PREPARATION AND PRESENTATION OF ANATOMCIAL SPECIMENS AT THE UNIVERSITY OF SYDNEY

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INTRODUCTION

The Anatomy & Histology Department at the University of Sydney is housed in the Anderson Stuart Building (after Sir Thomas Anderson-Stuart, the foundation Professor of Anatomy and Physiology 1883 - 1890), which was commenced in 1884 and completed in 1889 (Photo 1).

While the building has considerable architectural beauty, it presents many difficulties for the teaching of Human Anatomy (Burkitt, Stump, 1930) which have been overcome in more recently designed buildings.

Prior to 1973, all gross anatomy was taught by a conventional lecture/dissection programme. From 1973 to 1987, dissection for medical students was replaced by a series of practicals and tutorials, utilizing prosected specimens prepared by staff.

Some limited dissection, on a voluntary basis was available to students during vacations.

Apart from lectures, the current teaching method consists of:

Med I. Semester 2 - Upper limb, lower limb and vertebral column - practicals and tutorials using prosected specimens.

Med II. Semester 1- Dissection of thorax and abdomen plus "chalk and talk" tutorials.

Med II. Semester 2.- Head and neck - practicals and tutorials using prosected specimens.

Med III. Semester 1- CNS by a combination of practicals, tutorials and dissection.

There is an intake of approximately 200 medical students per year.

The course is currently a 6 year undergraduate degree, but as of 1997, will change to a 4 year postgraduate degree.

A three year Bachelor of Medical Science course commenced in 1992 with approximately 100 students in the second year of the course and 60 in the third year, conducting study of gross anatomy.

By arrangement with Macquarie University in Sydney, anatomy is now taught to approximately 20 of their students studying for a Master of Chiropractic degree.

Gross anatomy is also taught to approximately 100 second year dental students by both tutorials and dissection.

Postgraduate courses and exams are conducted for the Royal Australasian College of Surgeons, Royal Australasian College of Dental Surgeons, Anaesthetists, Radiologists, Ophthalmologists and Orthopaedic specialists.

A collection of dissections was always maintained for examination purposes, but following the introduction of the tutorial programme in 1973, a much larger number of specimens required preparation and storage (viz. approximately 500 dissections of trunk, head and neck, limbs; 200 brain dissections; several hundred isolated viscera).

These dissections require constant repair and replacement as inquisitive student fingers and probes take their toll on delicate structures.

In the early 1980's, testing with Drager tubes indicated that formaldehyde vapour concentrations in the specimen preparation and storage areas occasionally rose above levels recommended by the National Health and Medical Research Council of Australia. At the time, the Threshold Limited Value (TLV) was 2.0 parts per million.

The TLV's now adopted by the National Occupational Heath and Safety Commission are based on recommendations by the American Confederation of Governmental Industrial Hygienists. The current TLV being 1.0 ppm, with a Short Term Exposure Level (STEL) of 2.0 ppm, which should not exceed 15 minutes duration and not occur more than 4 times per day. Members of staff likely to encounter high formaldehyde vapour concentrations were each issued with their own full-face respirator.

Around that time, changes were made to the National Occupational Health and Safety Act which require greater efforts form employer and employee alike, to provide a safe and healthy workplace.

It became necessary, therefore, to consider not only chemicals and vapours, but also lighting, seating, manual lifting procedures and "good housekeeping" principles.

The University established a Department of Risk Management who liaise with the Department of Industrial Relations (Division of Occupational Health) and other groups concerned with occupational health and safety.

In 1984, I was awarded the Centenary Fellowship for Medical Technicians (Sydney University). This enabled me to travel widely through the United Kingdom, Western Europe and South Africa (see appendix A).

Observations made on this trip were discussed with other senior members of staff who likewise, had travelled to other similar institutions in Australia and overseas.

Further discussions were held with the Department of Risk Management, engineers and other interested parties, prior to the implementation of procedures which provide a more pleasant environment for students and staff alike.

