for example hand-washing facilities, fittings, finishes and furniture, storage of chemicals etc) is given in Chapter 4.

3.21 Special equipment such as exhaust protective cabinets and fume cupboards will be required (see Chapter 6 for further details). See also fire precautions in the 'Firecode' suite of documents.

3.22 Provision should be made for the storage of, and easy access to, first-aid products, chemical poison antidotes and eye-care items.

3.23 See Appendix 9 for guidance on fire safety.

Infection control

3.24 Pathology facilities should be designed for easy, frequent and thorough cleaning. The number and design of waste bins need careful consideration.

3.25 The number and location of clinical hand-wash basins should be decided by the infection control team in conjunction with clinical staff. Alcohol hand-rub dispensers should be provided. Space should also be provided for sharps bins to allow sharps to be discarded at point of use.

Containment level

3.26 All laboratories in which routine pathology work is conducted should be at a minimum of containment level 2.

3.27 For microbiology work, separate laboratories at containment level 3 are required if work is to be carried out on hazard group 3 organisms and specimens. Pathologists will require access to containment level 3

accommodation as the need arises (see paragraphs 4.167–4.169 and paragraphs 7.3–7.11 for further details).

3.28 See Appendix 9 for 'Regulations and guidance relating to containment laboratories'.

Security

3.29 Pathology facilities contain equipment and other items that are both valuable and vulnerable; access should therefore be restricted to authorised personnel only (this is a requirement of CPA). This should be attained by the use of security measures, for example swipe cards or locks to control entry.

3.30 Good security is also essential due to the serious danger presented to unauthorised persons from exposure to potential hazards in laboratories.

3.31 The entire laboratory area should be planned as a secure area, with all entrances capable of being controlled in accordance with the security policy of the whole hospital. Where microbiological cultures are present, reference should be made to the Anti-Terrorism, Crime and Security Act 2001.

3.32 Security arrangements should provide for staff safety out-of-hours, due to many pathology services operating 24 hours a day, seven days per week. The "mastering" of keys and their availability outside normal working hours are matters for local decision.

FINISHES, FITTINGS AND EQUIPMENT

Benching

3.33 Bench surfaces should be easily cleanable, resistant to acids, alkalis, solvents and disinfectants (in normal use), and impervious to water. Ideally, they should be made of a solid plastic laminate or epoxy, and not scribed directly to a wall but to an up-stand or back plate.

3.34 The colour of work surfaces should provide a suitable background without creating any problems of glare. For further information see HTM 67 – 'Laboratory fitting-out systems'.

3.35 All benches should have minimal joints and seams, but where these are necessary (for example where benches meet, between bench and up-stand, around sinks, taps, sockets, shelf supports etc) they should be sealed with non-shrinking sealant such as two-part epoxy grout. No open holes should be allowed for the feeding of cables etc.

3.36 Reference should be made to BS EN 13150.

Flooring

3.37 Floor coverings should be appropriate to functional use and contribute towards the creation of an attractive environment, but should not present a hazard to disabled people or the movement of wheeled equipment. Patterning should not produce disorientation.

3.38 Floor surfaces should be easily cleanable, resistant to acids, alkalis, solvents and disinfectants (in normal use), and impervious to water. They should be smooth and slip-resistant. Floors should only be non-slip (rather than slip-resistant) where specific conditions require this, for example in wet areas.

3.39 Joints in the flooring material should be kept to a minimum and sealed by hot welding. At wall junctions, the flooring should be coved to walls and sealed (a sit-on coved skirting is not acceptable).

Sinks

3.40 General laboratory sinks should be "all-in-one" units to avoid the need for sealing around the sink. They should be epoxy or stainless steel and should drain directly to the waste via a simple S-bend trap.

3.41 A dedicated sink is required when liquid radioactive or clinical waste is disposed of by dilution.

3.42 A sluice will also be required where urine samples are handled.

Clinical hand-wash basins

3.43 Wall-mounted paper towel and soap dispensers should be provided at each clinical hand-wash basin.

3.44 Taps should be lever-, knee- or automatic sensor-operated.

3.45 Eyewash stations should be provided adjacent to clinical hand-wash basins. Ideally, these should double up as emergency shower hoses.

Emergency showers

3.46 An emergency shower should be provided in a lobby or corridor adjacent to any work area in which there is a risk of severe chemical contamination. It should provide an immediate high-volume output of water. Floor drainage needs to be provided.

Laboratory furniture

3.47 Laboratory furniture should demonstrate good ergonomic design and must be compliant with BS EN 14056.

Pathology equipment

3.48 The In Vitro Diagnostics Directive covers much of the equipment used in pathology laboratories. When planning and designing a laboratory that will house in-vitro medical devices, instructions provided by the manufacturer, particularly regarding installation and site specifications, should be followed.

3.49 Reference should be made to 'Management of In Vitro Diagnostic Medical Devices' (Medicines and Healthcare Products Regulatory Agency).

INFORMATION TECHNOLOGY

3.50 Pathology facilities require modern IT systems capable of supporting rapid information transfer and providing a remote service. The system should meet the needs of pathology providers and users. It should also be capable of transferring information across multiple sites including acute hospital sites, "standalone" pathology facilities, GP surgeries, TCs and POCT facilities, and between laboratory networks.

3.51 During the initial planning phase, consideration should be given to the provision of adequate computer terminals within laboratories and associated offices. Separate accommodation for network services for laboratory information management systems may be required. Other issues that should be addressed include:

- system integration and standardisation;
- automated test ordering and results delivery;
- data protection and confidentiality.

3.52 Any new or upgraded IT system should be designed in conjunction with the guidance given on pathology information systems by the NHS Information Authority (NHSIA) and the National Accreditation and Procurement Process Service (NAPPS).

Clinical science building 2, Manchester Royal Infirmary

4 Specific functional and design considerations

CENTRAL SPECIMEN RECEPTION AND HANDLING

4.1 Ideally, there should be a single specimen reception area on each pathology site, which should process all test requests and distribute samples to the appropriate laboratory. It should have a direct and secure connection to the outside in order to receive external samples via post or courier.

4.2 Internal samples should, where appropriate, be transported via pneumatic air tube transport systems. These provide a viable and rapid alternative to porters for moving specimens. Adequate contingency plans should be available in the advent of a breakdown of the air tube system.

4.3 For further information on pneumatic air transport systems see HTM 2009 – 'Pneumatic air tube transport systems'.

4.4 The specimen reception area should comprise a reception room with a reception hatch – with a fixed counter and secure hatch doors. This will allow specimens not transported by pneumatic air tube to be deposited.

4.5 The counter surface should be easy to clean, impervious to water and resistant to disinfectants.

4.6 Immediately adjacent to the reception area, a specimen sorting area for processing request forms and producing labels should be provided. This area requires a number of workstations, each comprising a desktop PC, appropriate-sized desk, adjustable-height office chair and appropriate lighting for computer use. The office chair should have an impervious covering.

4.7 Adjacent to the specimen sorting area, a separate specimen processing area should be provided for centrifuging, aliquoting, and dispatching samples to the appropriate laboratory.

4.8 The specimen processing area will require space for centrifuges, a laboratory sink, a refrigerator/freezer and, possibly, a microbiological safety cabinet (see paragraphs 7.21–7.28 for further guidance on microbiological safety cabinets). Bench working space will be required for paperwork and packing samples prior to despatch to laboratories. Storage for small items of laboratory equipment and hand-washing facilities will also be required. Appropriate cooling to match the heat gain should be allowed.

4.9 Facilities should be provided for the reception of specimens contaminated with radioactive materials or highly infectious specimens. Facilities should also be provided for the decontamination of staff. Storage will be required for equipment and protective clothing.

4.10 The specimen processing area should be constructed to a suitable acoustical standard to reduce the effect of noisy equipment (for example centrifuges) on neighbouring users as well as users of the space itself.

4.11 Ideally, this area should be directly connected to the laboratories receiving samples (for example via a hole in the wall) to avoid any sample holding.

4.12 The use of communications systems (for example e-ordering and electronic patient records) should be considered. These allow specimen details and test requests to be entered into computers directly linked to the appropriate analytical instruments, which in turn will reduce transcription error (labelling, sorting, aliquoting, order entry etc).

Out-of-hours facility

4.13 Provision for holding specimens and blood cultures taken outside normal working hours and cross-matched blood (at 4ºC, room temperature and 37ºC) should be available. This facility should be accessible without the need to enter laboratory areas.

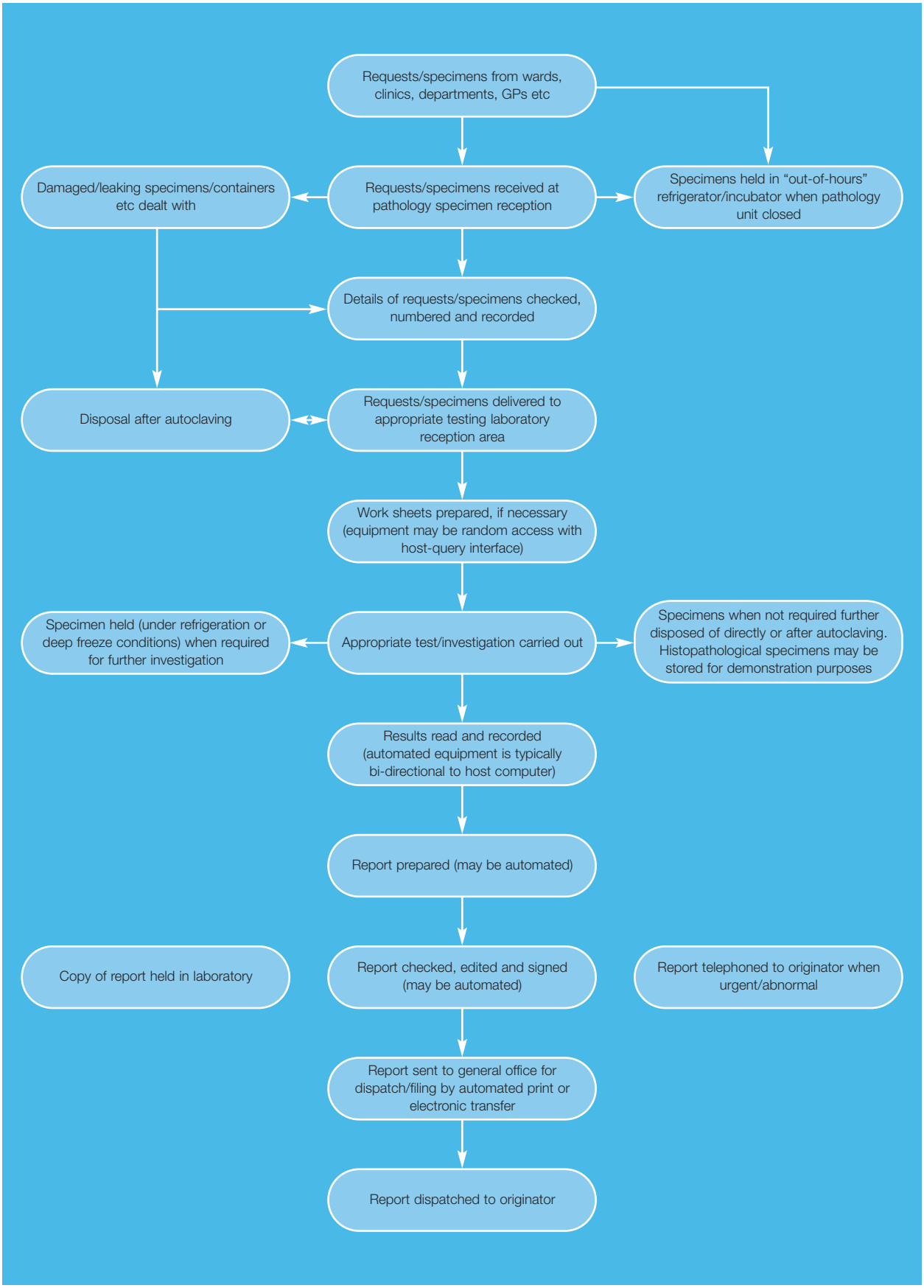
OFFICES

4.14 All office areas should be sited outside the laboratory zones. Offices opening off laboratory areas are not acceptable.

Administration office

4.15 Normally, all reports of pathological examinations conducted on one site will be dispatched through a central administrative office. Reports received from the laboratories will be entered into the computer system, printed and posted.

Figure 4.1 Flow of requests, specimens and reports



4.16 The office should have a dedicated area for housing printers and one computer workstation per desk.

Single-person offices

4.17 Single-person offices, which are sufficiently private for confidential discussions between staff, will be required for senior clinicians and managers. Two types of office will be needed:

1. Type A – This office is for administrative duties. It should accommodate an office workstation with monitor and keyboard, seating for up to three other people, and storage for books and files.
2. Type B – This office is the same as type A but with additional space for a bench for the microscopic examination of slides.

Multi-person staff offices

4.18 Multi-person offices are required for secretarial, administrative and other desk-based work. Each secretarial workstation should have a desk with a monitor and keyboard. The position of all display equipment, and the design and type of desk and chair, should comply with relevant guidelines on ergonomics and lighting.

4.19 Space should be provided for holding files, limited quantities of stationery and office supplies, and for hanging coats.

4.20 All offices for laboratory and support staff should have easy access to the laboratories. The types of office will be determined once service needs have been identified. The local project team will establish the number of offices required.

STAFF ACCOMMODATION

4.21 The provision of well-designed and appropriate staff facilities is very important to the functioning of a pathology service and essential for compliance with CPA requirements.

4.22 Facilities should include:

- staff changing and shower facilities, including toilets and secure storage for personal effects;
- protective clothing storage;
- a rest room;
- kitchen and vending facilities;
- education and training facilities.

Staff changing and shower facilities

4.23 Provision should be made for separate male and female changing facilities, including secure full-length lockers for holding outdoor clothing and personal possessions. Access to changing areas should be via doors with close-proximity card facilities or a similar security system.

4.24 The number of changing spaces and lockers should reflect the number of full-time and part-time staff, including trainees and students.

4.25 Separate male and female shower facilities should be provided.

4.26 Changing areas should be equipped with mirrors, hair dryers and shaving points.

4.27 Separate male and female WCs, and an accessible WC, should be provided. Each WC should comprise a self-contained room to provide maximum privacy; cubicles are not acceptable. For guidance on the appropriate number of male and female WCs see the Workplace (Health, Safety and Welfare) Regulations 1992.

Protective clothing storage

4.28 A clean linen store should be sited adjacent to the changing facilities for issuing clean protective clothing (that is, white coats).

Rest room

4.29 A rest room is required where staff can relax and consume beverages and snacks. The room should have windows with a pleasant outlook, providing natural lighting and ventilation.

4.30 The room should contain comfortable seating and low tables. A dining table and chairs should also be provided to enable staff to eat and drink in comfort.

4.31 Where a TV or music system is available in the room, a separate “quiet” area should be provided for staff wishing to read or talk.

4.32 The room should have direct access to a small kitchen.

Kitchen and vending facilities

4.33 Kitchen facilities are required for preparing beverages and light snacks, washing and storing crockery and cutlery, and storing limited quantities of dry goods and refrigerated items.

4.34 Fittings and equipment should include a stainless steel sink and drainer, kettle, microwave cooker, worktop with cupboards, automatic dishwasher and a clinical hand-wash basin.

Cytopathology screening laboratory (left) and automated laboratories (housing haematology and chemical pathology) (below) at Manchester Royal Infirmary

4.35 A vending machine alcove should be provided adjacent to the kitchen with access from the rest room to accommodate drink and snack vending machines.

Education and training facilities

4.36 Facilities should include a seminar room and a library. All staff will need access to IT facilities.

4.37 The seminar room is required for teaching, tutorials and meetings. Furniture and equipment should include upright stacking chairs with writing arms, a wall-mounted whiteboard, an imaging viewer, a video/TV monitor and a computer and keyboard.

4.38 A computer image projector is required. A retractable ceiling-mounted screen should be provided, with efficient blackout curtains and facilities for projection of slides and overhead transparencies.

4.39 A separate library room is required that can satisfy the CPA requirement for a quiet room for private study. The library should have adequate storage for books and technical journals, and computer terminals with internet access.

NON-LABORATORY SUPPORT SPACES

4.40 Non-laboratory support spaces will be required to store supplies, service equipment and deal with waste. These may be shared by all pathology disciplines. It is a CPA requirement that there are separate storage facilities for the following:

- process and quality records;
- clinical material;
- blood and blood products;
- hazardous substances;
- drugs, vaccines and other therapeutics;
- reagents.

Equipment service room

4.41 Facilities are required for equipment servicing and the storage of spare parts (as defined in equipment manufacturers' user manuals, supplemented by any formally agreed local instructions). Local instructions may require the provision of additional facilities.

4.42 Electronics and medical engineering technicians carrying out minor scheduled or unscheduled servicing will use this room.

4.43 Space provision should be sufficient to park and manoeuvre equipment and accommodate a workbench with integral lockable cupboards. There should be sufficient socket-outlets protected by residual current devices (RCDs). A clinical hand-wash basin should be provided.

4.44 Manufacturers' user manuals should be kept in this room.

4.45 Medical gas outlets should supply oxygen, compressed air and vacuum.

4.46 Some items of equipment may require decontamination prior to servicing. Local policy will identify how and where this is undertaken.

Equipment and supplies store

4.47 Bulk supplies and small items of equipment should be held in a central lockable laboratory store. A mobile racking system will maximise the available space. An area for storekeeping and material handling activities should be allowed.

4.48 Non-flammable laboratory chemicals should be stored together – in a poisons cabinet, if appropriate.

4.49 A "just in time" system, which uses a barcode system to top up supplies on a regular basis, will minimise the quantity of supplies needed to be stored.

Clinical science centre at Wythenshawe Hospital (above; Photo: Bob Collier); automated laboratories (housing haematology and chemical pathology at Manchester Royal Infirmary (right)

External gas bottle storage area

4.50 A vented weatherproof store will be necessary to accommodate a range of gas cylinders. A secure store, separate from the main building, may be required for the storage of hydrogen cylinders.

External flammable goods store

4.51 The main stock of flammable materials used in pathology should be stored in a vented, secure, external flammable goods store that is easily accessible from the laboratories. It may be grouped with other flammable goods stores to share vehicle access.

4.52 Day-to-day supplies of flammable materials should be stored in flameproof cabinets in each laboratory area. Advice on the storage of flammable materials can be found in 'Firecode'.

4.53 Histopathology laboratories, in particular, use absolute ethanol; external stores that are used for this solvent have to be licensed by HM Customs and Excise.

Waste handling and disposal holding area

4.54 Secure facilities for the temporary holding of packed refuse should be provided. Disposal of laboratory waste, and the identification of waste by colour coding, will depend on whole-hospital policy. The size of the disposal hold should be determined by the frequency of collection.

4.55 A convenient and safe route should be provided from the decontamination and media preparation suite (see paragraphs 4.116–4.126) to the holding area.

Housekeeping room

4.56 Where pathology facilities are split over more than one floor, each floor should have one housekeeping room.

4.57 The room should provide easy access to cleaning equipment and materials, and adequate space for manoeuvring machines, emptying and filling of buckets, and the routine servicing and cleaning of equipment.

4.58 There should be unrestricted access to the sink, which should be supplied with hot and cold water, and to a clinical hand-wash basin. The room should be well lit and ventilated so that equipment can dry quickly.

Chemical store – preparation area

4.59 A chemical store will be required for the storage of reagents and solutions, flammable and toxic chemicals, and strong acids and bases. It is important that the various classes of chemical (for example flammables, oxidising agents, acids and bases) are stored in separate areas within this room.

4.60 A flammable liquids cabinet and a poisons cabinet should be provided. The poisons cabinet will need to be in a separate secure room and may require a Home Office licence. A fume cupboard will also be required (see paragraphs 7.29–7.41 for further details).

4.61 This room will also be used for weighing and preparing reagents for use in the laboratory areas. Provision should be made for storing glassware and other equipment. There should be adequate benching for both working, and holding balances, mixers, stirrers, a hot plate and a hot air oven. A sink and refrigerator will be required. A glass wash facility should be associated with the chemical storage and preparation area.

4.62 Facilities for holding and storing protective clothing, and for hand-washing, should be available.

AUTOMATED LABORATORIES

4.63 The increased automation of pathology tests has led to a demand for open-plan laboratories that can accommodate free-standing analytical equipment. Each laboratory should be modular in nature and sized to accommodate the analytical equipment required (see paragraphs 3.13–3.16 for details of laboratory modules).

4.64 A range of automated equipment is available for performing tests in chemical pathology, haematology, microbiology, immunology and virology.

4.65 Automated tests for chemical pathology and haematology (together with limited tests for immunology and viral serology) can currently be carried out on the same equipment. Further integration of tests from different disciplines onto one platform may take place in the future.

4.66 See Appendix 1 for typical workflow and tests in haematology and Appendix 2 for typical workflow and tests in chemical pathology.

4.67 Most existing equipment incorporates dedicated data processing systems linked to laboratory information management systems (LIMS).

4.68 There is evidence that future equipment will be more compact, modular and versatile.

4.69 Automated laboratories should be open-plan, with minimal or preferably no internal column structure to enable a good line of sight. A central open floor should be provided to allow optimal configuration of analysers with access from all sides.

4.70 The laboratory should be as close as possible to the specimen reception area, preferably connected; consideration should be given to installing a conveyor belt to transfer samples from the specimen reception area directly to the analysers.

4.71 If such a close arrangement is not possible, the use of a pneumatic air system may be required – in which case bench space will be needed in the laboratory for receiving specimens.

4.72 Fixed laboratory benching may not be required in the centre of the laboratory (where blood cell counters and other analysers are located), but perimeter benching will be needed to accommodate small bench-top analysers and microscopes. The microscope area should be quiet to allow undisturbed examination of stained slides.

4.73 Automated laboratories should be designed with adaptability in mind. The ability to install new pieces of equipment in the central area (to supplement what is already installed) and/or change the layout of the analysers is important.

4.74 Engineering services should also be designed to allow for such adaptation – not only in terms of service connections, but also to deal with changing heat output and electrical supply and drainage needs as new modules of equipment are added or removed.

4.75 The design should allow for any future increase in the demand for engineering services. Consideration should be given to providing a drop-down distribution system from the ceiling level in order to supply additional IT cabling.

4.76 Most analysers require under-floor services in the form of drainage connections, and overhead services in the form of power and data connections. Overhead services should be provided via a services wing directly above the equipment.

4.77 Cupboards and refrigerators will be required for storing "in-use" reagent solutions in small and large volumes. Storage should also be provided for disposables and small, miscellaneous items of equipment.

4.78 Specimens and reagents will need to be held under refrigerated or deep-freeze conditions. This requirement can be met by the provision of an adjacent support laboratory for refrigerators and freezers and a +4ºC cold room.

4.79 Adjustable shelving should be provided in the cold room for holding various types of tube, bottle, rack and basket.

4.80 Figure 4.2 shows a possible layout of an open-plan automated laboratory, plus adjacent support laboratories and a specialised laboratory (based on modules given in Figure 3.1).