It is appropriate to discuss procedures step-by-step.

1. RECEIPT OF CADAVER

Approximately 70 bodies are received by this Department each year and are delivered by contracted undertakers.

The average age is 80 years.

A list of diseases is issued to the undertakers which renders cadavers unsuitable for donation (see appendix B).

The list is basically that of infective diseases notifiable in NSW, but also includes diseases of the central nervous system which may prove to be of viral aetiology.


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2. PRE-EMBALMING

As screening reduces the risk of infection but does not eliminate it, staff always dress in protective clothing during embalming procedures. The protective gear comprises - surgical gown, plastic apron, cap, goggles, mask, gumboots and surgical gloves (2 pairs) (Photo 2).

The body is delivered by contracted undertakers to the mortuary in a waterproof plastic "body bag" which is opened via a perimeter zipper. Clothing, hair and dentures from the body are resealed in the bag, which in turn, is place in an autoclave bag and autoclaved before disposal.

Any faeces or body fluids present at this stage are treated with NEACO "Absorb-Plus". This is a commercially manufactured powder containing Sodium dichloroisocyanurate which absorbs water and becomes a solid, while at the same time releasing bactericidal chlorine. Information on this product, provided by the Canadian Centre for Occupational Health and Safety, indicates that it can be safely used by personnel wearing protective clothing (described above). Residual amounts left on the embalming table can be safely flushed down the drain.

The body is liberally sprayed with a surface disinfectant comprising 70% alcohol, 5% Dettol, 25% water.

All orifices are plugged with cotton wool.

Appropriate documentation takes place as required by the Anatomy Act and Inspector of Anatomy.

Bodies fitted with pacemakers require special consideration, as the Crematorium will not accept these.

At the time of dissection, the pacemakers are removed and disposed of with biological waste.

3. EMBALMING

Two methods are routinely used: either gravity feed into a femoral artery or via peristaltic pump into a radial artery. The radial artery is preferred because only a small incision is required to locate and cannulate the vessel and it seldom presents with arteriosclerosis. Common carotid arteries are seldom used. There is no exsanguination. Occasionally, latex is injected into the blood vessels of cadavers designated for special vascular prosections.

The composition of the EMBALMING FLUID has been under continuous review for many years. The traditional formulae contained varying percentages of formalin, phenol, Methylated spirit, glycerine and water.

In attempts to improve the texture of the embalmed tissues, fungicidal/bactericidal characteristics and general aroma, all the constituents of the embalming fluid have come under consideration.

When changes were made to the formula, a random sample of bodies were embalmed, stored for 12 months and then dissected. Only after demonstrable improvement could be repeated in a variety of cadavers, would any alteration be made to the formula.


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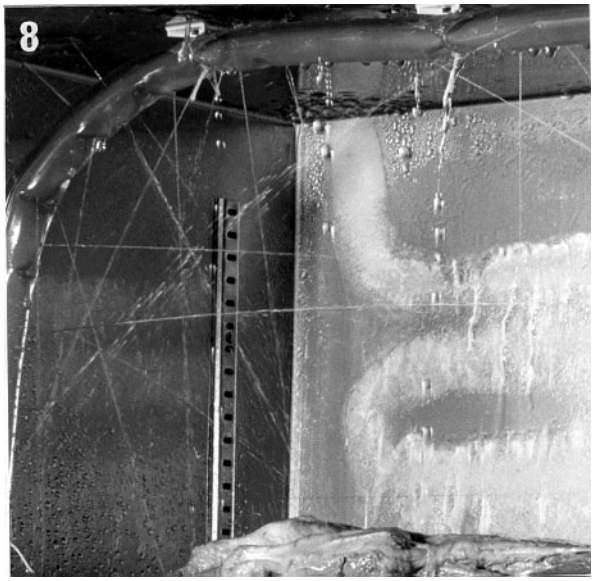
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Two formulae are currently in use:

(A)

55%	Methylated spirit
1.8%	Pine Oil
2%	"PHYLATOL" di (2-hydroxyethoxy) methane
4%	Formaldehyde
20%	propylene glycol
4%	phenol
13%	Water
0.2%	sodium lauryl sulphate

(B)

81%	Water
16%	Formaldehyde
1%	Potassium nitrate
2%	Potassium acetate

For several years, we used another formula based on preservatives manufactured in Germany. This comprised:

55%	Methylated spirit
5%	"FUGATEN"
5%	"LYSOFORMIN"
0.5%	"PHYLATOL"
20%	Water
4%	Formaldehyde
10%	glycerine
0.5%	Pine Oil

Notes

i) The inclusion of the "FUGATEN" and "LYSOFORMIN" demonstrably (with Drager tubes) reduced formaldehyde vapours in the dissecting room. However, over the past few years, these chemicals became prohibitively expensive to import into Australia and this formula has been discontinued. Recently, the ventilation was upgraded in the dissecting room with 100% cooled fresh air intake at ceiling height and floor level exhaust. This has resulted in an atmosphere containing less than 1ppm of formaldehyde vapour.

ii) The high summer temperatures and humidity in Sydney are very conducive to mould growth, particularly penicillium simplicissimum and penicillium waksmanii. The combination of pine oil, phenol and particularly "PHYLATOL" in formula (A) has almost completely eradicated this problem. Vigilance is only required for areas of poor fixation, such as gangrenous extremities. Phenol is not used in tank storage solutions. Formula (A) is routinely used for preserving cadavers destined for the dissecting room or prosected specimens.

iii) Formula (B) is a modified Kaiserling solution and is used to embalm cadavers destined for cross- section and plastination. In both of these applications, the initial high formaldehyde concentration is removed from the finished product. The absence of alcohol makes it easier to freeze the specimen prior to sectioning.

iv) With both formulae, at least 20 litres of embalming fluid are introduced into each body.


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v) Fingers and toes are routinely injected by pressure at the completion of the embalming process, as well as any other areas that received insufficient embalming fluid. A locking mechanism prevents the hypodermic needle from being dislodged off the pump under pressure.

vi) Instruments are washed free of any coagulum in cold running water prior to sterilisation.

4. POST EMBALMING

The injected blood vessel is ligated and the incision sutured.

The body is washed down with tap water then sprayed with surface disinfectant (70% alcohol, 5% Dettol, 25% water) and placed in a cold room at 4-6^{0}C for 12 months prior to use.

The embalming table, embalmer's apron and boots are washed down with surface disinfectant. Wall tiles and floor are washed down with Sodium hypochlorite (AIDS National Task Force, Australia, 1985). Dettol is poured into all drains.

Surgical gowns are placed in an alginate plastic bag separate to the Departmental laundry. Laundry personnel have a protocol for dealing with linen contaminated with potentially infectious biological waste.

Notes

i) Staff who undertake embalming and dissection are given Hepatitis B vaccination and BCG immunisation (if Mantoux negative).

ii) Any staff or students injured in the Department are referred to the University Health Service for tetanus injections (if required) and the accident logged on accident report forms.

5. GROSS DISMEMBERMENT FOR PROSECTIONS

This work is carried out in a well-lit and well-ventilated room using a large band saw. Staff wear protective waterproof clothing, cap, mask, goggles, boots and gloves. (Photo 3). All sectioned parts are identified with embossing tape labels. It is considered necessary to remove faeces and other alimentary tract contents when exposed by sectioning. It is also considered necessary to immerse specimens displaying inadequately fixed cut surfaces or exposed cavities in embalming-strength fixative as a precaution against potentially viable microorganisms. The specimens are stored in fixative several months prior to dissection.

The University acknowledges the onerous and unpleasant nature of this work and pay a special loading to the staff concerned.

6. MORTUARY

After many years of representations from our Department to the University administration, the mortuary precinct was refurbished in 1993 at a cost of Aust$535,000. The whole area was gutted and completely rebuilt. Mortuary staff had significant input into the refurbishment design and are pleased with the finished result.