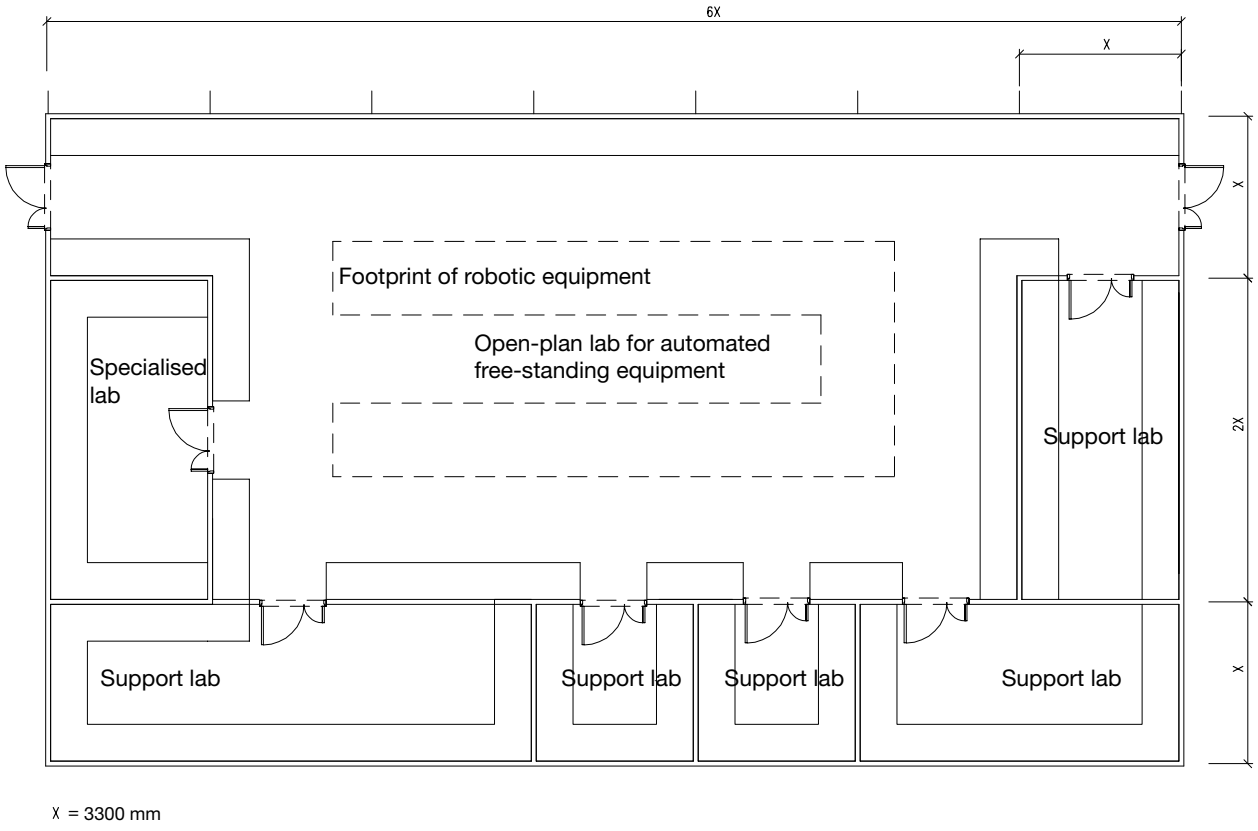


Figure 4.2 Possible layout of open-plan automated laboratory and support laboratories (see schedules of accommodation for indicative areas for individual laboratories)

GENERAL LABORATORIES

4.81 General laboratories may be used across a range of disciplines. It is important to design each laboratory to support the requirements of the particular function that it will house. However, in order to allow future flexibility the design should be as generic as possible.

4.82 Such laboratories are currently used for general microbiology (see Appendix 3) and general histopathology work (see paragraphs 4.218–4.225).

4.83 A general laboratory can vary from a single standalone module to several double modules (see Figure 3.1).

4.84 Fixed benching with above-bench shelving and cupboards and below-bench cupboards should be provided. A sink should be provided for every two to three modules, and a clinical hand-wash basin for each laboratory area. An area for floor-standing equipment should also be provided. Engineering services to a typical laboratory module are discussed in chapters 5–8.

4.85 Figures 4.3 and 4.4 show possible models of general laboratories, plus adjacent support laboratories and specialised laboratories (based on modules given in Figure 3.1).

Microbiology laboratories

4.86 Where general laboratories are used for microbiology work, space will be required for the reception of specimens from the main specimen reception area before despatch to the appropriate workstation in the laboratory.

4.87 Some microbiological laboratories will require a separate reception area for the examination of food, water and environmental samples. This is specified by the accreditation scheme for such tests operated by the United Kingdom Accreditation Service (UKAS).

4.88 Bacteriology work is normally undertaken at allotted workstations based on specimen type, for example urines, wounds and other swabs, genito-urinary specimens, faeces etc. One or two persons may operate at any workstation.

4.89 Space will be required for bench and free-standing equipment, and to allow for bench activities (see Appendix 3 for further details).

4.90 Storage may be required for standard commercial media formulations, which are stored in a dried state and prepared as required. Alternatively, ready-to-use products can be bought in at a higher cost.

4.91 Centrifuges will be required. These create noise and vibration problems and may interfere with other operations, for example the use of microscopes. Consideration should be given to housing these facilities in a dedicated support laboratory (see paragraphs 4.112–4.113 for further details).

4.92 Facilities will be required for staining slides and microscopy work, including fluorescence microscopy. As benches used for microscopy work should be free from vibration, this work should be carried out on a dedicated bench. An additional microscope will be required at the urine examination workstation.

4.93 Inoculated media should be incubated under highly controlled temperature and atmospheric conditions, for example aerobically, anaerobically or in carbon dioxide atmospheres, to obtain growth of organisms.

4.94 Access to a hot room maintained at 37ºC, and use of separate incubators, will therefore be necessary. Anaerobic isolation of organisms may require the use of special equipment with space and service implications, for example an anaerobic chamber.

4.95 Cell culture work will take place in a specialised cell culture laboratory (see paragraphs 4.143–4.144 for details).

4.96 A category 3 facility will be needed if samples from patients with SARS or TB are to be tested. This is due to the risk of infection to the operator when processing samples that may contain hazard group 3 micro-organisms. For guidance on the design of category 3 facilities, see paragraphs 4.167–4.169.

SUPPORT LABORATORIES

4.97 These accommodate functions directly supporting automated, general and specialised laboratories. No testing is carried out in support laboratories, which include equipment rooms, instrument rooms and preparation rooms.

4.98 They should comprise a central aisle with work areas on each side to accommodate free-standing or bench-mounted equipment.

4.99 A support laboratory can vary from a ⅓ module to a double module (see Figure 3.1).

4.100 Figures 4.2, 4.3 and 4.4 show possible layouts of support laboratories, of varying size, opening onto open-plan laboratories (automated and general).

4.101 Support laboratories may include the following:

Common equipment rooms

4.102 Common equipment rooms should house a mixture of laboratory equipment in common use by the testing laboratories. They should be carefully situated to support the main laboratories and designed with a

mixture of wall benching for bench-mounted equipment and areas for floor-standing equipment.

4.103 Careful attention should be paid to the heat loads generated by the mixture of equipment likely to be in the room.

Cold room (+4ºC)

4.104 Cold rooms are needed by a number of pathology disciplines for storing specimens and reagents requiring refrigeration. These rooms should be maintained at +4ºC. Floor drainage will be required. Adjustable shelving should be provided for holding various types of tube, bottle, rack and basket. Cold rooms should be sited within easy reach of their main users.

Cryo-preservation room

4.105 A cryo-preservation room may be required to accommodate liquid nitrogen freezers, which come in a range of sizes. The freezers may be refilled via portable

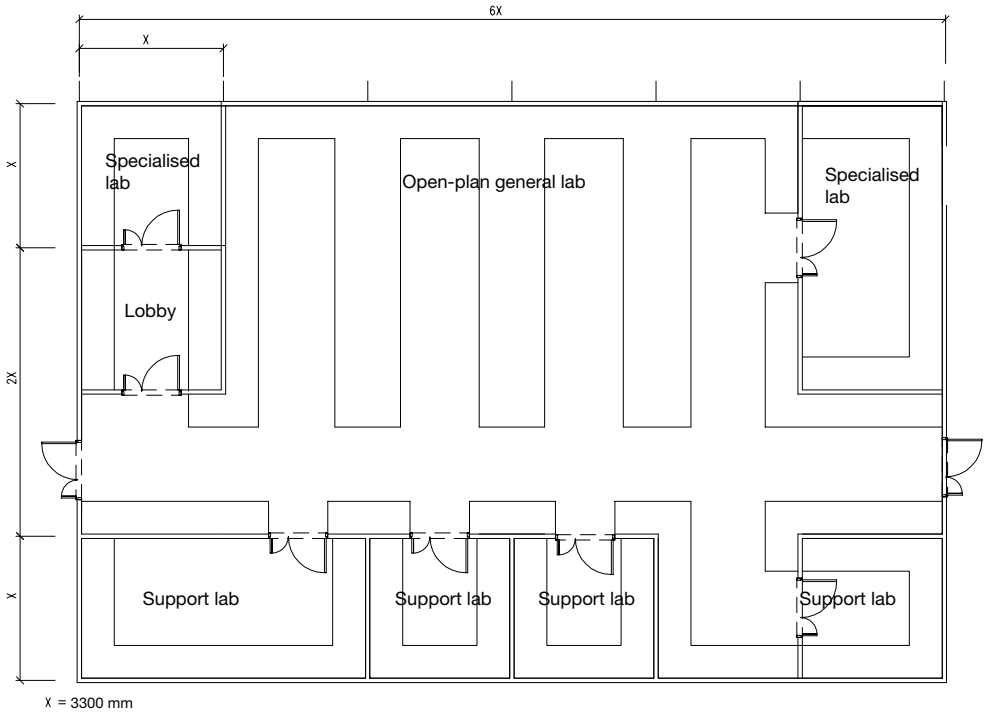


Figure 4.3 Possible layout of open-plan general laboratory and support laboratories (see schedules of accommodation for indicative areas for individual laboratories)

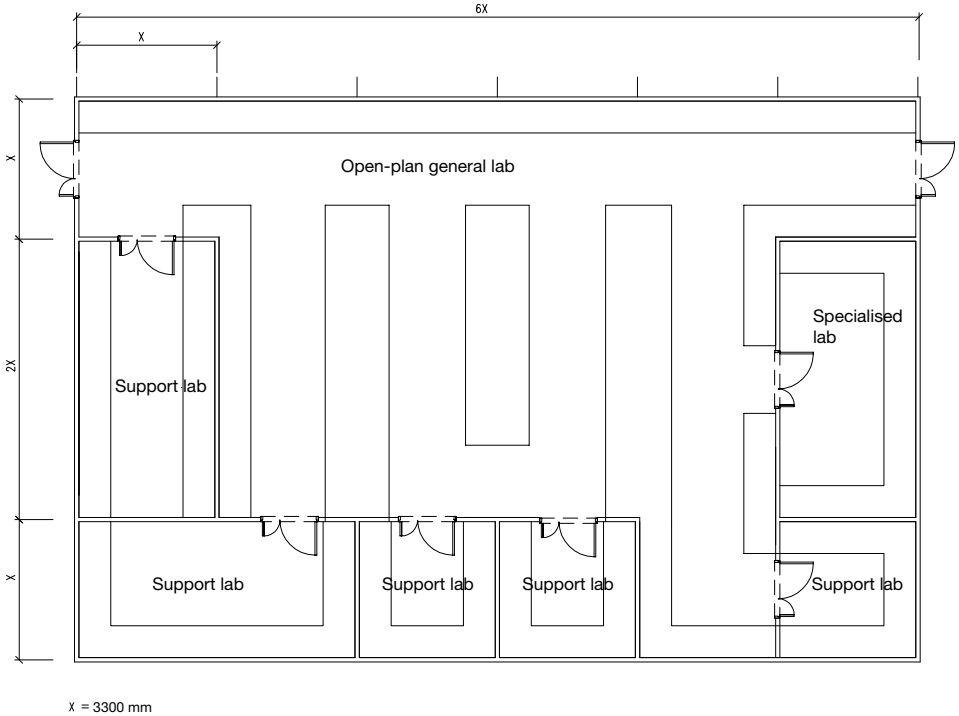


Figure 4.4 Possible layout of open-plan general laboratory and support laboratories (see schedules of accommodation for indicative areas for individual laboratories)

dewars or a piped liquid nitrogen system from an external large-capacity tank. Facilities will need to take account of this.

4.106 Storage will be required for face shields, cryogenic gloves and aprons.

4.107 Liquid nitrogen can damage flooring. Disposable (moveable) rubber matting should be considered as a second layer of flooring within the room to protect the main floor finish.

4.108 See Chapter 6 for information on ventilation.

37ºC room

4.109 A hot room (at 37ºC) may be required for incubating cultures. Adjustable shelving should be provided for holding tubes, bottles, racks and baskets.

Darkroom

4.110 A darkroom may be required for visualising DNA under UV light and will be needed for fluorescence microscopy, for example for immunology. The room should be fitted out with laboratory benching, under-bench storage and over-bench shelving, and should include a laboratory sink.

4.111 A specialist revolving darkroom door will be required to avoid leakage of light into the room.

Centrifuge room

4.112 If compatible with laboratory operations, centrifuges should be housed in a single room due to the noise and heat gain of this equipment. The room may need to contain bench-top and floor-standing centrifuges.

4.113 Above-bench shelving and under-bench storage units may be required for the storage of rotors.

Refrigerator/freezer storage room

4.114 Refrigerators and freezers should be located in one room due to the high heat gain of this equipment. A combination of +4ºC, –18ºC and –80ºC equipment may be accommodated in this room. Shelving will be required.

Laboratory stores

4.115 Stores for working stocks of materials and equipment will be required. They should be easily accessible from the relevant laboratory areas.

Decontamination and media preparation suite

4.116 A decontamination and media suite may be required for production of in-house bacteriological culture media. Space requirements should be discussed and agreed with the pathology team during the early planning stage, since procedures for media preparation are changing and increasingly media is bought in.

Clinical science centre, Wythenshawe Hospital (Photo: Bob Collier)

4.117 The suite should comprise:

- central wash-up and sterilizing area;
- media preparation room;
- plate pouring/media dispensing room.

4.118 Each room should be based on the standard laboratory modules (see Figure 3.1). See Figures 4.2, 4.3 and 4.4 for possible layouts of support laboratories.

4.119 The central wash-up and sterilizing area should have direct access to the media preparation room, which in turn should have direct access to the plate pouring/media dispensing room.

Central wash-up and sterilizing area

4.120 The central wash-up and sterilizing area may need to use demineralised water for media preparation. It will need to house autoclaves and hot-air ovens. Equipment for producing demineralised water may be located in the wash-up area or provided as part of the central plant installation.

4.121 Very efficient ventilation is essential in this area, as unpleasant smells and considerable heat can be generated. Air-cooling may be necessary to maintain optimal working conditions.

4.122 Space will be required in the central wash-up and sterilizing area for:

- disinfection of contaminated material before disposal, and of glass and plastics prior to cleaning or disposal;
- disposal of solid and liquid waste;
- washing glassware by automatic machines or manually, including specialised glassware;
- capping cleansed tubes and containers and subsequent sterilization;
- storing sterilized items and materials;
- sterilizing bulk media in laboratory autoclaves;
- drying glassware in drying cabinets and sterilizing by dry heat.

Media preparation room

4.123 Where media is produced on the premises, a media preparation room will be required for:

- preparing solid and liquid media in bulk;
- storing bulk materials such as dried media preparations on open shelves or under refrigerated conditions;
- filling of sterilized containers with prepared liquid media (using either manual or automated methods);
- storing miscellaneous laboratory containers, tubes and caps, consumables and disposable items, labels and sundry items of minor equipment.

Plate pouring/media dispensing room

4.124 The process of media preparation tends to disperse fine dust into the atmosphere; plate pouring should therefore take place in a separate area.

4.125 The plate pouring/media dispensing room will require a laminar flow cabinet if plate pouring is undertaken manually. Otherwise, equipment will be required to do this – some of which can sterilize, pour and stack plates. Bench space will be required for labelling prepared media, tubes and bottles.

4.126 See Appendices 4 and 5 for workflow through the decontamination and media preparation suite.

SPECIALISED LABORATORIES

4.127 Each pathology discipline currently has its own specialised tests (and techniques). For some smaller disciplines, for example immunology, histocompatibility and immunogenetics, most of the tests are specialised.

4.128 A specialised test is one that is extremely difficult to perform, is rarely requested or is a new and emerging test. As technology develops or clinical needs change, certain investigations may move from the “specialised” category; it may then be appropriate for the test to be performed as part of a routine repertoire in a more general laboratory environment.

4.129 It may be possible for different tests to share the same laboratory space (as is the case with mass spectrometry and chromatography testing), and this should be explored with user groups.

4.130 Specialised laboratories should be designed as generically as possible to allow for future flexibility. Each laboratory will require space for specialised testing equipment, which may be bench-top mounted or floor-mounted.

4.131 Bench space will be required for receiving specimens from the main specimen reception area. Further space may be required for preparing samples prior to testing and recording results.

4.132 Specimens and reagents will need to be held in refrigerated or deep freeze conditions in adjacent support laboratories.

4.133 All specialised laboratories require hand-washing facilities close to exits, coat pegs (for hanging protective

clothing), and an area for storing linen bags (for discarded dirty protective clothing).

4.134 A specialised laboratory can vary from a ⅓ module to several double modules depending on the quantity of tests, equipment and staff.

4.135 They should comprise a central aisle with work areas on each side to accommodate free-standing or bench-mounted equipment.

4.136 Figures 4.2, 4.3 and 4.4 show possible layouts of specialised laboratories, opening onto open-plan laboratories (automated and general).

4.137 Specialised laboratories may include, but are not limited to the following:

Immunoassay testing

4.138 An immunoassay involves the analysis of body fluids to monitor hormone imbalances (associated with thyroid and reproductive functions) and cancer and other tumour markers. There are an increasing number of other applications, for example screening for drugs of abuse and infectious diseases.

4.139 Many immunoassay tests take place in automated laboratories, but some need to be carried out in specialised laboratories, for example if level radioisotopes and/or flammable solvents are used.

4.140 Enzyme-linked immunosorbent assays (ELISAs) are often performed on automated equipment. The capacity of such equipment and diversity of manufacturers supplying reagents and equipment mean that within any pathology facility several instruments will be needed. Allergy testing is currently carried out on specific semi-automated equipment. ELISAs may be carried out in a specialised or automated laboratory.

Chromatography testing

4.141 Some pathology centres may undertake chromatography testing as part of their chemical pathology, toxicology and haematology programmes. Gas liquid chromatography (GLC) and thin layer chromatography (TLC) cannot be accommodated in general laboratories due to the environmental requirements. High-pressure liquid chromatography involves the use of a self-contained instrument, which may be located in a general laboratory.

4.142 Chromatography equipment tends to be bench-top mounted and controlled by an adjacent computer. Equipment for undertaking GLC and TLC may require dedicated ventilation and piped gases such as helium. Attention to the operating environment is important. Manufacturer information should be sought at an early stage of the design process to determine the appropriate temperature and humidity of the laboratory as well as the acceptable particulate matter level and sensitivity of the equipment to vibration.

Cell and tissue cultivation

4.143 A cell culture laboratory for the cultivation of cells and tissues may be required if genetics and virology testing is planned. Class II safety cabinets will be required.

4.144 Each laboratory should accommodate a bench-mounted microscope, under-bench fridge and freezer, bench-mounted centrifuge, a floor-standing incubator and a sink.

Mass spectroscopy

4.145 A mass spectroscopy (MS) laboratory may be required if testing for steroids, immunosuppressive drugs and poisons.

4.146 Mass spectroscopy equipment tends to be bench-mounted with an accompanying computer workstation. However, larger equipment is available that is floor-mounted. All types may require dedicated ventilation above the equipment to vent toxic vapours, ozone and heat. The weight and size of the equipment should be taken into account when specifying laboratory furniture.

4.147 All MS tests require gas supplies, typically argon and oxygen. The type and nature of gases required are dependent on the individual equipment and test, and should be carefully checked at the planning stages.

Trace metal testing

4.148 If testing for trace metals is planned, an atomic absorption laboratory may be required.

4.149 The laboratory should have a dust-free, low-humidity atmosphere. Usually the equipment is not located near windows, doors or any other area where drafts may cause unstable thermal conditions.

4.150 Atomic absorption (AA) equipment is usually located on a workbench. The workbench must be free from vibration, and stable and strong enough to support the weight of the equipment. It should be large enough to permit the free circulation of air around the instrument.

4.151 Since the AA equipment emits fumes and vapours, it must be located under a flue that is vented by an exhaust fan and ducted to an external vent. Ducting must be corrosion-resistant and fireproof.

4.152 Piped gases will be required to the AA equipment; the type and volume will depend on the

individual requirements of the test and the manufacturer of the equipment.

Polymerase chain reaction

4.153 Molecular biology techniques are used increasingly in pathology. These techniques may be used in virology testing programmes as well as molecular diagnostics and genetics. A key technique is the polymerase chain reaction (PCR), which involves taking small quantities of a DNA molecule and creating millions of copies of it.

4.154 Due to the extreme sensitivity of PCR, any contamination can cause widespread problems. To minimise the risk of contamination, sample processing, PCR set-up and post-PCR analysis involving electrophoresis (see paragraphs 4.160–4.164) should be done in separate areas, preferably in separate laboratories with controlled access.

4.155 The use of sterile disposables (for example pipette tips and tubes) is recommended for the extraction process. Storage and disposal areas for disposables will therefore be required.

4.156 All tubes should be centrifuged prior to opening; an area for a bench-mounted centrifuge should be provided.

4.157 Areas used for PCR set-up should be away from high-traffic areas, with minimal disturbance. They should not be directly under or near windows, air vents or frequently-used doors. Mini hoods containing a UV light source for disruption of contaminating DNA can be used to create a “mini PCR set-up area” that is self-contained. These are best used in a designated PCR set-up room as an extra safeguard against cross-contamination.

4.158 Gloves should be worn and changed regularly; storage and disposal areas for gloves will therefore be required.

4.159 Space should also be provided for sufficient stocks of reagents, for example primers and sterile PCR-grade water.

Electrophoresis

4.160 Routine electrophoresis work is automated. However, specialised work is more manual and may require a specialised laboratory.

4.161 All areas used for post-PCR analysis should be kept thoroughly clean before and after use. Cleaning should be carried out using 70% ethanol or 10% bleach. Floor, wall and work surfaces therefore need to be easy to clean and capable of withstanding this cleaning regime. Care should be taken with the detailing of the wall and floor junctions, and the junctions between different materials, to allow for easy cleaning.

4.162 Such a laboratory will need to accommodate small-scale bench-top equipment comprising a small gel tank, cooled passively or by water, and a compact, lightweight power unit.

4.163 Gloves should be worn to protect against the staining agent, ethidium bromide; storage and disposal areas for gloves will therefore be required.

4.164 This laboratory should be located in close proximity to a cold room and a darkroom.

Flow cytometry

4.165 Flow cytometry equipment, used mainly for immunology and haematology work (but also for histocompatibility and immunogenetics), tends to be bench-mounted and controlled via computer.

4.166 Centrifuges are frequently used when preparing samples for examination by flow cytometers; access to centrifuges, as well as reagents in fridges/freezers, will be required. Access to a safety cabinet may also be required. This must be appropriately sited since many samples analysed by flow cytometry will be HIV (and HCV) positive.

Containment level 3 facilities

4.167 Laboratory activities on specimens known or suspected to contain pathogens from hazard group 3 should take place in a separate room. This should conform to containment level 3 requirements (see paragraphs 7.3–7.11 for further details).

4.168 No access hatches (or anything else that breaks the sealed floor) should be located in floors within containment zones. There should be a lobby at the entrance/exit to containment level 3 rooms.

4.169 See Appendix 9 for ‘Regulations and guidance relating to containment laboratories’.

ELECTRON MICROSCOPY FACILITIES

4.170 Transmission electron microscopy (TEM) is used in diagnostic pathology for a number of processes including renal biopsy interpretation, investigation of myopathies and neuropathies, and virus identification.

4.171 Scanning electron microscopy (SEM) is rarely used for diagnosis, although it continues to have a role in research.

Transmission electron microscopy

4.172 A TEM suite should comprise:

- sample preparation room;

- TEM laboratory;
- darkroom;
- office.

4.173 The sample preparation room should be maintained as a clean environment, with the air double high-efficiency particle arrester (HEPA) filtered.

4.174 Bench space will be required for equipment and preparation work. The latter uses toxic and flammable chemicals, and appropriate ventilation should therefore be provided.

4.175 An ultramicrotome station will be required for cutting sections, and a fume cupboard for the preparation of resin (in which samples will be embedded).

4.176 Access to a +4ºC fridge will be needed for fixing samples, and to an oven for polymerising samples (following embedding in resin).

4.177 Gloves should be worn and changed regularly; appropriate storage and disposal areas should be provided.

4.178 The TEM laboratory requires space for the TEM and console. The equipment is extremely sensitive to vibration and, although usually supplied with an anti-vibration table, is best located on a ground-bearing slab rather than a suspended slab on an upper floor.

4.179 The room does not require windows and should be capable of total blackout.

4.180 A darkroom and an office may be required. See paragraphs 4.110–4.111 and 4.14–4.20 respectively.

Scanning electron microscopy

4.181 A SEM suite should comprise:

- sample preparation room;
- SEM laboratory;
- image processing room;
- darkroom;
- office.

4.182 The sample preparation room should be maintained as a clean environment, with the air double HEPA filtered.

4.183 Bench space will be required for a range of equipment including an evaporator, sputter coater, rapid-ion milling system, dimple grinder, jet electropolisher, microtome and ultramicrotome.

4.184 The SEM room requires space for the SEM and console. The equipment is extremely sensitive to vibration and, although usually supplied with an anti-vibration table, is best located on a ground-bearing slab rather than a suspended slab on an upper floor.

4.185 The room does not require windows and should be capable of total blackout. A storage area and separate area for housing the HT (high tension) tank are required.

4.186 An image processing room may be required for processing SEM images. Typically an ergonomically designed workstation is required for the image processing equipment. The room should be capable of blackout.

4.187 A darkroom and an office may be required. See paragraphs 4.110–4.111 and 4.14–4.20 respectively.

Future developments

4.188 Miniaturisation in electronics, particularly in semiconductors, has led to the development of the ultimate small-scale laboratory systems – so-called “lab on a chip” biological processors, which can detect and measure specific analytes.

4.189 “Lab-on-a-chip” (LOC) technology is a rapidly growing research topic within the instrumentation and healthcare industries. The principle is to produce an automated, microscale (or nano-scale) laboratory to enable sample preparation, fluid handling, separation, detection and analysis to be carried out on one platform within the confines of a single microchip.

4.190 “Lab on a chip” bioanalysers can move labs beyond messy, time-consuming gel preparation and electrophoresis.

4.191 The commercialisation of miniaturised devices is most advanced in the DNA analysis sector.

4.192 The equipment for LOC technology and DNA microassays is bench-mounted and supported by a flat screen display, keyboard and mouse. This can be accommodated in a specialised laboratory.

HISTOPATHOLOGY AND CYTOPATHOLOGY FACILITIES

Histopathology

4.193 Histopathology is the morphological study of cells arranged in tissues that have been removed from the human body. See Appendix 6 for details of processes and workflow for a histopathology service.

Clinical science centre, Wythenshawe Hospital (Photo: Bob Collier)

Cytopathology

4.194 Cytopathology is the morphological study of dissociated cells. See Appendix 7 for details of processes and workflow for a cytopathology service.

Histopathology and cytopathology specimen reception areas

4.195 Each specimen reception area should comprise a reception room with a reception hatch to allow for the deposit of specimens. The hatch should have a fixed counter and secure hatch doors. The counter surface should be easy to clean, impervious to water, and resistant to disinfectants expected in normal use.

4.196 The reception area should be separated into two areas: one for sorting and handling specimens; and the other for booking in specimens. The booking-in area should comprise desk-height workstations, while the sorting area should contain bench-height workstations.

4.197 An adequate ventilation system is required to deal with formalin spillages (from specimens delivered in formalin).

4.198 Consideration should be given during the early design stage to merging the specimen reception areas of histopathology and cytopathology with the central pathology reception area. A pneumatic air tube system is not suitable for transporting specimens.

Histopathology cut-up area (specimen dissection)

4.199 The cut-up area should contain height-adjustable down-draught benches, which provide intermittent exhaust ventilation. Ventilated benches should incorporate a sink and macerator, and a sluice for the disposal of specimens. Particular attention should be paid to the point at which air extracted from the cutting-up bench is vented, so that it does not re-enter the building or adjacent buildings.

4.200 The ventilation requirements of formalin solution make-up and dispensing areas also need careful consideration.

4.201 Exhaust ventilation is required for waste disposal units used for the disposal of “fixed” specimens.

4.202 Particular attention should be given to the noise levels of the ventilated benches to ensure an acceptable working environment.

4.203 A free bench is required for the organisation of the work.

4.204 Floor space should be sufficient to enable the parking of a trolley without blocking any of the aisles.

4.205 A separate room is required for high-risk cut-up of potentially infectious specimens. There should be a lobby at the entrance/exit to the room. The room should

contain a class 1 microbiological safety cabinet for handling specimens. See paragraphs 7.21–7.28 for details.

4.206 A clinical hand-wash basin station is required at the exit to the room.

Histopathology processing room

4.207 Space will be required for tissue processors.

4.208 Most tissue processors do not require ventilation while in use. When changing reagents, fumes can be released; good ventilation and a down-draught bench are therefore required.

4.209 The processing room should be separate from other facilities as it presents a fire risk, and suitable fire precautions need to be incorporated into the design.

4.210 A free bench is required for the organisation of work. A clinical hand-wash basin station is required at the exit to the room.

4.211 The processing room should be adjacent to the cut-up room.

Histopathology wet specimen store

4.212 Space will be required for the storage of large specimens in various sized containers.

4.213 Space will also be needed for the preparation of tissue for prolonged storage in plastic bags (using heat sealing) and for mounting prepared tissue for demonstration purposes.

4.214 The room should be mechanically ventilated to deal with formalin and other nuisance vapours.

4.215 Alternatively, ventilated cupboard units may be used; these may be situated here or in the cut-up room depending on available space.

4.216 It may be necessary to store fresh tissue in –20ºC or –80ºC freezers, in which case a separate space should be provided in the central freezer storage room (see paragraph 4.114).

4.217 A separate wash-up area containing a sink with a waste disposal unit and a sluice will be required.

General histopathology laboratory

4.218 This laboratory should house a number of microtomy workstations, each comprising a microtome,

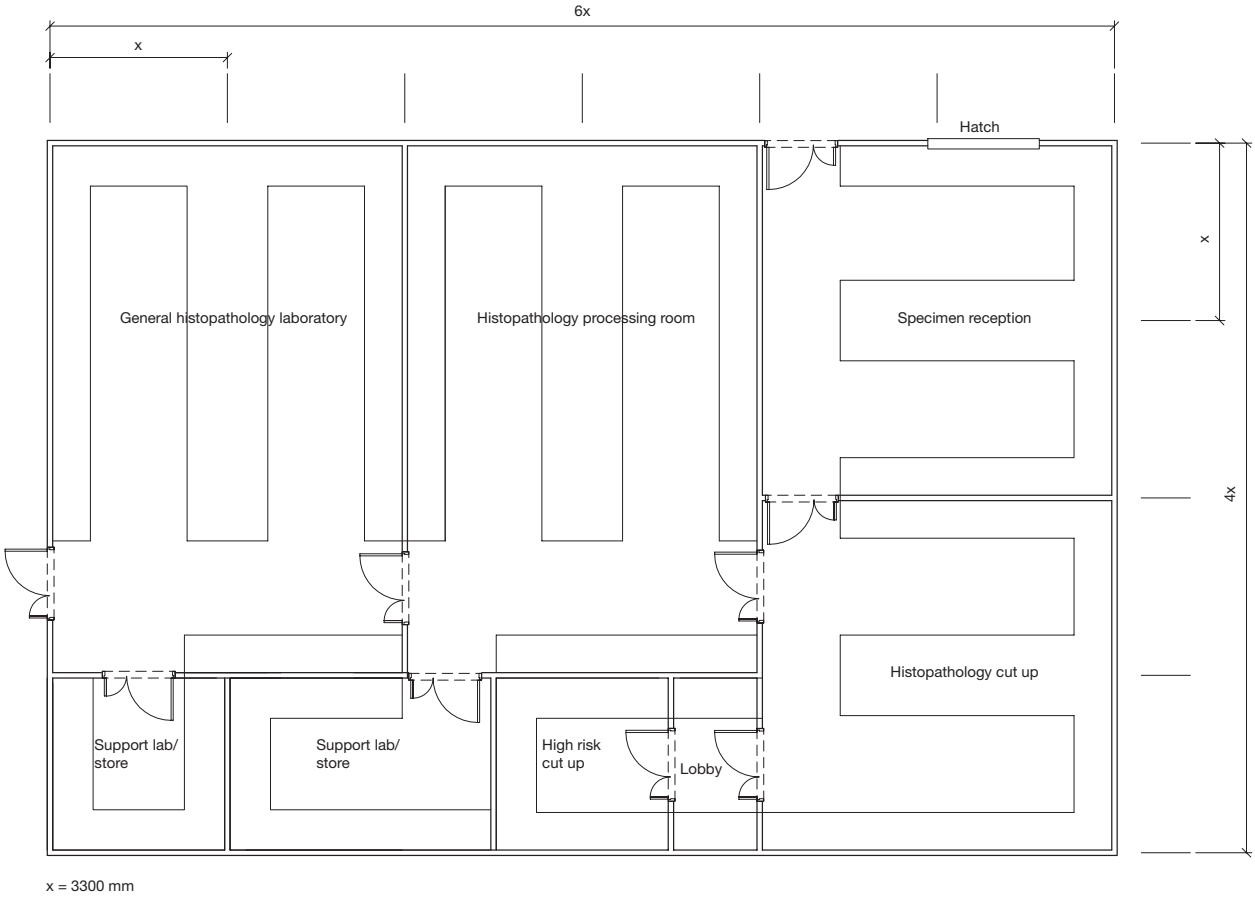


Figure 4.5 Possible layout of histopathology laboratory facility (see schedules of accommodation for indicative areas for individual laboratories)

water bath, hot plate and ice tray. The number of microtomes required will depend upon the workload.

4.219 Routine stains are normally automated, but special stains are carried out manually. A sink, drying oven and automated staining machine should be provided.

4.220 Bench space will be required for holding glass dishes (used in manual staining) and laying out slides.

4.221 Separate workstations for frozen section work should be provided. These should comprise a below-bench freezer and cryostat or a freezing microtome. Free wall space should be provided if cryostats are to be used. The workstation should have access to facilities for drying and staining sections.

4.222 A dedicated area for resin work should be provided, housing a thin resin section microtome and fume cupboard. The area should incorporate dedicated facilities for staining and mounting slides. Alternatively, resin work can take place in a separate laboratory.

4.223 Bench space should be provided for special histopathology procedures. This can be in a designated area of the laboratory or in a separate laboratory.

4.224 Down-draught benching should be used throughout the laboratory to remove fumes from the staining and mounting processes.

4.225 A clinical hand-wash basin station should be provided at the exit to the room.

Histopathology slide and block store

4.226 Storage space for histopathology slides and blocks should be provided, based on annual workload. The floor loading of such storage items needs to be considered when designing the store.

4.227 Consideration should be given to locating long-term storage off-site or distant from the histopathology area.

Histopathology chemical store and preparation area

4.228 An area for storing the chemicals and preparing the solutions and stains associated with histopathology work should be provided.

Cytopathology processing laboratory

4.229 Laboratory bench space will be required for sorting and recording prepared slides and specimens suspended in fluid.

4.230 A microbiological safety cabinet (class 1) may be required for processing specimens suspended in fluid.

4.231 A centrifuge should be provided for specimens that need to be centrifuged prior to mounting on slides.

4.232 Prepared slides may be stained by automated or manual methods.

4.233 A slide staining machine and sink should be provided for manual staining.

4.234 Automated staining requires dedicated floor or bench space to accommodate the equipment.

4.235 A small oven or incubator should be provided for drying stained slides. A cover-slipping machine should also be available for applying glass cover slips.

4.236 Down-draught benching should be used to remove fumes from the staining and slide mounting processes.

4.237 A separate area for the preparation of semenology specimens may be required.

4.238 Access to a category 3 facility may be required from time to time. See paragraphs 4.167–4.169.

4.239 A clinical hand-wash basin station is required at the exit to the room.

Cytopathology reporting room

4.240 An area is required for a number of desk-top mounted double- or multiple-headed microscope stations for teaching and discussion purposes. This should take place in a carpeted office environment.

4.241 The position of all display equipment and microscopes, and the design of desks and chairs, should be carefully considered to minimise glare and provide a comfortable seating position.

Cytopathology screening area

4.242 A quiet, carpeted area should be provided for the microscopic examination of slides. The grade of carpet should minimise the release of fibres.

4.243 A quiet environment is necessary in order to aid the high levels of concentration needed by operators checking slides for subtle cellular differences. Operators should have access to windows giving views of the distant horizon to enable them to rest their eyes.

4.244 Consideration should be given to the control of glare through the use of blinds and careful positioning of monitors.

4.245 Purpose-designed, height-adjustable chairs with adjustable backrests should be provided. Fabric covers and a wide seat base are preferable. Where possible, seats should be positioned to allow external views.

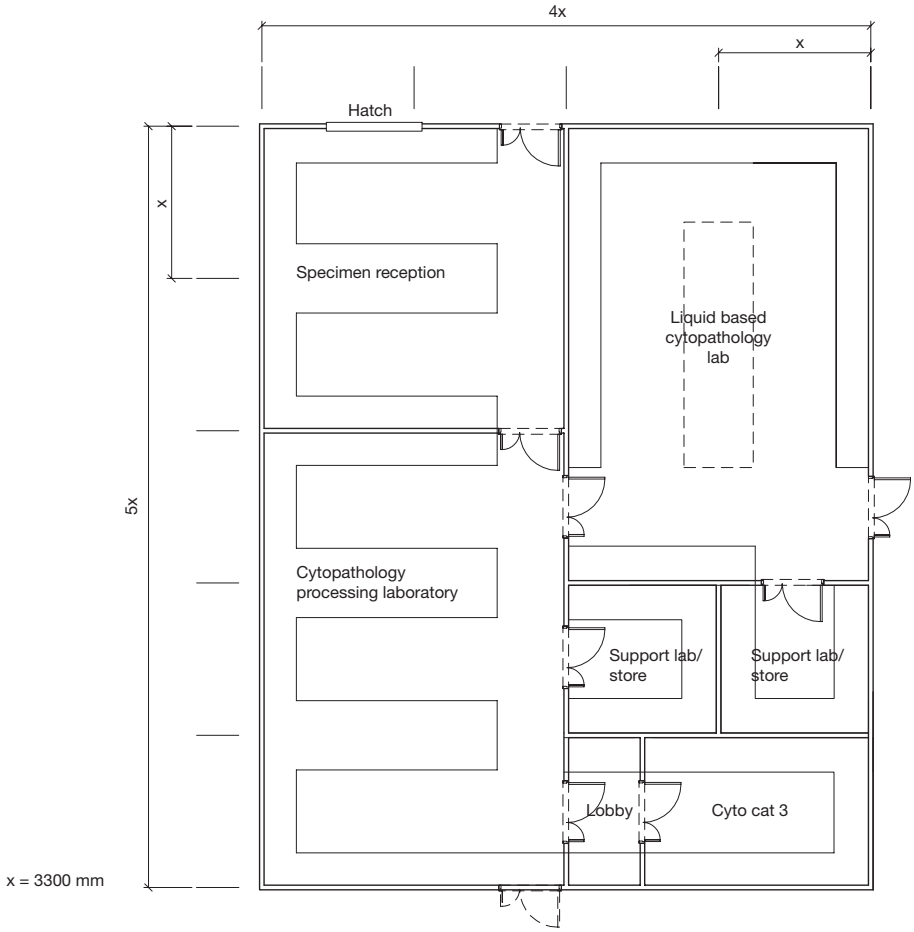


Figure 4.6 Possible layout of cytopathology laboratory facility (see schedules of accommodation for indicative areas for individual laboratories)

4.246 Backrests should be stable to avoid unwanted movements. All seat adjustments and controls should lock securely. Where foot support rings are used, these should allow operators to place their feet flat on the floor. Where circumstances allow, consultation with individual operators is strongly recommended.

4.247 Height-adjustable benches that offer stable support for microscopes should be provided. Benches should be uniform, neutral in colour and have non-glare surfaces. Each bench should provide a minimum working surface area of 1.5 m (width) x 0.9 m (depth). Space should allow for free circulation behind each operator without disturbance.

4.248 Artificial light sources that imitate daylight should be provided. Task and pool lighting are not appropriate.

4.249 The room should be provided with air-conditioning and humidity systems that can be controlled locally. Air outlets should be positioned to avoid disturbing operators with air movements. The use of baffles and diffusers may be helpful.

4.250 See 'Cytology screening – Ergonomic working standards for personnel engaged in the preparation, scanning and reporting on cervical screening slides', MDA (Medical Devices Agency) for further details on appropriate working arrangements for cytopathology.

Cytopathology slide storage

4.251 A room for prolonged storage of cytopathology slides and reports will be needed. This will create an abnormal floor loading condition, which should be considered at the earliest stage of planning.

Cytopathology offices

4.252 A multi-person open-plan office should be provided for secretarial staff. A number of type A offices for laboratory managers and type B offices for consultants will also be required.

Liquid-based cytopathology laboratory

4.253 Where liquid-based cytopathology (LBC) is undertaken, the processing laboratory will require adequate mechanical ventilation to deal with xylene and formaldehyde vapours. This may become the main cytopathology processing laboratory in the future.

Cytopathology training school, Manchester Royal Infirmary

4.254 The use of an automated system for monitoring formaldehyde levels should be considered. This requires large bench-top equipment, with its associated heat load and service demands.

4.255 There will be a greater requirement for disposal of biological waste, including contaminated plastic, glass and liquid. This may be met by a commercial supplier.

4.256 Storage space for a month's supply of waste buckets should be provided. See HTM 2065 – 'Healthcare waste management' for further details.

4.257 Storage space should also be provided for consumables such as collection vials, preservatives and biohazard vessels.

4.258 LBC may enable the introduction of automated image scanning devices and create extra demand for LAN (local area network) connection points.

BLOOD BANK, BLOOD GROUPING AND CROSS-MATCHING FACILITIES

4.259 Facilities should be available for storing blood received from the Regional Blood Transfusion Service and samples of patients' blood. Facilities will also be required for blood grouping and cross-matching.

4.260 Exceptionally, a venepuncture room may be required for collecting blood from donors.

4.261 See Appendix 8 for details of tests undertaken.

Blood bank area

4.262 The blood bank reception area should be adjacent to the blood grouping and cross-matching laboratories, and allow for the reception and delivery of blood.

4.263 See Appendix 8 for workflow through this area.

4.264 Storage space should be provided for blood transport boxes. Facilities will also be required for recording and labelling blood.

4.265 Blood should be stored in blood bank refrigerators. Cross-matched blood should be stored in separate refrigerators from those containing blood that has not been cross-matched.

4.266 Authorised hospital staff will require access to the blood bank at all hours. It should therefore be accessible to staff working in the cross-matching and blood grouping laboratories, and allow out-of-hours access. Its location should not require entry to the laboratory areas, nor should it create a security problem.

Blood grouping laboratory

4.267 This area should contain centrifuges, incubators, water baths, cell washers and automated blood grouping apparatus.

4.268 Refrigerators and freezers will be required for storing test materials.

4.269 The size of the blood grouping laboratory may be based on the standard modules for laboratories (see Figure 3.1 for details).

Cross-matching laboratory

4.270 This should be a similar workspace to the blood grouping laboratory.

POINT-OF-CARE TESTING FACILITIES

4.271 The rapid development in recent years of analytical techniques has brought many diagnostic tests closer to the patient both in the hospital ward and in the GP's surgery. Many methods are in routine use, and include blood and urine stick tests.

4.272 Commercial interests are driving developments in this field, with the production of more sophisticated POCT equipment including small haematology and chemistry analysers.

4.273 Testing may take place on the ward, in the operating theatre, coronary care unit, critical care area or A&E department. For details of POCT in an A&E setting, see HBN 22 – 'Accident and emergency facilities for adults and children'.

4.274 Testing may also take place at home (for example glucose and pregnancy tests) or at the GP surgery (for example urine dipstick tests).

4.275 The facilities required for POCT will vary depending on the equipment used.

4.276 Typical equipment includes:

- reagent-impregnated strips for urine or blood;
- single test equipment for glucose or cholesterol;
- fully automated instruments such as blood glucose monitoring systems and blood gas/critical care analysers.

4.277 In a hospital environment (for example within A&E), a 2.95 m wide (minimum) x 2.95 m long laboratory module, allowing back-to-back working at laboratory benches, is recommended. This can be scaled up to suit the workload and types of test undertaken.

4.278 This module should contain a sink, laboratory benching on which testing equipment and computers can be placed, floor space for under-bench refrigerators, and separate clinical hand-washing facilities. Storage space should be provided both above and below benching for equipment and supplies.

4.279 In a primary care environment, a POCT consulting area containing an examination couch, desk and chairs, clinical hand-washing facilities and POCT equipment should be provided.