The mortuary was last renovated in 1955 and obviously occupational health and safety guidelines have changed in the intervening period.

Following my overseas trip in 1984, I was able to incorporate some meritorious features seen overseas into the new design. In particular, a bio-spray system has been

built into the coolrooms based on similar systems in use at Heidelberg and Dusseldorf.
The mortuary refurbishment was quite a saga and deserves an article in its own right. I will write an article about this for another edition of the IAS Journal.

7. PROSECTION

For routine undergraduate teaching, sixteen different types of regional prosection are prepared using the prosection index in "A New Approach to Teaching and Learning Anatomy" (Blunt, 1976) textbook as a guide.

Seven different types of brain and spinal cord prosection, as well as numerous isolated thoracic and abdominal viscera are also prepared.

The dissection is carried out at a large stainless steel bench which exhausts vapours down and away from the breathing zone of the preparators (Photo 4) who are seated on multi-postural chairs.

8. SPECIMEN STORAGE

(a) Specimens required for immediate use are placed in refrigerated prosection storage cabinets (Photo 5).

The Department has 10 cabinets - one in each of eight tutorial rooms and two in the Dissecting Room. These cabinets were made in Sydney, but incorporate design features similar to units in other institutions. John Davies from Manchester and Roland Klomfass from the Witwatersrand University in Johannesburg were particularly helpful in the early design stages. Mr Alan Williams, since retired, of Sydney University draughted the final design.

The lockable cabinets are of all stainless steel construction and refrigerated to 8-100C. The shelving is adjustable vertically and the lower shelves slide backwards and forwards for easy access to heavy trunk specimens (Photo 6). **NB** Trunk specimens have ropes and handles attached to facilitate lifting by two people if necessary.

Some experimentation was necessary to develop a durable system for keeping specimens moist. In the early stages, ultrasonic nebulisors were used but found not to be sufficiently robust. Currently we are using submersible pumps installed in preservative fluid in the bases of the cabinets. The pumps are controlled by computerised time clocks to spray specimens intermittently via soaker hoses installed on the walls and roofs of the cabinets (Photos 7 & 8).

The preservative fluid used in the cabinets comprises:

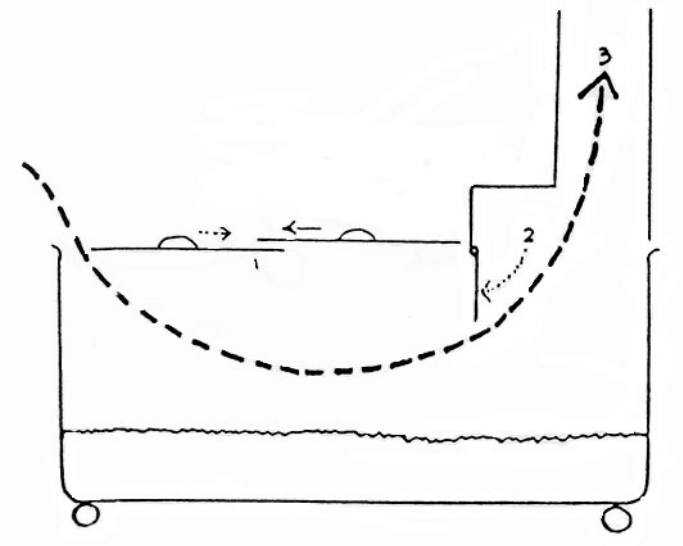
1%	"PHYLATOL"
1%	2-Phenoxyethanol
30%	Methylated spirit
65%	water

NOTES:

i) The only formalin is the residual amount in the tissues of the specimen from the original fixation.

ii) The 2-phenoxyethanol is a post-fixation preservative which helps diminish formaldehyde vaporisation from the specimens.

iii) These cabinets have been in use for 7 years and the specimens remain in excellent condition.
(iv) Those specimens not required for immediate use (or waiting dissection) are stored in large polythene tanks on mobile chassis. The tanks are located in storage rooms and have purpose-built ventilation (Photo 9).