5 General engineering principles

ECONOMY AND VALUE ENGINEERING

5.1 Engineering services account for a significant proportion of the capital cost and a continuing charge on revenue budgets. The project design engineer should ensure economy in provision, whilst achieving functional requirements and maintaining clinical standards.

5.2 Lifetime costs should be identified as part of the cost-benefit analysis.

ENERGY CONSERVATION AND SUSTAINABILITY

5.3 Energy usage has a major impact on the environment. Heating, ventilation, cooling and lighting should be automatically controlled when not in use (for example at night or weekends).

5.4 Facilities should be designed to meet the requirements of the Building Regulations 2000 Approved Document Part L2, Department of Transport, Local Government and the Regions (DTLR).

Natural lighting

5.5 Natural lighting should be used where possible. Passive solar design (PSD) should ensure that laboratory areas are located where they can benefit from natural daylight. Areas that do not benefit from natural lighting (for example stores and toilets) should be located towards the core of the facility.

5.6 Solar protection should be provided to minimise solar gain and control glare. This may include the use of brise soleil, solar reduction glazing and internal or mid-pane blinds. Areas where glare may be a problem (for example rooms where computers are routinely used) should be located away from direct daylight.

5.7 Glazing solutions should achieve an average daylight factor of 2%. This should result in the optimum control of glare and solar gain consistent with adequate daylight. Where solar performance glass is used, this should be a neutral colour to ensure good colour rendering.

Natural ventilation

5.8 Natural ventilation should be used where possible.

5.9 The design should incorporate measures for minimising solar heat gain (see paragraph 5.6). This will reduce the need for mechanical ventilation.

Mechanical ventilation

5.10 The shape of the building and/or spatial relationships may result in some enclosed internal areas. Ventilation costs can be minimised by ensuring that internal areas are reserved for:

a. rooms that require mechanical ventilation irrespective of whether their location is internal or peripheral (for example sanitary facilities);

b. spaces that only have transient occupation and therefore require little or no mechanical ventilation (for example circulation and some storage areas).

Heat recovery

5.11 Where it is essential for ventilation systems to use 100% fresh air, the practicalities of heat recovery should be investigated. Consideration should be given to the following potential hazards:

- leakage/recirculation between intake and exhaust air streams;
- biohazards to maintenance staff;
- chemical reaction on plant.

SPACE REQUIRED FOR PLANT AND DISTRIBUTION SYSTEMS

5.12 Plant areas should provide convenient and safe access, arranged to prevent unauthorised entry. Plant and equipment should be spaced to permit access for routine inspection and maintenance. Removal and replacement of plant and components should be possible without disruption to other services.

5.13 To be most economical, plant should be located as close as possible to the areas served, but with regard to factors such as noise, vibration, flooding and fire. The risks asssociated with these factors can be minimised by the introduction of measures such as active fire suppression systems and additional acoustic treatment. A risk analysis should be undertaken to explore the most appropriate solution.

5.14 See Appendix 9 for "Regulations and guidance relating to spatial requirements".

MAINTENANCE OF PLANT AND SERVICES DISTRIBUTION

5.15 All plant (except heat rejection and certain ventilation extract plant) should be located within plantrooms. Main services distribution (cabling and pipework) should be routed above corridors and other circulation spaces. This will allow inspection, maintenance, modifications, additions and renewals to be undertaken without disruption to the pathology facility.

5.16 In clean areas it is important to ensure that plant and equipment are arranged so that access to the space is only required for terminal outlets.

5.17 Engineering services within the pathology facility should be arranged so that they are secure but accessible for maintenance purposes. Only services that serve the facility should be located above false ceilings, with the exception of drainage.

5.18 In clean areas and other areas requiring non-accessible ceiling voids, access for terminal filters etc should be from below. Access for items such as ceiling void smoke detectors should be via lighting fittings. This will avoid the need for sealed access panels. Where suspended drainage above clean areas cannot be avoided, the system should have extended cleaning eyes that are accessible remote from the user space.

FLEXIBILITY OF DESIGN

5.19 Engineering installations should provide an organised and systematic arrangement that can be modified to facilitate changes in service requirements. This should be achieved by distributed systems with vertical or horizontal services ducts and bench spines. These should be readily accessible so they can be remodelled and maintained with minimal disruption to the pathology facility.

5.20 Designers should provide solutions that enable alternative items of equipment to be used in the future, without causing extensive cost and disruption to the associated engineering service infrastructure.

DESIGN FOR SAFETY

5.21 Devices for the control and isolation of primary engineering services should be located in areas where they can be protected against unauthorised interference. This includes plantrooms, engineering service spaces and circulation areas. They should not be located in working areas.

5.22 Engineering design has an important role in infection control, particularly the design of water and ventilation services. See HTM 2027 – 'Hot and cold water supply, storage and mains services', HTM 2040 – 'The control of legionellae in healthcare premises – A code of practice' and HTM 2025 – 'Ventilation in healthcare premises' for further details.

5.23 The Health and Safety at Work etc Act 1974 imposes a statutory duty on all persons who design, manufacture, import, supply, install or erect "articles for use at work". See Appendix 9 under "Key regulations relating to premises and work equipment".

NOISE

5.24 Excessive noise can adversely affect the operational efficiency of a pathology facility and cause discomfort. The limits and means of control are described in HTM 2045 – 'Acoustics'.

5.25 Auditory privacy may be required. Acceptable noise levels and requirements for auditory privacy in individual areas are shown on the Activity Data A-sheets.

FIRE SAFETY AND PRECAUTIONS

5.26 The principles of fire safety apply equally to new projects, alterations and upgrading of existing buildings.

5.27 Consideration should be given to the fire safety strategy during the design stage. The architect and engineer should verify the proposals with the relevant fire authority. The project team and all other planning staff should be fully acquainted with the fire safety strategy. This will include operational aspects such as staff responsibilities, equipment provision, building and engineering layouts.

5.28 Fire safety policy is set out in the 'Firecode' series of documents. See Appendix 9 for "Guidance on fire safety".

5.29 Designers must comply with Building Regulations 2000, Approved Document B, Office of the Deputy Prime Minister.

DECONTAMINATION OF SYSTEMS

5.30 Engineering services should be designed to allow incidents (for example a spillage of hazardous material) to be dealt with effectively and with minimal risk to staff.

5.31 The design should permit the shortest possible exit route from the hazard area and ready access, if required, to a drencher. Rooms should be able to safely contain any contamination until it can be removed and fumes have been extracted to a safe concentration level.

6 General mechanical engineering services

HEATING SYSTEMS

6.1 Spaces heated by low-pressure hot water systems should use low surface temperature radiators or overhead radiant ceiling panels. The surface temperature of wall-mounted radiators should not exceed 43ºC. Ceiling-mounted radiant panels can exceed this surface temperature and allow space savings.

6.2 Radiators should be located under windows or against exposed walls. There should be space between the top of the radiator and the windowsill to prevent curtains reducing the output. There should be adequate space underneath (at least several inches) to allow cleaning machinery to be used. Where a radiator is located on an external wall, back insulation should be provided to reduce the rate of heat transmission through the building fabric.

6.3 All radiators should be fitted with thermostatic control valves. These should be of robust construction and selected to match the temperature and pressure characteristics of the system. The thermostatic head should incorporate a tamper-proof facility for pre-setting the maximum room temperature. It should be controlled via a sensor located integrally or remotely. To provide frost protection, the valve should not remain closed below a fixed temperature.

6.4 Radiators should be used to offset only building fabric heat loss in mechanically ventilated rooms. All rooms should have local heating controls; the facility should be controlled throughout by the building management system (BMS) (see paragraphs 6.63–6.65 for details).

VENTILATION AND AIR-CONDITIONING SYSTEMS

6.5 Where possible, natural ventilation should be used.

6.6 Mechanical ventilation should be provided to general areas such as plantrooms, toilets and storage areas.

6.7 Mechanical ventilation to internal rooms other than laboratories should provide minimum air change. In some cases, cooling will be necessary to maintain comfortable conditions. A low-velocity mechanical ventilation system should be used.

6.8 Diffusers and grilles should be located to encourage uniform air movement without causing discomfort to staff. The design should allow for airflow from naturally ventilated spaces or spaces with a mechanical air supply, into spaces that have only mechanical extract ventilation, via transfer grilles in doors or walls.

6.9 The design should avoid the introduction of untempered air and should not prejudice the requirements of fire safety, privacy, security or comfort.

6.10 There may be limited scope for using recirculated air ventilation systems in pathology facilities. However, the viability of this energy-saving option should be considered.

6.11 The supply air distribution system should not distort the unidirectional and stable airflow pattern required for fume cupboards and microbiological safety cabinets. Supply air ceiling diffusers or grilles should not discharge directly towards fume cupboards or safety cabinets, unless the terminal velocity is such that the airflow pattern is unaffected.

6.12 Grilles and diffusers should be positioned some distance from the front face of fume cupboards and safety cabinets. The design should ensure that high air change rates and/or opening and closing doors do not have an adverse effect on the performance of safety cabinets or fume cabinets. A damped door closure mechanism may help.

6.13 The airflow rate for laboratory spaces will be determined by the following criteria:

- minimum requirement for air changes per hour (when occupied);
- heat gain from laboratory equipment;
- solar heat gain;
- use of fan coil or split local air-conditioning units to offset heat gains;
- extraction air volumes from fume cupboards, safety cabinets and other items of extract equipment.

6.14 Laboratories containment rooms and rooms using solvents or hazardous materials should be designed with supply and extract systems balanced to maintain

negative pressure. Negative pressure will range from –30 Pa to –50 Pa.

6.15 Ventilation systems for clean laboratories should maintain positive pressures at all times. They should normally use 100% fresh air. In some circumstances, however, it may be possible to re-circulate the ventilated air. Temperature control should be achieved by means of reheat coils in supply air systems.

6.16 Design of ventilation systems for summer conditions should be in accordance with CIBSE Guide A.

HOT AND COLD WATER SYSTEMS

6.17 Hot and cold water supplies to laboratories should be served by separate storage vessels and pipework distribution systems. There should be signs stating that the water is non-drinkable.

6.18 Hot and cold water for general areas of the facility should be taken from the general water supply.

6.19 The hot water supply should be 60ºC ± 2.5ºC at the storage vessel outflow. The return temperature at the calorifier should be at least 50ºC.

6.20 Outlet temperatures and fittings for washbasins, sinks and showers are shown on Activity Data Sheets relating to pathology facilities.

6.21 The cold water supply should be kept below 20ºC to restrict microbiological growth.

6.22 All pipework, valves and flanges for water supply systems should be insulated and vapour-sealed.

6.23 An emergency drenching shower should be provided for staff. The floor below the shower should be graded and drain into a suitable gully.

6.24 Hot and cold water systems should be designed in accordance with a number of regulations and guidance (see Appendix 9 for "Regulations, codes and guidance relating to hot and cold water systems").

6.25 To limit the risk of legionellae bacteria, the water services should meet the requirements of HTM 2040.

COOLING SYSTEMS

6.26 Chilled water cooling systems should be used rather than the direct expansion type. If the location permits, the pathology facility could be connected to the main hospital chilled water plant.

6.27 Evaporative-type heat rejection plant should not be used. If cooling cannot be provided from a central chilling plant, a separate air-cooled chiller plant using environmentally friendly refrigerant should be used.

6.28 There may be a need to maintain temperatures within specified limits to prevent equipment failure. Temperature limits should be obtained from equipment manufacturers.

6.29 Consideration should also be given to the selection of a chilling plant that offers low ambient free cooling to applications requiring year-round cooling (for example chilled water circuits serving fan coil units in equipment rooms).

DRAINAGE AND WASTE SYSTEMS

6.30 The internal drainage system should use the minimum of pipework and remain water/airtight at all joints and connections. The system should be sufficiently ventilated to retain the integrity of water seals.

6.31 Laboratory waste systems should be made of heat-sealed polypropylene. High silicone iron alloy (14.5%) should be used below ground.

6.32 Laboratories should be provided with an acid-resistant waste and vent system connected, after dilution, to the foul sewer outside the building perimeter. Space should be available for a neutralisation tank since this is likely to be required in the future.

6.33 Sink traps and piping to floor drops should be made of acid-resistant materials. Below ground, acid-resistant pipes will not be damaged by minor quantities of acids and solvents. Vents should be routed through the roof and not connected to sanitary vent piping.

6.34 Drainage systems from pathology laboratories may contain pathogens. To prevent any risk of cross-infection, the system should be routed to avoid other hospital accommodation such as critical care areas, operating theatres and catering departments.

6.35 Drainage may also contain chemicals and should be designed for maximum dilution. Frequently-used large-volume appliances such as glassware washing machines should be located upstream. Large-capacity catch-pot receivers should be provided where appropriate.

6.36 The internal drainage system should be connected to the main drainage system as far downstream as possible to ensure maximum dilution. The designer should liaise with the statutory authority to agree maximum discharge volumes and the method of connection to main services.

6.37 The drainage system should allow easy access for inspection and maintenance. Access should be above the appliance flood/rim level so that spillage of contaminated effluent can be minimised. Access for cleaning should cause minimal disturbance to laboratory staff.

6.38 The designer should be familiar with the types of discharge produced by specialist equipment and the effect that the mixing of various chemical discharges may have upon the drainage system.

6.39 If radioactive effluent is to be discharged into the drainage system, the requirements for catch-pot recovery, dilution and maintenance should be discussed and agreed with the radiological protection advisor.

6.40 Autoclaves (except those used for decontamination of infected material), glassware washing machines and refrigerators should not be connected directly to the drainage system. They should have an air gap to prevent the ingress of bacteria.

6.41 The sterilizer for discarded material should be connected to the drain via a vented break tank and trap. The break tank should be vented outside the building. The vent termination should be above roof level and clear of any ventilation inlet or window. The trap should be positioned between the break tank and the connection to the drainage system.

6.42 Floor gullies can become contaminated, and should be avoided or minimised.

6.43 Metal pipework is not suitable for use in pathology laboratories. Copper and lead are not suitable for use with effluents containing azide and mercury compounds.

6.44 Glass, polypropylene, and other plastics are suitable, but consideration should be given to the chemical characteristics, temperature of the fluids discharged, and arrangements for fixing and supporting the drain.

EXTRACT SYSTEMS

6.45 Extract fans should be located close to the point of discharge to ensure that the extract system is maintained at negative pressure.

6.46 Extract ducts from general extract, chemical fume cupboards and other special extract systems within the same laboratory unit may be combined into extract manifolds on each floor. A manifold system offers the following advantages:

- greatest dilution at stack discharge;
- increased flexibility for future additions;
- capital cost saving because of fewer fans and controls;
- optimum use of roof space;
- higher efficiency of energy use;
- reduced maintenance cost;
- energy recovery capability.

6.47 Staining areas should have bench extract systems that ensure air flows away from operators' faces. Low-level extract should be provided adjacent to equipment for use when solvents are changed or when specimens in formaldehyde are opened.

6.48 External discharge arrangements for extract systems should be protected against back pressure from adverse wind effects. They should be located to avoid reintroduction of exhausted air into the building through air intakes and windows.

CONTROL SYSTEMS

6.49 All supply and extract systems should have local control systems. These should be integrated with the overall BMS (see paragraphs 6.63–6.65 for details).

6.50 Controls should include temperature, pressure and time-switching functions. Their selection should take account of the extent to which they can be linked to the BMS serving the whole hospital.

6.51 Supply and extract fans should be interlocked. This will ensure that the supply fan will not operate unless airflow is established with the extract system.

6.52 All heater battery coils and filters should be provided with frost protection control.

6.53 Control systems should incorporate energy-efficient equipment including:

- high-efficiency motors;
- variable air volume systems (in laboratories);
- suitable air-to-air heat recovery systems.

6.54 Laboratory air-conditioning systems should be controlled to ensure comfort, operational safety and regulatory compliance, and to satisfy process constraints. A well-controlled system should provide flexibility and minimise the operational costs of the system.

6.55 A control system should provide the following minimal safety responses:

- detection of equipment failure by the BMS and automatic initiation of standby equipment;
- maintenance of relative negative and positive pressures in the laboratories;
- cessation of the air supply to laboratories to increase negative pressure levels in response to fire or smoke detection. Opening exit doors should not be affected by this provision.

6.56 The control of supply air volumes using a variable air volume (VAV) type system is recommended for large laboratories. Supply and extract air volumes should be balanced to achieve desired pressurisation levels. Each fume cupboard should be controlled to maintain a constant face velocity. The VAV supply system should provide temperature control and maintain the minimum room ventilation rate.

6.57 Laboratory spaces should be comfort cooled without local humidity control. Large laboratory spaces should be zoned, with each zone equipped with a thermostat for individual control.

Local control of ventilation plant

6.58 It may be necessary to have more than one microbiological safety cabinet and fume cabinet. Therefore, local controls for operating any associated ventilation plant will be necessary.

6.59 Work in the containment level 3 rooms should only be undertaken when ventilation systems serving associated rooms are operating.

6.60 Where “make up” air is provided by mechanical ventilation, a supply air failure warning system should be provided. If any safety enclosure or room extract system fails, the associated supply system should be capable of being shut down automatically or reduced to prevent pressurisation of the room and possible contamination of adjacent areas.

6.61 The ventilation control system for safety cabinets should incorporate a five-minute delay timer. This will ensure that the system will continue to run after work has finished and purge any remaining contaminants.

PNEUMATIC TUBE SYSTEMS

6.62 A pneumatic tube system will be required for the transfer of specimens to and from other departments to stations within the pathology facility. The system should be designed in accordance with HTM 2009.

BUILDING MANAGEMENT SYSTEM

6.63 Engineering plant and equipment should be monitored and regulated by the BMS, in accordance with HTM 2005 – ‘Building management systems’.

6.64 Plant and system operational data should be recorded and reported. The BMS should also monitor, measure and record energy consumption for the facility.

6.65 If the main site has a BMS, the pathology facility should be set up as an outstation so that systems serving the facility can be monitored and controlled at a central station. The engineering systems within the facility should be capable of management from both the central station and the outstation itself.

Cytopathology training school, Manchester Royal Infirmary

7 Specific mechanical engineering services

MAXIMUM DEMANDS

7.1 Discussions with end users and manufacturers should take place to determine the service requirements of specialist equipment.

7.2 The engineering service demands and capacities in Table 7.1 apply to a pathology facility of approximately 3000 m^2 gross area.

MECHANICAL ENGINEERING REQUIREMENTS OF SPECIFIC SPACES

Containment level 3 laboratories

7.3 Ventilation of containment level 3 laboratories should ensure a continuous airflow into the laboratory, when work is being undertaken on pathogens. The exhaust air should be ducted from a microbiological safety cabinet to the outside through a HEPA filter.

7.4 Containment level 3 laboratories must be maintained at negative air pressure.

7.5 In the event of fan failure, the system should indicate the failure through an alarm, and also fail to a safe operational state. To achieve this, the system should be designed to ensure that the air supply fan shuts down if a failure of the extract system is detected, thus avoiding positive pressurisation of the room.

7.6 The airtightness of the room should ensure that there is no leakage to the outside, but consideration should be given to the provision of a standby extract ventilation system. This should be operable from outside the containment room and should be protected by a HEPA filter.

7.7 Safety cabinets and any separate extract system should be locally controlled to reduce the frequency at which HEPA filters need to be changed, and to permit the cabinet and rooms to be sealed for fumigation if a spillage occurs.

7.8 Safety cabinet fan(s) should be interlocked with general ventilation systems to maintain the desired air flow patterns. Where a separate supplementary extract is provided, the extract volume can be varied to compensate for stationary safety cabinet fan(s).

7.9 Supply and extract systems should be interlocked to prevent positive pressurisation of the room in the event of failure of the extract fan. Ventilation systems should also incorporate a means of preventing reverse airflows.

7.10 The laboratory, including all ductwork and services, should be designed so that it can be sealed to permit fumigation. Ventilation controls for purging the space should be located outside the laboratory.

7.11 See Appendix 9 for "Regulations and guidance relating to containment laboratories".

TABLE 7.1

Service	Typical max demand	Notes
Heating/ventilation/domestic hot water service	430 kW	
Cooling	85 kW	
Cold water	2.5 litres/sec	10,000 litres storage (24-hour supply)
Laboratory cold water	3.0 litres/sec	12,000 litres storage (24-hour supply)
De-ionised water	1.9 litres/sec	400 litres storage
Hot water service	2.9 litres/sec	1000 litres storage (2 hours recovery)
Supply ventilation	12 m^2/s	
Extract ventilation	13.55 m^2/s	
Electrical	178 kVA	Inc 69 kVA essential
Fuel gas (bench services)	0.6 litres/sec	
Steam	0.1 kg/sec	At 5 bar

Hot rooms

7.12 Hot rooms should be well insulated and maintained at 37 ± 0.5ºC. They should have lockable doors with internal safety release mechanisms.

7.13 The design of the heating system should provide an even distribution of air without stratification within the space.

7.14 A recording thermometer should be visible from outside the room. It should be connected to local and remote high/low temperature alarms.

Cold rooms and blood bank

7.15 Cold rooms should be maintained at a temperature of 5 ± 1ºC. They should be well insulated and designed in accordance with BS 2502. Doors should have internal safety releases.

7.16 Ceiling-mounted evaporators should provide low-velocity air distribution without stratification and with sufficient capacity to allow a rapid response to changes in temperature.

7.17 Free-standing blood bank cabinets should operate at 5 ± 1ºC and should be designed in accordance with the relevant BS EN Code of Practice.

7.18 They should be capable of storing blood at a uniform temperature throughout the cabinet. There should be no rise in the internal temperature of the cabinet during the defrost cycle.

7.19 Refrigeration systems should incorporate duty and standby compressors. Selection of the duty compressor should be manual, with automatic changeover to standby if the duty compressor fails. Air-cooled condensers should be located outside the building.

7.20 Each cold room and blood bank cabinet should have a tamper-proof temperature recorder mounted externally. It should be equipped with a battery-maintained audio/visual alarm providing remote indication at the telephone exchange (or other permanently manned station). This should warn if the temperature rises or falls beyond a pre-set range. A pulsating lamp signal should indicate when there has been a refrigeration system malfunction or a mains failure.

MECHANICAL ENGINEERING REQUIREMENTS OF SPECIFIC EQUIPMENT/FURNITURE

Microbiological safety cabinets

7.21 A class 1 microbiological safety cabinet should be specified for routine work involving group 3 pathogens.

7.22 Siting and installation are of particular importance since:

- the protection afforded to the operator by the cabinet depends on a specific and stable unidirectional airflow through the open front;
- the protection afforded to the environment by the cabinet depends on the high-efficiency particulate air filters as shown in Table 7.2.

7.23 Exhaust air should never be regarded as totally free from microbiological hazard.

7.24 Hazardous agents are contained within microbiological safety cabinets by maintaining negative pressurisation and use of HEPA filters. All safety cabinets should be equipped with visual and audible alarms warning of unsafe airflow.

7.25 The general extract from containment level 3 laboratories and from class 2 microbiological safety cabinets should be HEPA-filtered.

7.26 Microbiological safety cabinets in containment level 2 and 3 laboratories may be manifolded within the same laboratory unit. All microbiological safety cabinet extract should be separated from fume-cupboard and general extract.

TABLE 7.2

Microbiological safety cabinet class	Face velocity m/s	Airflow pattern	Containment level	Product protection
Class 1	0.7–1.0	In at front; extract through HEPA filter	2, 3	No
Class 2	0.4	Some air re-circulated through HEPA; laminar airflow; extract through HEPA	2, 3	Yes
Class 3	N/A	Supply air inlets and extract through 2 HEPA filters	3, 4	Yes

Notes
a) Class 3 microbiological safety cabinets have closed fronts with glove port assemblies
b) If extract air from a class 1 or class 2 microbiological safety cabinet is discharged into the room, double HEPA filters should be provided

7.27 The discharge from HEPA-filtered safety cabinets is relatively clean. Discharge to outside provides additional safeguards by dilution (in the event of filter failure). To avoid air re-entering the building, a roof-level discharge is preferred. In such an installation, the extract fan should be situated separate from the cabinet and close to the discharge outlet to maintain the duct under negative pressure.

7.28 The design, installation and use of microbiological safety cabinets are governed by a number of codes and standards. For further details see Appendix 9 under "Codes, standards and other guidance relevant to the design and use of microbiological safety cabinets".

Fume cupboards

7.29 Fume cupboards should have an adequate volume of draught-free replacement supply air and an effective exhaust system to enable the safe dispersal of waste products into the atmosphere.

7.30 Chemical fume cupboards should maintain an average velocity of 0.5 m/s at the design sash position. Constant volume fume cupboards will operate at lower velocities, down to a minimum of 0.3 m/s.

7.31 Fume cupboards should be constructed of non-combustible materials that are resistant to corrosion and deterioration.

7.32 Each fume cupboard should be equipped with a monitoring device and visual/audible alarm.

7.33 Fume cupboards designated by the Environmental Health and Safety Authority as especially hazardous should have a dedicated extract duct, fan and, if required, treatment system. This category may include radioisotope and perchloric acid cupboards.

7.34 The possibility of a fire or explosion that cannot be contained by a fume cupboard should be considered. A fume cupboard should not, therefore, be sited in a position where exit to an escape route will necessitate passing directly in front of it.

7.35 Fume cupboards fans should be installed as near as possible to the termination of the duct, thus maintaining the maximum amount of ductwork at a negative pressure. In certain circumstances, where there are adjacent buildings with open windows or where downdraught occurs, it may be necessary to increase the height of discharge ducts to achieve adequate dispersal.

7.36 To optimise the dispersal of fumes, a collection duct and a small stack may be considered where otherwise there would be a requirement for a large number of separate stacks.

7.37 The optimum height of the stack should be established by carrying out a wind tunnel test or computer modelling. The exhaust system of individual fume cupboards should discharge via non-return dampers into a collection duct.

7.38 The collection duct should have a large cross-sectional area to minimise the effect of individual exhaust systems. It should be open to the atmosphere, up-stream of the first connection, and discharge a total air volume at least equal to the combined individual extract systems.

7.39 Fume cupboards for certain processes should have separate exhaust systems.

7.40 Individual extract systems, discharging directly into the atmosphere or into a collection duct, do not require duplex fans. The collection duct provides dispersal of effluent for a number of individual extracts and should have duplex fans with automatic changeover.

7.41 Fume cupboards should be installed to the requirements of BS 7258 and designed in accordance with a number of British Standards (see Appendix 9 for "British Standards governing design of fume cupboards").

Dissecting benches

7.42 Air should flow towards dissecting benches from adjoining spaces. Local ventilation should limit the concentration of formaldehyde vapour within the breathing zone of the operator. The recommended threshold limit value is 2 ppm.

7.43 The following system parameters outlined are aimed at maintaining a concentration below 1 ppm.

7.44 A continuous run of benching (with a continuous up-stand at the rear) should be provided for dissecting activities. Benches should be a maximum of 650 mm deep (that is, from front to rear).

7.45 Each dissecting position should have a linear extract grille mounted with its face flush with the up-stand.

7.46 The bottom of the grille should be as close as practicable to the level of the working surface. For cleaning purposes, the minimum height of the bottom of the grille opening above the working surface should be 75 mm.

7.47 Each dissecting position should be 1.2 m long. The extract grille should also be 1.2 m long and 150 mm high. It should be mounted on a purpose-designed plenum box to ensure a minimum uniform face velocity of 1 m/s along the total length, and across the full height, of the grille opening.

7.48 The grille should be easily de-mountable to permit periodic internal cleaning of the plenum box and any guide vanes.

7.49 Filtration of the extract system is not necessary.

Extract hoods and laminar flow cabinets

7.50 Hoods are required over some equipment for the extraction of toxic fumes, odours heat and vapours.

7.51 A minimum hood face velocity of 0.2 m/sec should provide sufficient capture velocity near the process. A compact arrangement of equipment will minimise the hood area and reduce the air volume necessary to achieve the optimum capture velocity.

7.52 Hoods required for the control of heat gain and vapours can be connected to the general extract system. Guidance on the design of hoods is available in CIBSE Guide B2.

7.53 Very high temperatures are produced when burning nitrous oxide and acetylene in atomic absorption spectrometers. Heat damage can be avoided by designing the hood and extract system to ensure adequate dilution of the products of combustion. Provided flue gases are adequately diluted, the extract system may be connected to one of the main laboratory extract systems. A separate discharge is preferred where corrosive resistant ductwork materials are necessary.

7.54 Vertical laminar flow cabinets (designed in accordance with BS 5726) may be required for media preparation. These cabinets operate by drawing air from the laboratory and discharging filtered air unidirectionally over the workspace.

7.55 Although they protect the media from contamination, protection of the operator depends on the design of the cabinet and subsequent maintenance. Limitations on the use of class 2 cabinets are given in 'The management, design and operation of microbiological containment laboratories', Advisory Committee on Dangerous Pathogens.

Washing/drying machines

7.56 Washing/drying machines will be required to ensure that soiled glassware and hollowware are clean and microbiologically safe for re-use. The machines should be purpose-designed, and the final rinse cycle should allow the use of de-ionised water.

7.57 A minimum water pressure of 1 bar is required.

Sterilizers

7.58 Sterilizers are required for sterilizing media, apparatus and discarded materials. Two multifunctional units will be required. Each unit should have a capacity of 0.4 cubic metres and a peak steam supply of approximately 180 kg/hour at a pressure of 5.0 bar(g).

7.59 Automatic media preparation systems are also used for sterilizing microbiological culture media. They consist of two or three modules designed to provide controlled preparation, sterilization, cooling and dispensing of media with minimum intervention by the operator..

7.60 The sterilizer plantroom should be ventilated to offset the heat generated by the plant. It should be protected from frost when it is not in use. Additional space should be provided if separate steam generators and water treatment plant are to be installed.

7.61 Further guidance concerning the selection and installation of sterilizers is contained in HTM 2010 – 'Sterilization'.

MECHANICAL ENGINEERING REQUIREMENTS OF SPECIFIC FIXTURES/FITTINGS

Building extract stacks and air intakes

7.62 The fume extract stacks should terminate above the highest point of the building including penthouses and roof parapets. This will facilitate the removal of hazardous materials from the building and ensure safe dilution levels. The height of the stacks should be carefully determined in conjunction with local regulations.

7.63 Stacks should be tall enough to offer adequate protection to maintenance personnel. The minimum height of the termination point should be 3 m above the highest point of the building, or 1.25 multiplied by the highest point of the building in metres (whichever is greater).

7.64 The minimum discharge velocity from the stacks should be 15 m/s. This will counteract any re-entrainment due to varying wind direction or environmental features. If vapour condensation may occur inside the stack, the discharge velocity should not exceed 10 m/sec.

7.65 Stacks should not terminate within enclosures or architectural screens. Architectural masking structures may be used, but the stack must extend at least one diameter above the structure.

7.66 Re-circulation of hazardous fumes from the stacks should be avoided by sufficient separation of exhaust from air intakes.

7.67 Air intakes should be located high above the ground to avoid dust or vehicle exhaust, and away from other sources of potential contamination such as vehicle waiting areas and refuse collection points.

7.68 Consideration should be given to the effect of local physical and environmental conditions such as building geometry, wind conditions, surrounding buildings and trees, which may affect the effluent dispersion patterns around the pathology building.

Filters

7.69 Pre-filters and main filters should be provided for all air-conditioned spaces. Pre-filter efficiency should be G3 and final filter efficiency should be F6 (F8 if followed by HEPA terminal filter).

7.70 HEPA class 14 to BS EN 1822-1 filtration standard is required for certain laboratories such as biological containment category 3 laboratories, suites dealing with radioactive materials, and all clean rooms (for example tissue culture, DNA extraction and PCR rooms).

7.71 Filters should be readily accessible for replacement and maintenance purposes. They should be provided with audible and visual pressure-differential alarms to indicate when replacement is required.

Ductwork and fans

7.72 Laboratory air extract systems should remove laboratory air through fume cupboards, canopy hoods, safety cabinets, snorkels or ceiling grilles. Extract from like areas may be grouped together into the same extract system.

7.73 Supply air, return air, and non-contaminated laboratory extract air should be handled in galvanised steel low- and medium-pressure ductwork.

7.74 Fume cupboard extract ducts should be constructed of 16- or 18-gauge stainless steel, PVC-coated galvanised steel, polypropylene or PVC ductwork. Longitudinal sections of extract ducts should be a continuous seamless tube or continuously-welded formed sheet.

7.75 Low leakage levels should be maintained in both the supply and extract ducts. Duct velocity in the fume extract duct mains should not exceed 10 m/s.

7.76 In event of failure, balancing and control dampers in the extract system should fail in the open position.

7.77 Fire dampers should not be placed in the fume extract ductwork.

7.78 All fume cupboard extract ductwork within the building should be under negative pressure; fans should discharge directly to the extract stacks.

7.79 All fan materials or coatings in the air stream of the fume extract should be corrosion- and solvent-resistant. Fans should be located outside the building or in a separate room under negative pressure and provided with direct access to the outside.

Fire resistance of ductwork

7.80 Extract duct routes should avoid passing through other fire compartments. If this is unavoidable, the duct should be fire-resistant or have fire dampers.

7.81 Extract systems for microbiological safety cabinets and fume cupboards used for processes involving highly toxic and/or aggressive substances should not have fire dampers. These ducts should be provided with fire protection or fitted with intumescent collars.

MECHANICAL ENGINEERING REQUIREMENTS RELATING TO PROVISION/TREATMENT OF MATERIALS

Purified water

7.82 A supply of de-ionised water will be required for laboratory use and for the final rinse cycle of glassware washing machines. It should be produced in a central plant dedicated to pathology use.

Clinical science centre, Wythenshawe Hospital (Photo: Bob Collier)

7.83 Small quantities of distilled water will be required in some laboratories and should be produced locally using portable electrically-operated automatic stills. Alternatively, supplies of treated water may be brought in. Condensed steam from the hospital boiler plant is not a suitable alternative.

7.84 The central de-ionisation plant and purification modules should be determined by local needs.

7.85 A laboratory grade BS EN ISO 3696 grade 1, 2, 3 reverse osmosis de-ionised water system should be supplied at 2-mega ohm cm resistivity at point of use, recirculated and filtered to maintain high purity.

7.86 Final selection will depend upon the raw water supply, the aggregate demand and the purity level required.

7.87 A reverse osmosis unit combined with ion exchange, together with an appropriate storage unit, will normally provide the most efficient and economical installation.

7.88 The size and location of the plant and storage tank should be determined at an early stage. This will ensure that the required flow rates are obtained economically and efficiently, and distribution pipework is kept to a minimum.

7.89 Attention is required in the construction of the storage and distribution system to ensure the purity of the water. Distribution pipework and the storage vessel should be manufactured from ABS class E or UPVC plastics. The system should have a fully automatic "dump" facility to ensure that water below the required standard is discharged to drain.

7.90 Purified water (10–18 mega ohm cm) should be supplied using de-ionised water from local polishing units in selected laboratories (as requested in the Activity Data Sheets).

7.91 De-ionised water pipework should be high-density polyethylene or unpigmented polypropylene with heat-sealed joints.

7.92 The laboratory hot and cold water services should be copper tube standard BS EN 1057, R250 (class X) with copper fittings to BS EN 1254.

7.93 The purified water system should be designed in accordance with HTM 2027.

Laboratory gases

7.94 Pathology gases should be piped, although small quantities may be supplied from portable cylinders (for example acetylene at gauge pressures not exceeding 0.6 bar). Prior approval of proposals should be obtained from the Health and Safety Executive.

7.95 A specialist contractor should install and test the pipe system for laboratory gases.

7.96 The system should be capable of modification and extension. However, plugged tee outlets for future change of use should not be provided.

7.97 Terminal units for medical gases, medical compressed air and medical vacuum should not be used in a pathology laboratory.

7.98 A piped vacuum system is not required. Portable vacuum pumps working at –0.5 to –0.6 bar should be sufficient.

7.99 Oil-free compressed air should be supplied by exclusive small local units. A piped system is unnecessary.

7.100 Laboratory gases should be stored in a ventilated, secure external enclosure similar but separate from the medical gases store.

7.101 Further guidance on medical gases is contained in HTM 2022 – 'Medical gas pipeline systems'; this information is also applicable to laboratory gases.

Steam

7.102 Sterilizers, washing/drying equipment and humidifiers will require steam. If hospital steam is available, it should be reduced to a pressure of 5.0 bar(g). Clean steam is not required for this purpose.

7.103 If hospital steam is not available, a local steam generating plant should be provided. It should be able to respond to sudden changes in demand. Steam generators should be fired on natural gas and/or gas oil to avoid the high operating cost of electricity.

Clinical waste

7.104 Waste that is not miscible with water should be incinerated or consigned to the local authority/private contractor for disposal (after it has been effectively treated in accordance with Health Guidance Note – 'Safe disposal of clinical waste – whole hospital policy guidance').

7.105 Waste disposal units should be free-standing and permanently connected to the main drainage system. They should have a solenoid valve to prevent operation unless a minimum flow of water is established. The branch drain should be located where adequate dilution can be assured. The unit should incorporate pressurised flushing and cleaning of the waste hopper.

8 Electrical engineering services

INCOMING SUPPLY AND DISTRIBUTION BOARD

8.1 The point of entry for the electrical supply will be a switchcupboard housing the main isolators and distribution equipment. This space should also be the distribution centre for subsidiary electrical services.

8.2 Wherever possible, all equipment should be mounted at a height to give easy access from a standing position.

8.3 All switchgear should be lockable in the "off" position.

EMERGENCY ELECTRICAL SUPPLIES

8.4 Emergency electrical provision should comply with the requirements of HTM 2011 – 'Emergency electrical services'. It should have an automatic changeover to an emergency generator supply in the event of a mains failure.

8.5 The emergency generator should be capable of providing full (100%) backup to the pathology facility, excluding the refrigeration plant serving the air-conditioning and comfort cooling plant.

8.6 If the 100% coverage requirement cannot be met using an existing generator, it will be necessary to replace it with a larger set or provide separate essential and non-essential distribution systems, as detailed in HTM 2011.

8.7 Equipment and systems that cannot tolerate the delay inherent in bringing an emergency generator supply on line (particularly computer equipment associated with automated analytical systems) should be provided with an uninterruptible power supply.

8.8 In the event of a main supply or local final circuit failure, escape routes should be illuminated in accordance with HTM 2011 and BS 5266. These should be self-contained, battery-powered luminaires, charged continuously from the main supply and capable of providing illumination for a period of three hours.

ELECTRICAL INSTALLATIONS

8.9 Electrical installations should comply with BS 7671 (IEE Regulations – 16th edition), and HTM 2007 – 'Electrical services supply and distribution'.

8.10 Electrical installations in occupied areas should be concealed using low smoke and fume (LSF) insulated cable in containment conduit or trunking. In certain circumstances, mineral-insulated metal-sheathed cables may be necessary.

8.11 There should be separate containment for communication and data systems. This should be concealed wherever possible.

8.12 Laboratory sub-distribution panel-boards with locking covers should be located in corridors for safe access in the event of an emergency. Non-laboratory loads should be served by separate sub-distribution panel-boards located in the electrical rooms (or corridors, if necessary) relevant to the particular floor.

8.13 Laboratory sub-distribution panel-boards should serve one or two laboratory units, depending on size. The panel-board bus bars should be suitably rated to allow for future flexibility and additional spare capacity.

8.14 Dual compartment trunking should be used at bench tops. One compartment should be for power distribution and the other for data and communications distribution.

8.15 Due to potential electromagnetic interference between power and IT cabling, parallel services should be run with suitable separation between them other than at bench tops and workspaces.

8.16 There should be sufficient 13 amp switched shuttered socket-outlets, connected to ring circuits or spurs, to allow all portable appliances (likely to be used simultaneously) to be individually supplied. The installation of twin outlets should be considered where these activities occur in juxtaposition. An above-average provision of socket-outlets will be required for bench services.

8.17 A socket-outlet trunking system can provide flexibility and minimise disturbance when repositioning or adding outlets. See HTM 2007 for information on RCD protection in laboratories and areas with trailing leads. For general guidance on the use of RCD protection also see HTM 2007.

8.18 Domestic cleaning appliance flexible leads are 9 m long. Socket-outlets should be provided to enable the machines to operate over the whole area of the facility.

8.19 Fixed appliances rated up to 13 amps should be permanently connected to double-pole switched spur boxes and fused as required. Appliances rated in excess of this load, or those requiring a three-phase supply, should be permanently connected to separate final circuits from fuse-boards. These should be independently switched at a local isolator of appropriate rating.

8.20 Local switches or other means of electrical isolation should be provided adjacent to plant. The equipment should be suitably labelled to ensure the safety of operators and maintenance staff.

8.21 Ventilation equipment and automatically operated equipment should be provided with indicator lights to show when the equipment is energised. Indicators should be incorporated in the control panel of the apparatus, in the control switch, or in the outlet from which the apparatus derives its supply.

8.22 The electrical supply to electro-medical equipment should comply with BS EN 60601-1 to avoid corruption of input data. Some equipment may require automatic disconnection, with manual reset, following a mains failure. Other computer-controlled analytical equipment may require an uninterruptible power supply from a static inverter of appropriate capacity.

8.23 A dedicated, clean earth network should be accessible to all laboratories and laboratory support spaces requiring a clean earth for laboratory instruments. This system should consist of a network of large-capacity cables with connections into all laboratory areas. The network should terminate in a single-point earth connection.

ELECTRICAL INTERFERENCE

8.24 Guidance concerning the avoidance and abatement of electrical interference is given in HTM 2014 – 'Abatement of electrical interference'. Fluorescent luminaires should comply with BS EN 55015.

8.25 Care should be taken to avoid mains-borne interference, harmonics and electrical radio frequency interference, which could affect computers and other electronic equipment.

LINE CONDITIONING

8.26 High-energy transient voltage surge suppression devices should be provided with high-frequency line noise filtering, suitable for application in category A, B, and C3 environments as required.

ELECTROMAGNETIC INTERFERENCE

8.27 Electromagnetic interference is a potential problem requiring solutions to minimise the effect between power and data systems. The primary power service should be located as far as possible from laboratories.

LIGHTING

8.28 Practical methods of lighting the various functional spaces are contained in BS EN 12464-1. Luminaires should be manufactured and tested in accordance with BS 4533. Their location should afford ready access for lamp changing and maintenance, although the overriding requirement is that the recommended standard of illumination is provided.

8.29 Fluorescent lighting in consulting, examination, and venepuncture areas should be derived from lamps with suitable colour rendering, index 1a for clinical areas, and colour temperature 3000–4000 K.

8.30 Control of lighting is normally by local switches, and these should be provided in sufficient numbers to allow variation in lighting options. Such a facility is particularly important in large spaces where daylight levels are not uniform, and artificial lighting is likely to be needed for long periods in areas remote from windows.

8.31 To conserve energy, consideration should be given to photocell control of perimeter lighting zones and passive infra-red (PIR) control of lighting in intermittently occupied areas.

8.32 In areas where computer terminals are to be used, lighting should be designed to avoid bright reflections on the screen and to ensure that the contents of the screen are legible. Further guidance can be found in CIBSE Lighting Guide (LG) 3.

INFORMATION TECHNOLOGY (IT)

8.33 Where possible, a structured wiring system should be provided (see Health Guidance Note – 'Structured cabling for IT systems' for further details). This will permit a unified approach to the provision of cabling for:

- voice systems;
- data systems;
- imaging systems;
- CCTV;
- alarm systems.

8.34 Whilst this "universal" cabling system is initially more expensive than separate voice and data systems, the long-term cost is less.

8.35 In determining the nature of the IT system to be provided, it is necessary to identify:

- rooms to be served;
- whether structured cabling will be used;
- what density of outlets is to be provided (not fewer than two per workstation);
- whether wiring will be on a “flood” or “as required” basis.

TELEPHONE SYSTEMS

8.36 It may be beneficial to integrate voice cabling with the structured wiring system for IT.

8.37 Where a cabling system supporting voice/data is not available, the existing hospital block wiring should be extended to serve telephones within the pathology facility.

8.38 Telephones will normally be situated on desks, but wall-mounted telephones or a “hands-off” loudspeaking facility may be required in some areas. Wiring should terminate at each extension point in a standard point in a standard line jack unit.

SECURITY SYSTEMS

8.39 A closed-circuit television system should be provided or extended from existing site-wide systems. This should allow video recording and cover external, entrance and reception areas. The entry of the public into the facility should be controlled from the reception area.

8.40 Staff access should be by means of swipe cards with second-level entry (second card or priority card) to sensitive areas. This should be supported by appropriate intercom systems. All external doors, and doors to sensitive areas, should be monitored. Local alarms should be provided for high-risk areas.

FIRE DETECTION AND ALARM SYSTEMS

8.41 The fire detection and alarm system should have automatic detectors of dual heat/smoke type. It should conform to the requirements of BS 5839 (Part 1, system type L2) and the appropriate authorities.

8.42 The system should be a fully addressable monitored system. It should be mains-powered with battery back-up and have break-glass, push-button call points and sounders.

8.43 The system should be suitably zoned and incorporate a main fire alarm panel located at the main entrance/reception.

8.44 The fire alarm should interface with BMS, mechanical plant, generators, lifts, security and access control systems to control or shut down plant and release doors in the event of a fire.

LIGHTNING PROTECTION

8.45 A risk assessment should be carried out for the building in accordance with BS 6651. A lightning protection system should be provided that links all roof-mounted equipment and structural steel. Where possible, the building structure should be used for the main lightning protection conductors.

8.46 Transient over-voltage protection should be provided on the main LV switchboards and on distribution boards supplying sensitive equipment.

RADIO AND TV AERIAL SYSTEM

8.47 A system of terrestrial aerials, boosters and cabling should be provided to outlets in staff rooms and seminar rooms.

9 Cost information

INTRODUCTION

9.1 Building costs and revenue expenditure for all types of healthcare facility should be kept as low as possible, consistent with requirements. In applying this guidance, the need for economy should always be of prime concern. Where appropriate, space should be shared between similar activities taking place at different times. However, this solution should not be detrimental to the proper functioning of the spaces involved nor to the needs of users.

DEPARTMENTAL COST ALLOWANCE GUIDES (DCAGs)

9.2 Departmental Cost Allowance Guides (DCAGs) related to this HBN are published in 'Quarterly Briefing' (NHS Estates). For a full listing of all DCAGs see 'Healthcare Capital Investment' (NHS Estates).

9.3 The 'Capital Investment Manual: Business Case Guide' (DH) aims to reduce planning work and to encourage the production of sound business case support of both capital and revenue expenditure. Capital works estimates should be based, wherever applicable, on industry norms, such as DCAGs plus a percentage to cover on-costs.

9.4 The DCAGs for this HBN reflect the total building, engineering and accommodation requirements for pathology services generally located on an acute hospital site, where common services are shared. Costs are based on a typical two-storey new-build unit on a greenfield site with no planning constraints.

9.5 DCAGs are exclusive of VAT, building and planning fees and all local authority charges, and are based on a location factor of one.

ON-COSTS

9.6 An allowance for on-costs (such as external works, external engineering services and abnormals) should be added to the DCAGs. Abnormals will largely be determined by site characteristics (such as an inner-city location or poor ground conditions) and by the condition or type of any building to be refurbished.

9.7 Project teams should assess all likely on-cost implications of individual sites and schemes at the earliest opportunity.

LOCATIONAL FACTORS

9.8 Locational factor adjustments should be applied to works costs (that is, DCAGs plus established on-costs) to take account of local market conditions. For further information, see 'Quarterly Briefing'.

FUNCTIONAL UNITS

9.9 The schedules of accommodation use a modular approach to the planning of pathology facilities.

9.10 Examples using this modular approach are set out below. Areas given are for guidance only and will alter depending on the design solution. DCAGs have been calculated using the examples as a cost base.

SCHEDULES OF ACCOMMODATION

9.11 The schedules of accommodation show notional whole departments, which highlight the scope for sharing accommodation. The examples are not to be taken as ideal provision for any particular project.

9.12 The examples are as follows:

Example 1: Full pathology service on an acute site serving a whole network.

Example 2: Urgent and emergency pathology request service only on an acute site.

Example 3: Routine, specialised and non-urgent pathology service on a standalone site covering several acute sites.

DIMENSIONS AND AREAS

9.13 The critical dimensions of an area are determined by the spatial requirements of any activities to be carried out within it. Studies to establish dimensional requirements, in the form of critical dimensions, appear as ergonomic diagrams in HBN 40 – 'Common activity spaces'.

9.14 Planning teams should have data available at the earliest stages of a project to enable the approximate

assessment of sizes involved. Areas used for the purpose of establishing cost allowances are listed on pages 48 to 53. These areas do not represent recommended sizes and should not be regarded as specific individual entitlements.

9.15 The efficient planning of a building may necessitate a variation to the areas given. For example, in the refurbishment/conversion of older property:

- rooms tend to be larger than the areas given;
- some rooms may be too small or in the wrong location for efficient use;
- circulation space tends to form a larger than normal proportion of the total area.

CIRCULATION

9.16 All internal corridors, small vertical ducts, spaces occupied by partitions/walls and other space for circulation, are costed in the DCAGs. Provision is also made for a 5% planning zone and 3% engineering zone adjacent to the external walls.

9.17 Circulation figures included in the DCAGs are those anticipated for new-build facilities. Where constraints are encountered, for example in refurbishment/conversion of older types of property, this figure may increase.

COMMUNICATIONS

9.18 Staircases and lifts are not included in the DCAGs. Costs related to these elements, along with a suitable space allowance, should be made in the on-costs.

LAND COSTS

9.19 DCAGs are exclusive of all land costs and associated fees. However, costs associated with land costs should be included in business case submissions (as detailed in 'CIM') and may therefore have an important impact on the overall cost viability of a scheme.

ENGINEERING SERVICES

9.20 The following engineering services are included in the cost allowances (see chapters 5 to 8 and Activity DataBase for further information). Primary engineering services are assumed to be conveniently available at the boundary of the department.

9.21 Mechanical services:

- Heating – low-pressure hot water system.
- Ventilation – mechanical supply to, and extraction from, all laboratory areas and other areas requiring mechanical ventilation such as WCs and showers (excludes ventilation plant, such as air handling units or extract fans).
- Cold water – central supply to service points including drinking water (excludes storage tanks).
- Hot water – supply from a central system (excludes storage and generation).
- Piped medical gases – oxygen, compressed air and vacuum (excludes medical compressed air and vacuum plant).

9.22 Electrical services:

- Departmental distribution boards.
- General lighting, as required by task.
- Staff location system.
- Emergency luminaires, as appropriate.
- Socket-outlets and other power outlets for fixed and portable equipment.
- Supplementary equipotential earth bonding.
- Uninterruptible power supply (UPS) and equipment.
- Fire, security, blood bank, hot and cold rooms, safety cabinet and fume cupboard alarm systems.
- TV/radio wireways.
- Telephone internal cabling distribution and outlets (excludes handsets).
- Data wireways.

9.23 Equipment (Group 1):

- Autoclaves.
- Dry heat sterilizers.
- Microbiogical safety cabinets (classes 1 and 2).
- Fume cupboards.
- Washing/drying machines.
- Cold rooms.
- Hot rooms.
- Blood banks.
- Automatic dishwasher.
- Deionised water plant.
- Waste disposal units.

EXAMPLE 1: FULL PATHOLOGY SERVICE ON AN ACUTE SITE SERVING A WHOLE NETWORK

Activity space	Qty	Area m^2	Total area m^2	Para ref	Notes
Entrance and reception (including specimen) facilities					
Entrance foyer	1	–	–	–	Within circulation allowance
Reception: departmental and specimen	1	10.5	10.5	Para 4.4	–
Sorting and request processing area: specimen	1	21.0	21.0	Para 4.6	–
Processing area: specimen	1	21.0	21.0	Para 4.7	–
Specimen hold: out-of-hours bay	1	4.0	4.0	Para 4.13	–
Laboratory entry facilities					
Entrance lobby: laboratory	4	6.0	24.0	Para 3.17	Required at entrance to each laboratory cluster
Laboratory facilities: general automated tests					
Automated laboratory	1	189.0	189.0	Para 4.63	–
Laboratory facilities: histopathology					
Specimen reception: histopathology, sorting and request processing area	1	31.5	31.5	Para 4.195	–
Laboratory: histopathology, specimen cut-up area including wet specimen store	1	42.0	42.0	Para 4.199, 4.215	–
Laboratory: histopathology, high risk specimen cut-up	1	10.5	10.5	Para 4.205	–
Lobby: laboratory, high risk/containment level 3	1	5.0	5.0	Para 4.205	–
Laboratory: histopathology, processing	1	31.5	31.5	Para 4.207	–
Laboratory: histopathology, general and special including resin work	1	126.0	126.0	Para 4.218, 4.222, 4.223	
Store: histopathology, slide and block	1	21.0	21.0	Para 4.226	–
Store and chemical preparation area: histopathology	1	21.0	21.0	Para 4.228	–
Laboratory facilities: cytopathology					
Specimen reception: cytopathology	1	42.0	42.0	Para 4.195	–
Laboratory: cytopathology, cytopathology processing	1	63.0	63.0	Para 4.229	–
Laboratory: cytopathology, liquid-based cytopathology processing	1	63.0	63.0	Para 4.253	–
Reporting room: cytopathology, 12 workstations	1	63.0	63.0	Para 4.240	–
Screening area: cytopathology, 12 workstations	1	63.0	63.0	Para 4.242	–
Store: cytopathology, slide	1	31.5	31.5	Para 4.251	–
Laboratory facilities: blood bank, blood grouping and cross matching					
Blood bank area	1	31.5	31.5	Para 4.262	–
Laboratory: blood grouping	1	31.5	31.5	Para 4.267	–
Laboratory: blood cross-matching	1	31.5	31.5	Para 4.270	–
Blood bank: out of hours bay	1	5.0	5.0	Para 4.266	Accessed from laboratory and entrance circulation
Laboratory facilities: general microbiology tests					
Laboratory: microbiology	1	126.0	126.0	Para 4.86	–
Laboratory facilities: specialised tests					
Specialised laboratory: containment level 3	1	21.0	21.0	Para 4.167	–
Lobby: laboratory, high risk/containment level 3	1	5.0	5.0	Para 4.168	–
Specialised laboratory: immunoassay testing	1	31.5	31.5	Para 4.138	–
Specialised laboratory: chromatography testing & mass spectroscopy	1	31.5	31.5	Para 4.141, 4.145	–
Specialised laboratory: PCR sample preparation	1	10.5	10.5	Para 4.153	–
Specialised laboratory: PCR set-up	1	21.0	21.0	Para 4.153	–
Specialised laboratory: electrophoresis including PCR analysis	1	31.5	31.5	Para 4.153, 4.160	–
Specialised laboratory: flow cytometry	1	21.0	21.0	Para 4.165	–
Decontamination, wash-up and sterilizing facilities					
Central wash-up	1	21.0	21.0	Para 4.120	–
Media preparation and plate pouring/media dispensing facilities					
Media preparation laboratory	1	10.5	10.5	Para 4.123	–
Plate pouring and media dispensing laboratory	1	21.0	21.0	Para 4.124	–

Activity space	Qty	Area m²	Total area m²	Para ref	Notes
Shared decontamination and media preparation facilities					
Sterilizer loading/unloading area: 2 autoclaves/sterilizers	1	21.0	21.0	Para 4.120	–
Plantroom: 2 autoclaves/sterilizers	1	17.0	17.0	Para 4.120	–
Shared support facilities: whole unit					
Cold room: 4ºC	2	21.0	42.0	Para 4.104	–
Refrigerator/freezer room	4	21.0	84.0	Para 4.114	–
Common equipment room	2	21.0	42.0	Para 4.102	–
Centrifuge room	2	21.0	42.0	Para 4.112	–
Hot room: 37ºC	1	31.5	31.5	Para 4.109	–
Cryo-preservation room	1	31.5	31.5	Para 4.105	–
Darkroom	1	31.5	31.5	Para 4.110	–
Store and preparation area: chemicals	1	21.0	21.0	Para 4.59	–
Service room: equipment	1	21.0	21.0	Para 4.41	–
Store: equipment and supplies including storekeeping area	1	63.0	63.0	Para 4.47	–
Store: laboratory working stock	4	10.5	42.0	Para 4.115	–
External store: gas cylinders	1	–	–	Para 4.50	ECA
External store: bulk flammable goods	1	–	–	Para 4.51	ECA
Housekeeping room	2	7.0	14.0	Para 4.56	–
Hold: disposal	2	10.0	20.0	Para 4.54	–
Switchgear room	2	4.0	8.0	Para 8.1	–
Computer communication: IT hub room	1	9.0	9.0	–	–
Staff support facilities: whole unit					
Rest and dining room: 40 staff	1	50.0	50.0	Para 4.29	–
Beverage and snack preparation bay	1	12.0	12.0	Para 4.33	–
Refreshment: vending machine	1	3.0	3.0	Para 4.35	–
Staff changing room: 50 places	1	25.0	25.0	Para 4.23, 4.26	Male staff
Shower: ambulant (non patient)	2	2.5	5.0	Para 4.25	Male staff
WC and wash: ambulant	3	2.0	6.0	Para 4.27	Male staff
Staff changing room: 40 places	2	20.0	40.0	Para 4.23, 4.26	Female staff
Shower: ambulant (non patient)	4	2.5	10.0	Para 4.25	Female staff
WC and wash: ambulant	4	2.0	8.0	Para 4.27	Female staff
WC and handwash: accessible, wheelchair assisted	1	4.5	4.5	Para 4.27	Male and female staff
Store: protective clothing	1	4.0	4.0	Para 4.28	–
Seminar and training room: 30 persons	1	55.0	55.0	Para 4.37	–
Library and study room: 10 persons	1	30.0	30.0	Para 4.39	–
Office: 1 staff	12	10.5	126.0	Para 4.17	HBN 15 type A: administrative
Office: 1 staff	8	12.0	96.0	Para 4.17	HBN 15 type B: includes microscope bench
Office: 6 staff	1	36.0	36.0	Para 4.15, 4.18	Administrative
Office: 2 staff	2	13.0	26.0	Para 4.18	–
Office: 3 staff	2	18.0	36.0	Para 4.18	–
Office: 6 staff	1	36.0	36.0	Para 4.18	–
Net allowance			2483.5		
5% planning allowance			124.0		
Total			2607.5		
3% engineering allowance			78.0		
25% circulation allowance			652.0		
Total allowance			**3337.5**		
Optional accommodation					
Specialised laboratory: trace metal testing	1	21.0	28.5	Para 4.148	–
Specialised laboratory: cell and tissue cultivation	1	31.5	31.5	Para 4.143	–
Electron microscopy facilities					
Laboratory: TEM sample preparation	1	10.5	14.0	Para 4.173	–
Laboratory: TEM microscope	1	21.0	42.5	Para 4.178	–

EXAMPLE 2: URGENT AND EMERGENCY PATHOLOGY REQUEST SERVICE ONLY ON AN ACUTE SITE

Activity space	Qty	Area m^2	Total area m^2	Para ref	Notes
Entrance and reception (including specimen) facilities					
Entrance foyer	1	–	–	–	Within circulation allowance
Reception: departmental and specimen	1	10.5	10.5	Para 4.4	–
Sorting and request processing area: specimen	1	10.5	10.5	Para 4.6	–
Processing area: specimen	1	10.5	10.5	Para 4.7	–
Laboratory entry facilities					
Entrance lobby: laboratory	2	6.0	12.0	Para 3.17	Required at entrance to each laboratory cluster
Laboratory facilities: urgent and emergency pathology tests					
Laboratory: histopathology, urgent frozen sections	1	31.5	31.5	Para 4.81	–
Laboratory: haematology, urgent tests	1	31.5	31.5	Para 4.81	–
Laboratory: chemical pathology, urgent tests	1	31.5	31.5	Para 4.81	–
Laboratory: microbiology, urgent tests	1	31.5	31.5	Para 4.81	–
Laboratory facilities: blood bank, blood grouping and cross-matching					
Blood bank area	1	31.5	31.5	Para 4.262	–
Laboratory: blood grouping	1	31.5	31.5	Para 4.267	–
Laboratory: blood cross-matching	1	31.5	31.5	Para 4.270	–
Blood bank: out of hours bay	1	5.0	5.0	Para 4.266	Accessed from laboratory and entrance circulation
Decontamination, wash-up and sterilizing facilities					
Central wash-up	1	21.0	21.0	Para 4.120	–
Media preparation and plate pouring/media dispensing facilities					
Media preparation laboratory	1	10.5	10.5	Para 4.123	–
Plate pouring and media dispensing laboratory	1	10.5	10.5	Para 4.124	–
Shared decontamination and media preparation facilities					
Sterilizer loading/unloading area: 2 autoclaves/sterilizers	1	21.0	21.0	Para 4.120	–
Plantroom: 2 autoclaves/sterilizers	1	17.0	17.0	Para 4.120	–
Shared support facilities: whole unit					
Cold room: 4ºC	1	21.0	21.0	Para 4.104	–
Refrigerator/freezer room	1	31.5	31.5	Para 4.114	–
Common equipment room	1	21.0	21.0	Para 4.102	–
Centrifuge room	1	21.0	21.0	Para 4.112	–
Hot room: 37ºC	1	21.0	21.0	Para 4.109	–
Cryo-preservation room	1	21.0	21.0	Para 4.105	Optional
Darkroom	1	10.5	10.5	Para 4.110	–
Store and preparation area: chemicals	1	10.5	10.5	Para 4.59	–
Service room: equipment	1	12.0	12.0	Para 4.41	–
Store: equipment and supplies including storekeeping area	1	31.5	31.5	Para 4.47	–
Store: laboratory working stock	1	21.0	21.0	Para 4.115	–
External store: gas cylinders	1	–	–	Para 4.50	ECA
External store: bulk flammable goods	1	–	–	Para 4.51	ECA
Housekeeping room	1	7.0	7.0	Para 4.56	–
Hold: disposal	1	10.0	10.0	Para 4.54	–
Switchgear room	1	4.0	4.0	Para 8.1	–
Computer communication: IT hub room	1	9.0	9.0	–	–

Activity space	Qty	Area m^2	Total area m^2	Para ref	Notes
Staff support facilities: whole unit					
Rest and dining room: 10 staff	1	18.0	18.0	Para 4.29	–
Beverage and snack preparation bay	1	6.0	6.0	Para 4.33	–
Refreshment: vending machine	1	3.0	3.0	Para 4.35	–
Staff changing room: 10 places	1	8.0	8.0	Para 4.23, 4.26	Male staff
WC and wash: ambulant	2	2.0	4.0	Para 4.27	Male staff
Shower: ambulant (non patient)	1	2.5	2.5	Para 4.25	Male staff
Staff changing room: 15 places	1	10.0	10.0	Para 4.23, 4.26	Female staff
WC and wash: ambulant	2	2.0	4.0	Para 4.27	Female staff
Shower: ambulant (non patient)	1	2.5	2.5	Para 4.25	Female staff
WC and handwash: accessible, wheelchair assisted staff	1	4.5	4.5	Para 4.27	Male and female staff
Store: protective clothing	1	2.0	2.0	Para 4.28	–
Seminar & training room: 10 persons	1	20.0	20.0	Para 4.37	–
Library and study room: 5 persons	1	20.0	20.0	Para 4.39	–
Office: 1 staff	4	10.5	42.0	Para 4.17	HBN 15 type A: administrative
Office: 2 staff	1	13.0	13.0	Para 4.15, 4.18	Administrative
Office: 2 staff	1	13.0	13.0	Para 4.18	–
Net allowance			773.5		
5% planning allowance			38.5		
Total			812.0		
3% engineering allowance			24.5		
25% circulation allowance			203.0		
Total allowance			**1039.5**		

EXAMPLE 3: ROUTINE, SPECIALISED AND NON-URGENT PATHOLOGY SERVICE ON A STANDALONE SITE SERVING A WHOLE NETWORK

Activity space	Qty	Area m^2	Total area m^2	Para ref	Notes
Entrance and reception (including specimen) facilities					
Main entrance draught lobby	1	11.0	11.0	–	Includes entrance canopy
Entrance foyer	1	–	–	–	Within circulation allowance
Reception: departmental and specimen	1	10.5	10.5	Para 4.4	–
Sorting and request processing area: specimen	1	21.0	21.0	Para 4.6	–
Processing area: specimen	1	31.5	31.5	Para 4.7	–
Laboratory entry facilities					
Entrance lobby: laboratory	4	6.0	24.0	Para 3.17	Required at entrance to each laboratory cluster
Laboratory facilities: general automated tests					
Automated laboratory	1	252.0	252.0	Para 4.63	–
Laboratory facilities: histopathology					
Laboratory: histopathology, specimen cut-up area	1	31.5	31.5	Para 4.199	–
Store: histopathology, wet specimens	1	10.5	10.5	Para 4.212	–
Laboratory: histopathology, high risk specimen cut-up	1	10.5	10.5	Para 4.205	–
Lobby: laboratory, high risk/containment level 3	1	5.0	5.0	Para 4.205	–
Laboratory: histopathology, processing	1	31.5	31.5	Para 4.207	–
Laboratory: histopathology, general	1	94.5	94.5	Para 4.218	–
Laboratory: histopathology resin work	1	31.5	31.5	Para 4.222	–
Store: histopathology, slide and block	1	21.0	21.0	Para 4.226	–
Store and chemical preparation area: histopathology	1	21.0	21.0	Para 4.228	–
Laboratory facilities: cytopathology					
Specimen reception: cytopathology	1	42.0	42.0	Para 4.195	–
Laboratory: cytopathology, cytopathology processing	1	63.0	63.0	Para 4.229	–
Laboratory: cytopathology, liquid-based cytopathology processing	1	63.0	63.0	Para 4.253	–
Reporting room: cytopathology, 12 workstations	1	63.0	63.0	Para 4.240	–
Screening area: cytopathology, 12 workstations	1	63.0	63.0	Para 4.242	–
Store: cytopathology, slide	1	31.5	31.5	Para 4.251	–
Laboratory facilities: general microbiology tests					
Laboratory: microbiology	1	126.0	126.0	Para 4.86	–
Laboratory facilities: specialised tests					
Specialised laboratory: containment level 3	1	21.0	21.0	Para 4.167	–
Lobby: laboratory, high risk/containment level 3	1	5.0	5.0	Para 4.168	–
Specialised laboratory: immunoassay testing	1	31.5	31.5	Para 4.138	–
Specialised laboratory: chromatography testing & mass spectroscopy	1	31.5	31.5	Para 4.141, 4.145	–
Specialised laboratory: PCR sample preparation	1	10.5	10.5	Para 4.153	–
Specialised laboratory: PCR set-up	1	21.0	21.0	Para 4.153	–
Specialised laboratory: electrophoresis including PCR analysis	1	31.5	31.5	Para 4.153, 4.160	–
Specialised laboratory: flow cytometry	1	21.0	21.0	Para 4.165	–
Decontamination, wash-up and sterilizing facilities					
Central wash-up	1	21.0	21.0	Para 4.120	–
Media preparation and plate pouring/media dispensing facilities					
Media preparation laboratory	1	10.5	10.5	Para 4.123	–
Plate pouring and media dispensing laboratory	1	21.0	21.0	Para 4.124	–
Shared decontamination and media preparation facilities					
Sterilizer loading/unloading area: 2 autoclaves/sterilizers	1	21.0	21.0	Para 4.120	–
Plantroom: 2 autoclaves/sterilizers	1	17.0	17.0	Para 4.120	–

Activity space	Qty	Area m^2	Total area m^2	Para ref	Notes
Shared support facilities: whole unit					
Cold room: 4ºC	2	21.0	42.0	Para 4.104	–
Refrigerator/freezer room	4	21.0	84.0	Para 4.114	–
Common equipment room	2	21.0	42.0	Para 4.102	–
Centrifuge room	2	21.0	42.0	Para 4.112	–
Hot room: 37ºC	1	31.5	31.5	Para 4.109	–
Cryo-preservation room	1	31.5	31.5	Para 4.105	–
Darkroom	1	31.5	31.5	Para 4.110	–
Store and preparation area: chemicals	1	21.0	21.0	Para 4.59	–
Service room: equipment	1	21.0	21.0	Para 4.41	–
Store: equipment and supplies including storekeeping area	1	63.0	63.0	Para 4.47	–
Store: laboratory working stock	4	10.5	42.0	Para 4.115	–
External store: gas cylinders	1	–	–	Para 4.50	ECA
External store: bulk flammable goods	1	–	–	Para 4.51	ECA
Housekeeping room	2	7.0	14.0	Para 4.56	–
Hold: disposal	2	10.0	20.0	Para 4.54	–
Switchgear room	2	4.0	8.0	Para 8.1	–
Computer communication: IT hub room	1	9.0	9.0	–	–
Staff support facilities: whole unit					
Rest and dining room: 50 staff	1	60.0	60.0	Para 4.29	–
Beverage and snack preparation bay	1	12.0	12.0	Para 4.33	–
Refreshment: vending machine	1	3.0	3.0	Para 4.35	–
Staff changing room: 50 places	1	25.0	25.0	Para 4.23, 4.26	Male staff
Shower: ambulant (non patient)	2	2.5	5.0	Para 4.25	Male staff
WC and wash: ambulant	3	2.0	6.0	Para 4.27	Male staff
Staff changing room: 40 places	2	20.0	40.0	Para 4.23, 4.26	Female staff
Shower: ambulant (non patient)	4	2.5	10.0	Para 4.25	Female staff
WC and wash: ambulant	4	2.0	8.0	Para 4.27	Female staff
WC and handwash: accessible, wheelchair assisted	1	4.5	4.5	Para 4.27	Male and female staff
Store: protective clothing	1	4.0	4.0	Para 4.28	–
Seminar and training room: 50 persons	1	70.0	70.0	Para 4.37	–
Library and study room: 10 persons	1	30.0	30.0	Para 4.39	–
Office: 1 staff	12	10.5	126.0	Para 4.17	HBN 15 type A: administrative
Office: 1 staff	8	12.0	96.0	Para 4.17	HBN 15 Type B: includes microscope bench
Office: 6 staff	1	36.0	36.0	Para 4.15, 4.18	Administrative
Office: 2 staff	2	13.0	26.0	Para 4.18	–
Office: 3 staff	2	18.0	36.0	Para 4.18	–
Office: 6 staff	1	36.0	36.0	Para 4.18	–
Net allowance			2458.0		
5% planning allowance			123.0		
Total			2581.0		
3% engineering allowance			77.5		
25% circulation allowance			645.5		
Total allowance			**3304.0**		
Optional accommodation					
Specialised laboratory: trace metal testing	1	21.0	28.5	Para 4.148	–
Specialised laboratory: cell and tissue cultivation	1	31.5	42.5	Para 4.143	–
Electron microscopy facilities					
Laboratory: TEM sample preparation	1	10.5	14.0	Para 4.173	–
Laboratory: TEM microscope	1	21.0	28.5	Para 4.178	–

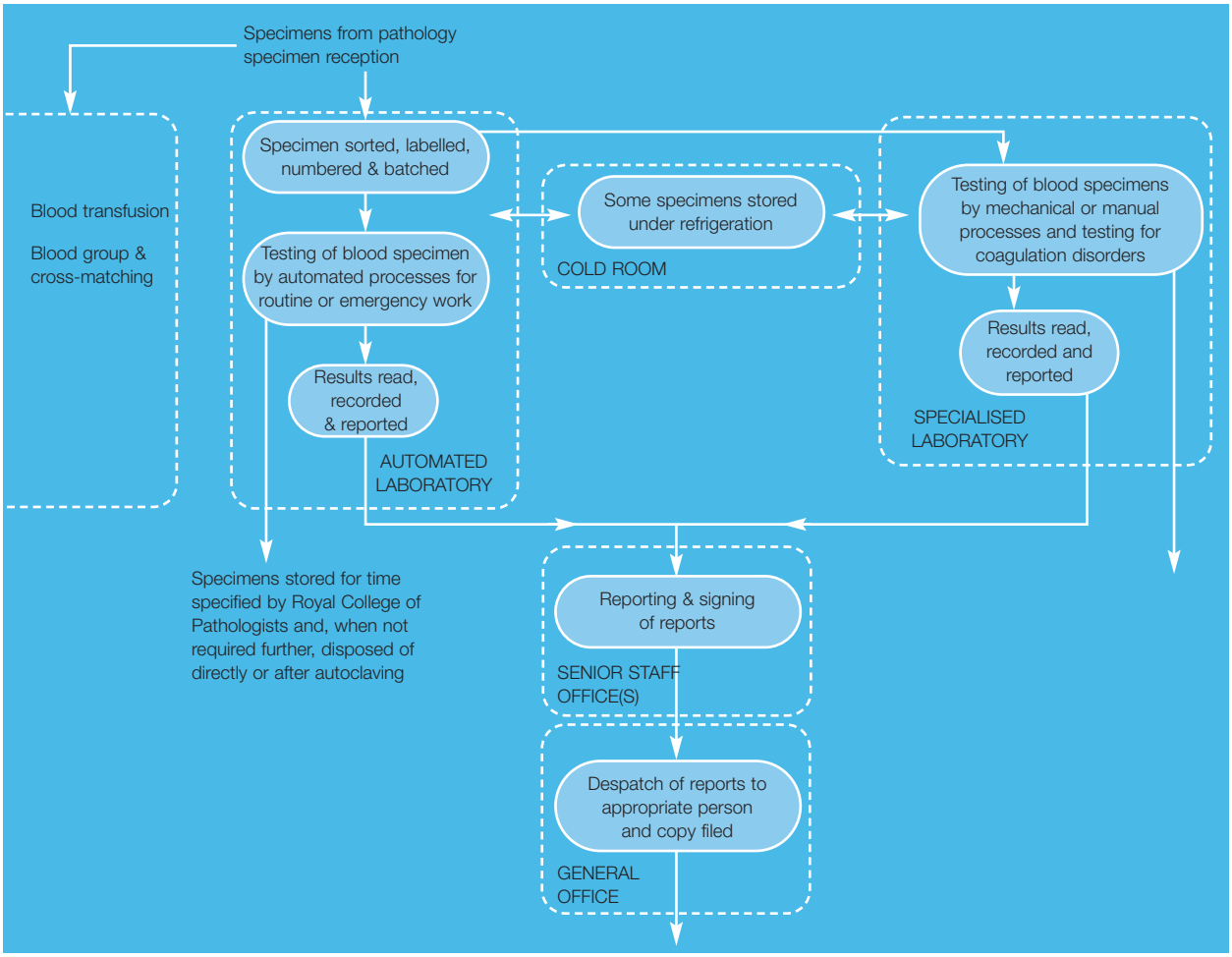
Appendix 1 – Automated haematology work

The following general haematology work is undertaken in automated laboratories:

- blood analysis – haemoglobin and platelet estimation and cell counting using automated analysers (commonly referred to as blood cell counters);
- assessment of red cell sedimentation rates using automated analysers;
- blood specimens spread on slides and stained for microscopic examination (staining will be via automated processing);
- microscopic examination of blood specimens and bone marrow preparations (non-automated).

The blood cell counter is a screening instrument that analyses blood cells and measures haemoglobin for a variety of haematological and physiological disorders. The basic methodology involves the application of reagents to separate the different types of white and red blood cell.

The method of analysis incorporating the whole blood count (WBC) measures several important parameters including blood cell structure and function. This is used to evaluate the adequacy of oxygen delivery to the tissues and to detect abnormalities in cell size and shape, which may provide clues to a variety of haematological conditions.



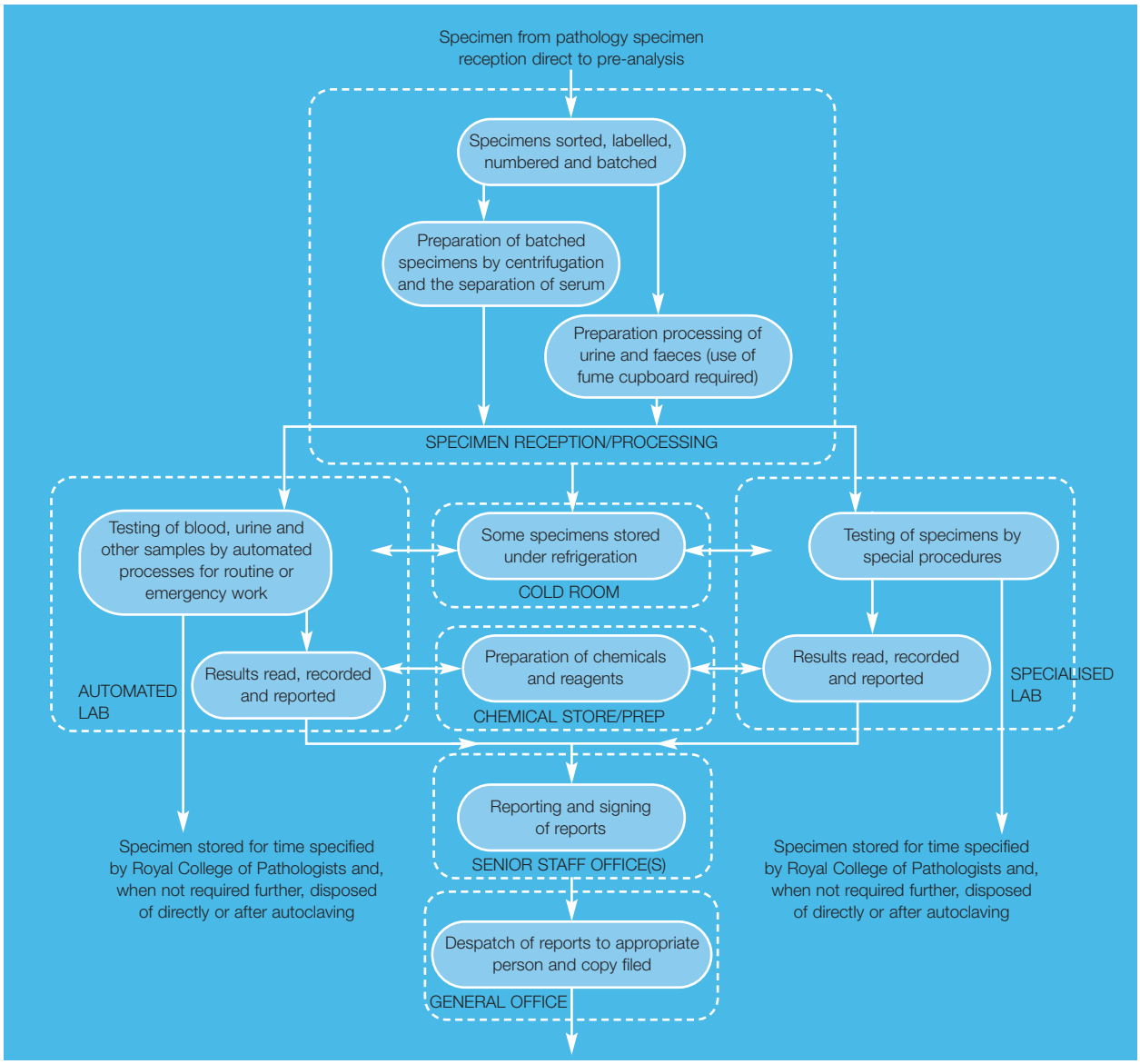
Workflow for haematology

Appendix 2 – Chemical pathology work

Chemical pathgology includes the analysis of body fluids, such as serum, blood, cerebral cerebrospinal fluid (CSF) and urine. Identification and monitoring of physiological changes and detection for the presence of unusual substances are part of the discipline's remit.

With current instruments, barcoded primary sample tubes are loaded onto analysers, and probes aspirate a minute portion of the sample and specific reagent(s) and mix within some form of reaction vessel. The reaction is then measured, often photometrically, and the results allow for diagnosis and appropriate treatment.

Applications include the diagnosis of liver, bone, thyroid and electrolyte complaints, the detection of drugs of abuse, and measurement of the success of therapeutic drugs.



Workflow for clinical biochemistry

Appendix 3 – Hospital microbiology work

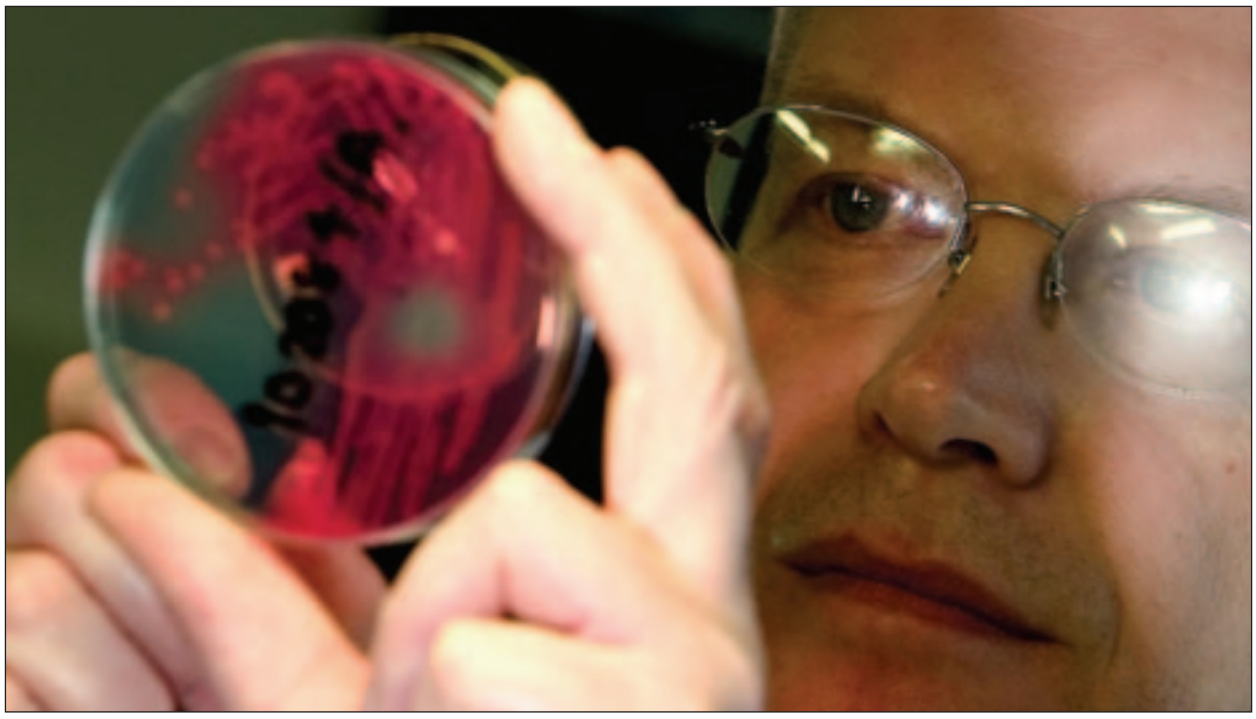
Hospital microbiology is concerned with the diagnosis of human microbial disease by the detection of micro-organisms, antigens, antibodies or DNA in clinical specimens. Microbiology encompasses bacteria, parasites, fungi and viruses as infectious agents. Direct microscopy of specimens may be used for rapid diagnosis. Molecular diagnostic tests that detect specific DNA are becoming more widely used, particularly in the detection of viruses and the bacteria that cause TB.

Bacteriology involves the examination of clinical specimens for the presence of bacteria, parasites or fungi that may be causing disease. It involves the following bench activities:

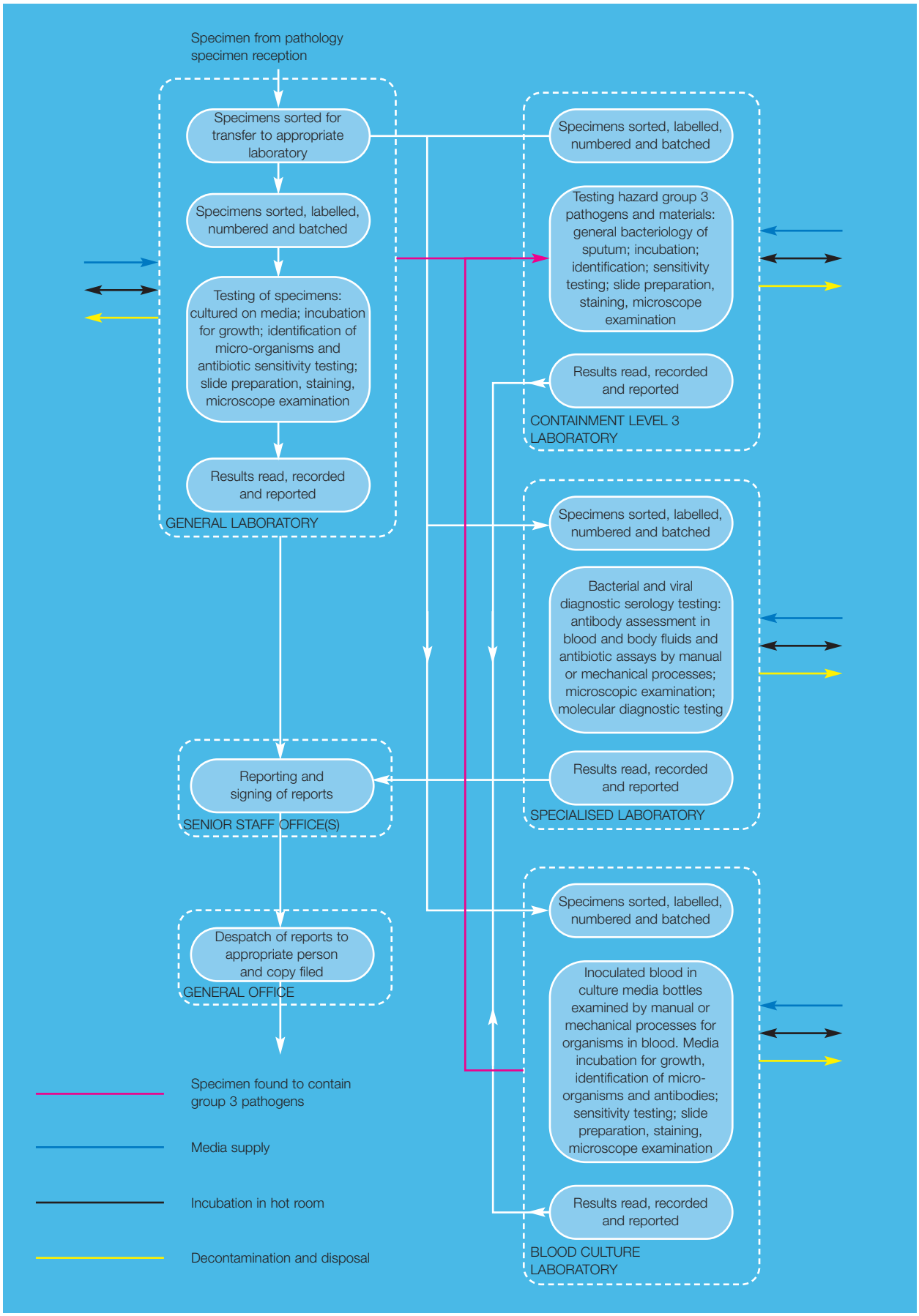
- preparation and staining of slides for microscopic examination;
- inoculation and plating out of specimens on appropriate culture media for the isolation and identification of bacteria or fungi;
- examination of cultures after overnight incubation;
- identification tests;
- antibiotic sensitivity tests;
- serum antibiotic levels.

Virology is concerned with the diagnosis of viral disease. This is usually done by serological tests that demonstrate the presence of antigens and antibodies in serum samples. These tests can confirm past exposure, active disease or convalescent status of a viral illness. Most of this work is done in batches but may be urgent, for example HIV antigen/antibody tests in a sharps injury case. Bench activities include:

- manual and automated serology tests;
- virus isolation by tissue cell culture (used less frequently nowadays);
- electron microscopy;
- molecular diagnostic tests.

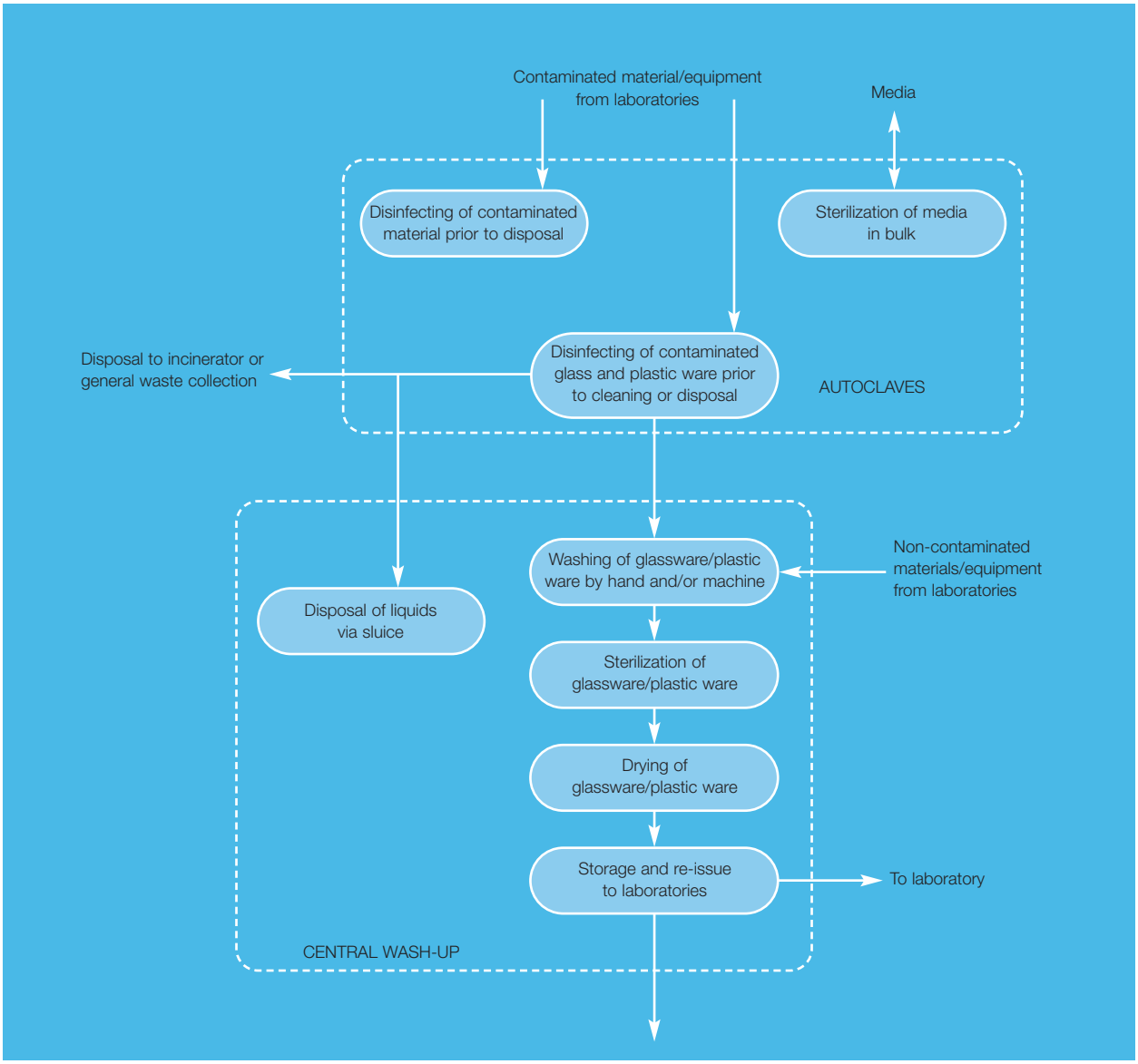


Clinical science centre, Wythenshawe Hospital (Photo: Bob Collier)



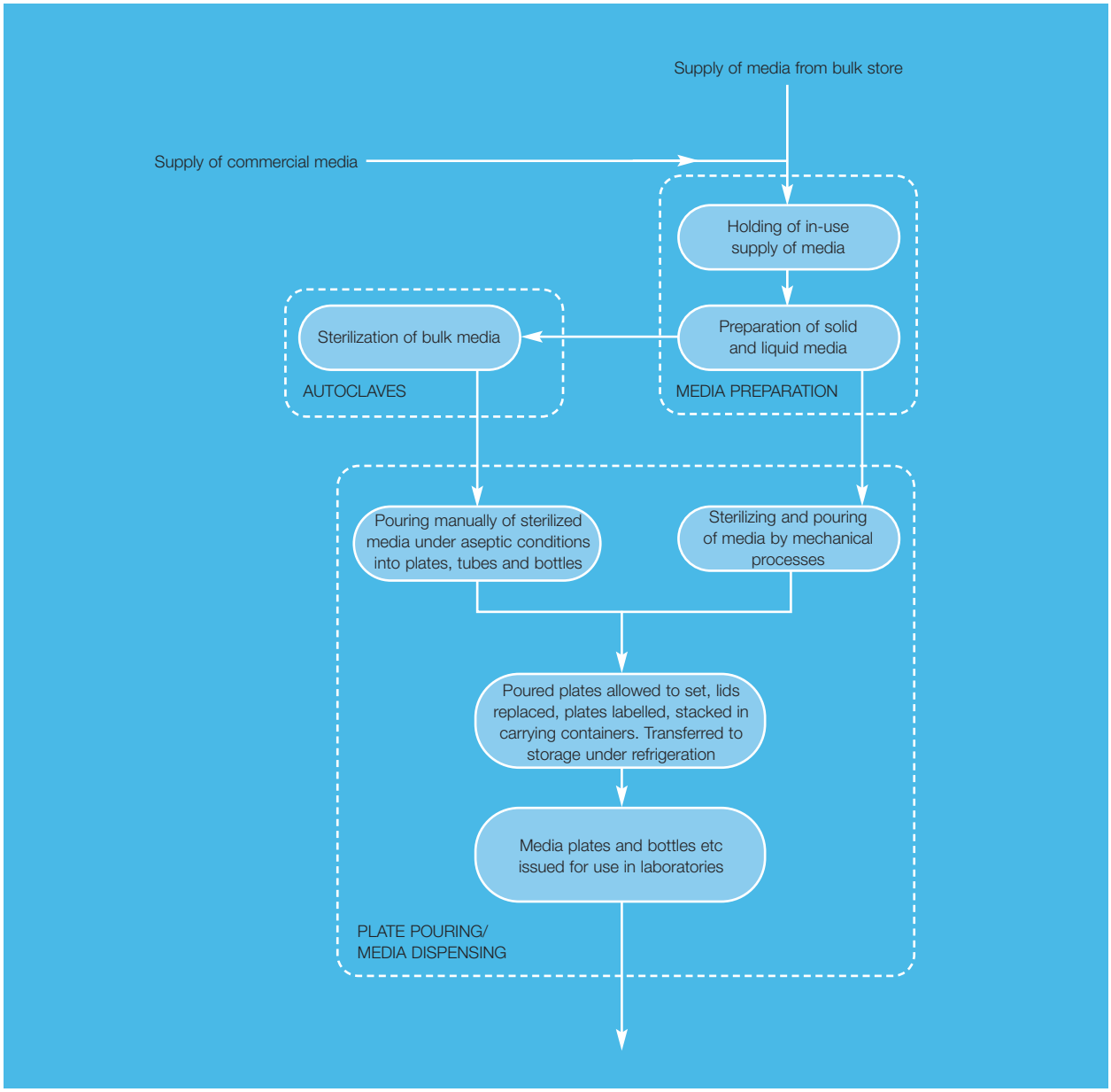
Workflow for microbiology

Appendix 4 – Workflow through central wash-up area



Workflow through central wash-up area (housing autoclaves)

Appendix 5 – Workflow through media preparation and plate pouring/ media dispensing areas



Workflow through media preparation and plate pouring/media dispensing areas

Appendix 6 – Histopathology work

Most histopathology specimens are received fresh from operating theatres, out-patient clinics and post-mortem rooms.

Formalin (a solution of formaldehyde gas in water) is used for fixing tissues.

Some samples, including small biopsies, are delivered in formalin and may require examination as frozen sections.

Large specimens will need to be dissected.

Selected portions of large specimens, or the whole of smaller specimens, are passed through automatic tissue processing machines overnight. This procedure may be associated with the emission of fumes from formalin, alcohol and other solvents.

Specimens are then commonly embedded in paraffin wax or resin blocks.

After specimen processing and embedding, sections are cut from the cooled wax or resin blocks and floated in a warm-water bath. These are then mounted on a microscope slide, de-waxed, and stained by mechanised or manual systems using routine or special techniques.

Glass coverslips are applied manually or mechanically over the sections using stryrene mountant, and slides are labelled.

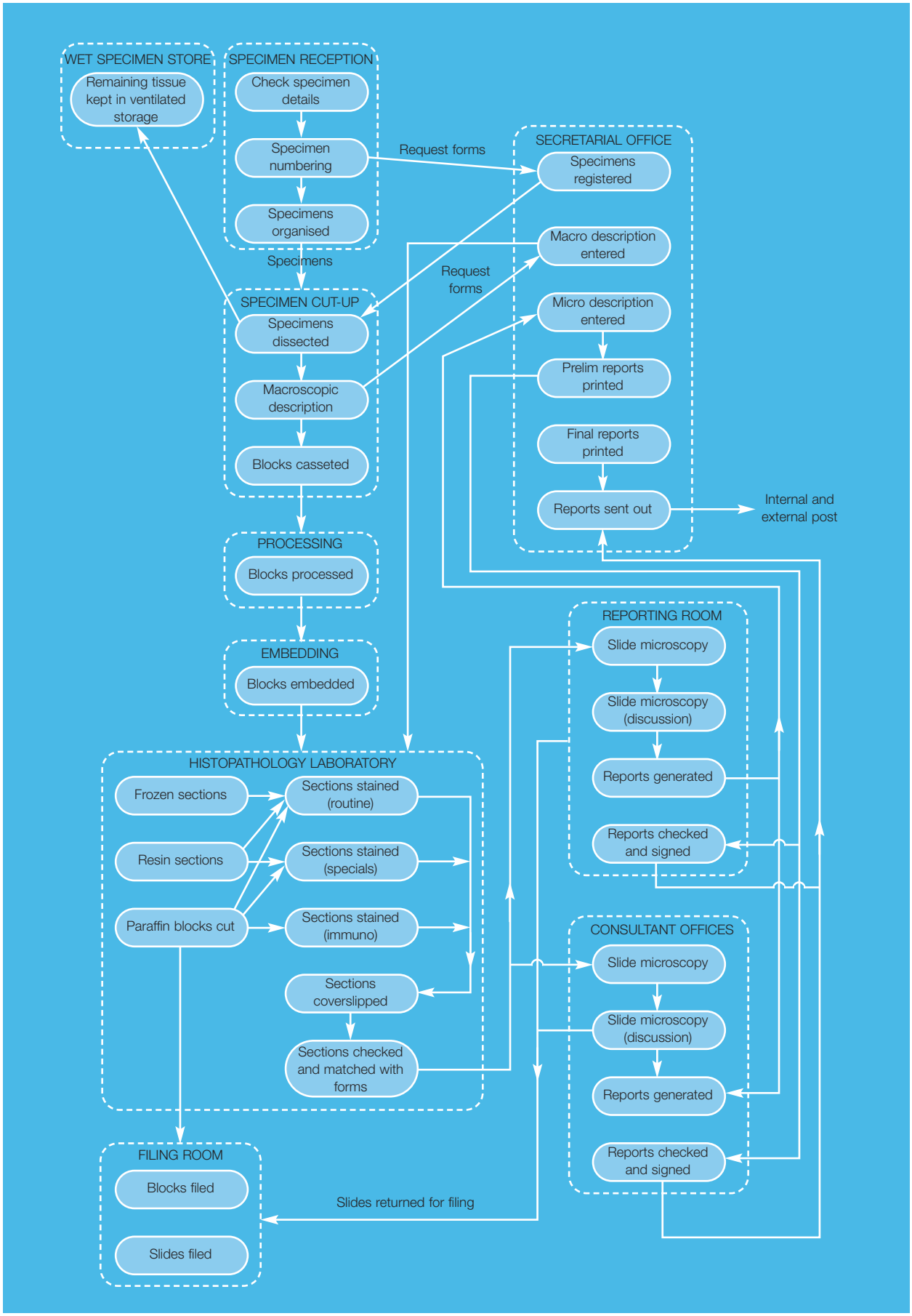
Frozen section investigations may be carried out on some specimens. This involves freezing a selected portion of the unfixed tissue and cutting sections, which are then dried or fixed and stained. Certain immunohistochemical techniques require this type of procedure.

All stained slides are placed in trays for despatch to the pathologist for microscopic examination.

Tissue remaining after the specimen has been cut up is stored until after the section has been reported.

Fresh specimens (wet tissue) are stored in formaldehyde until four weeks after the final report has been issued (see Interim Guidelines for the 'Disposal of tissue blocks and slides from biopsies and surgical resections' (*Bulletin of the Royal College of Pathologists*, **121**, January 2002)).

Histopathology blocks should be kept for 30 years, and slides should be kept for a minimum of 10 years (see 'Interim guidelines for the disposal of tissue blocks and slides from biopsies and surgical resections' (*Bulletin of the Royal College of Pathologists*, **121**, January 2002) for further details).



Histopathology workflow

Appendix 7 – Cytopathology work

Specimens will be received from the central specimen reception area.

A proportion of specimens received will be fixed on slides. Others will be suspended in fluid and will need to be spread onto slides or centrifuged before they are mounted and stained.

Stained slides are dried in a small oven or incubator and then a glass cover slip applied using a coverslipping machine.

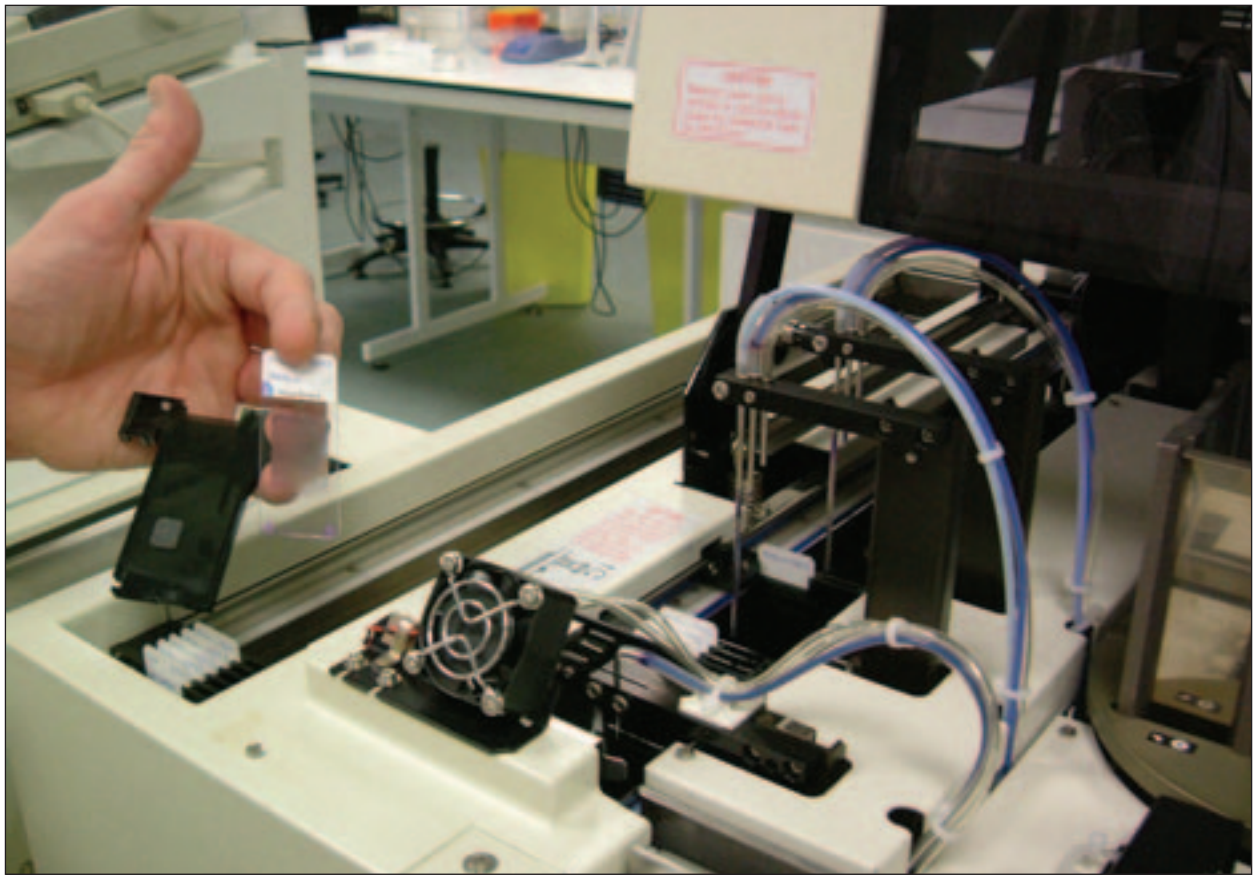
Stained slides will be viewed under a microscope by cytopathology staff and a report made. A proportion of slides should be referred to a consultant for further examination.

Liquid based cytopathology (LBC) is a method of preparing cervical samples.

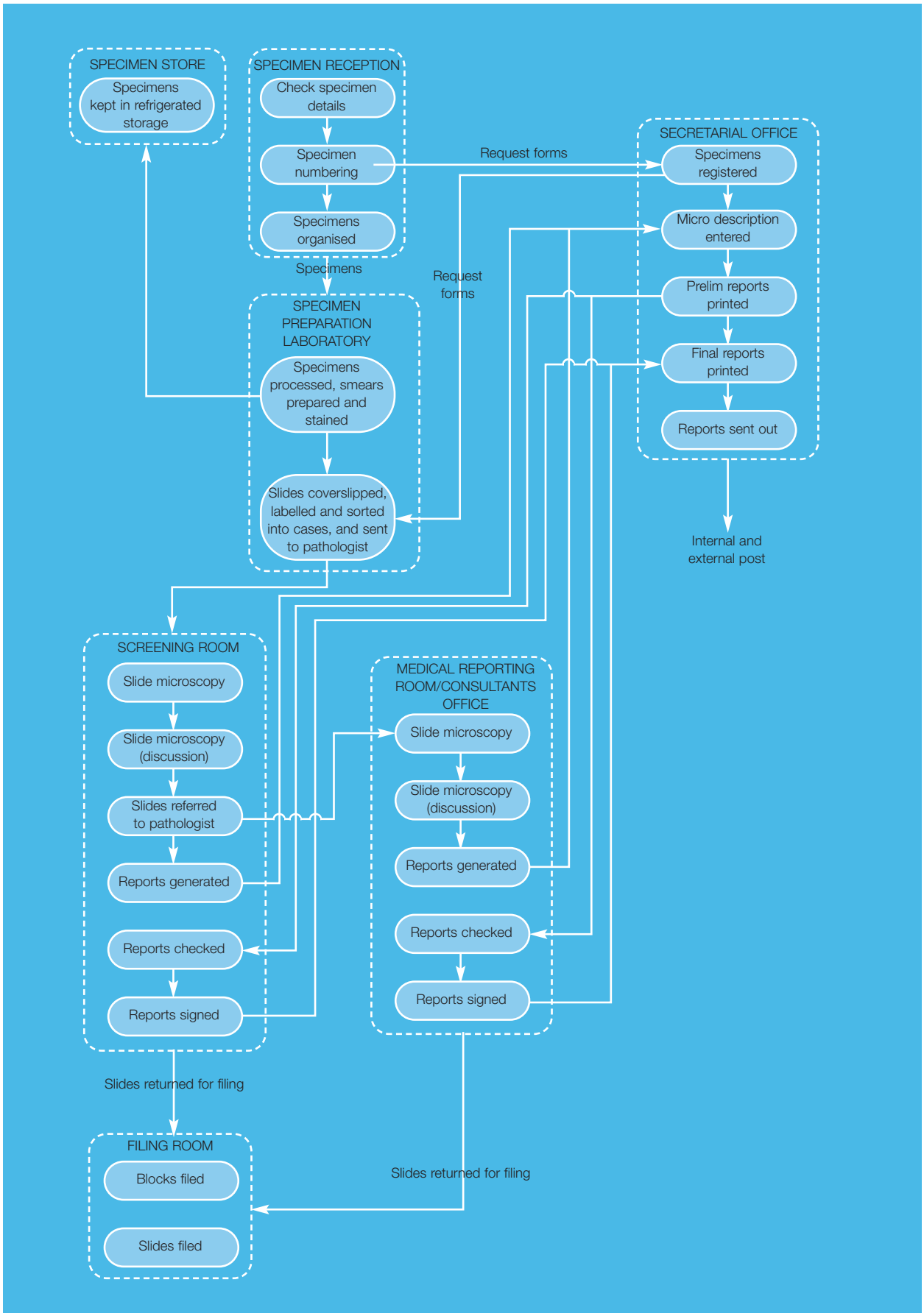
LBC samples are placed in a vial of preservative fluid (at the point at which the samples are obtained) instead of being smeared onto a slide. Samples are then sent to cytopathology processing laboratories. Here they undergo automated processing whereby they are transferred from the liquid-based medium onto glass slides for staining. Screening is carried out as for conventional smears.

All slides may have to be stored for many years.

Cervical smears should be kept for 10 years (see 'Interim guidelines for the disposal of tissue blocks and slides from biopsies and surgical resections' (*Bulletin of the Royal College of Pathologists*, **121**, January 2002) for further details).



Automated laboratories (housing haematology and chemical pathology), Manchester Royal Infirmary



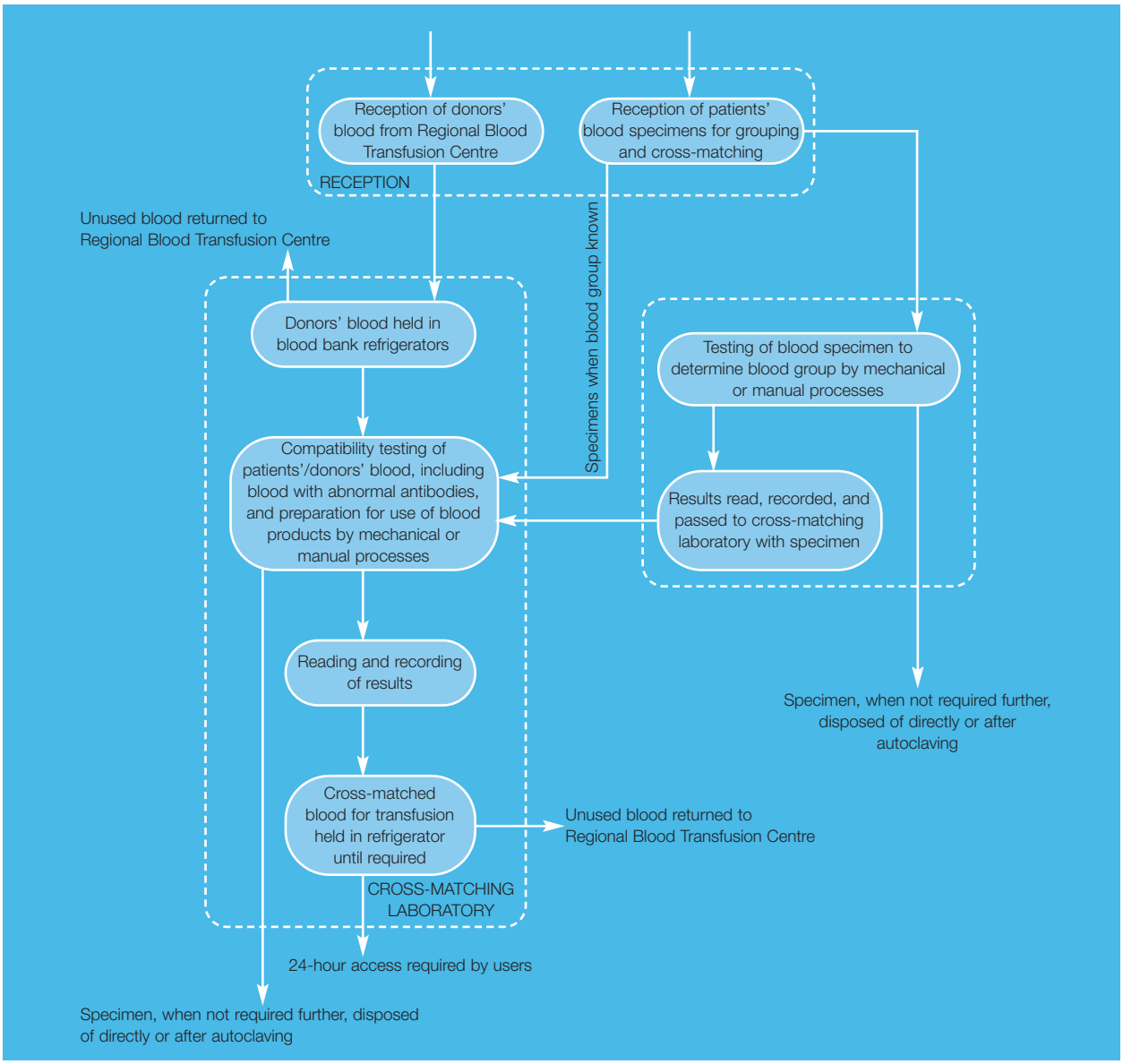
Cytopathology workflow

Appendix 8 – Blood grouping and cross-matching

Blood transfusion involves blood grouping and cross-matching.

General haematology tests include red and white cell counts, platelet estimation, sedimentation rate assessment and bone marrow studies.

Special procedures including serology, coagulation studies, electrophoresis, red cell enzyme analysis, detection of abnormal haemoglobins, and immunology.



Workflow through blood grouping and cross-matching laboratories

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** This supersedes **'Categorisation of pathogens according to hazard and categories of containment'**, 4th edition, ACDP 1995

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** This supersedes **'Categorisation of pathogens according to hazard and categories of containment'**, 4th edition, ACDP 1995

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