1. Lids slide together creating gaps fore and aft.
2. Hinged flap drops down.
3. Fresh air is sucked in at the front of the tank and exhausted at roof level from the rear. In this way formaldehyde vapours are removed from the tank prior to staff gaining access to specimens.

The tank solution comprises:

30%	Methylated spirit
0.5%	Pine oil
65%	water
4%	Formaldehyde
0.5%	"PHYLATOL"

9. DISSECTING ROOM

The Dissecting Room is old but large with a very high ceiling. Unfortunately it has a west facing aspect which is exposed to considerable heat on hot, summer afternoons. However, in 1987, considerable money was spent to install a system of 100% fresh air input conditioned to 20^0C with down draught ventilation.

32 cadavers are placed in the room each year for dissection by medical, dental and science students.

The cadavers are placed in plastic body bags with perimeter zipper. There is no terry towelling or shrouds. During dissection periods, students are requested to moisten the cadavers with hand sprays. The preservative fluid for the sprays comprises:

1% "PHYLATOL"

1% 2-phenoxyethanol

98% water

The normal dissection room rules apply with regard to decorous behaviour, no visitors etc. Also, the students are instructed as follows:

- To wear a surgical gown with long sleeves and waterproof front panel. These are preferable to white coats and are available at reasonable cost from the Sydney University Medical Society.

- To take the gowns home in a plastic bag and soak it in a bucket of germicidal bleach prior to washing separately from other clothing.

- To wear dust mask, goggles and surgical cap when using necropsy saws.

- To wear disposable vinyl or latex gloves.

NB All gloves are autoclaved before disposal.

- As medical students largely do "blunt" dissection of the thorax and abdomen, they are requested to purchase blunt-nosed scissors, forceps and probes only. Scalpels are issued and retrieved by supervisory staff as necessary.

10. OTHER TEACHING RESOURCES

WILSON MUSEUM OF ANATOMY

The museum is named after J T Wilson, the Challis Professor of Anatomy 1890-1920, who later took up the Chair of Anatomy at Cambridge. Approximately 750 preparations are mounted in acrylic containers with Wentworth Solution as the preservative. To enhance colour, sodium dithionite has been added to specimens prepared since 1964.

One of the great features of this museum is the comprehensive cataloguing of specimens. Students are able to purchase catalogues containing descriptive text and photographs which are in the format of a self-quiz.

PLASTINATION

After spending some time with Gunther Von Hagens at Heidelberg University in 1982, Mr Ken Parsons, Professional Officer, introduced the technique of plastination into this Department.

To date, over 300 specimens have been prepared and are in use in the classrooms. Specimens range from small isolated viscera to dissections of the central nervous system, head and neck, upper and lower extremity, thorax, anterior and posterior abdominal walls (Photo 10). Apart from their intrinsic anatomical value, plastinated specimens have greater longevity than normal wet specimens, are practically odourless and require no preservatives.

SECTIONAL ANATOMY

The collection of sectional anatomy specimens, related scans and photos was originally prepared for Trainee Radiologists (McGrath, Mills, 1981), but has now been incorporated into the undergraduate teaching programme.

Cadavers are sectioned in clinically significant planes and the sections encased in vacuum-sealed plastic bags. The sections thus permit tactile observation but are odourless and dry.

11. ACKNOWLEDGEMENTS

I particularly wish to thank Mr Ken Parsons, Professional Officer for his guidance and advice over many years and Mrs Anne MacIntosh who made the bequest which established the Centenary Fellowship for Medical Technicians (Sydney University), thus enabling my overseas study tour.

I am deeply indebted to all the people at the institutions visited who gave unselfishly of their technical expertise and hospitality. In particular, Mr Bari Logan (then Prosector, Royal College of Surgeons, London), Mr John Davies of Manchester University and Mr Roland Komfass (now retired) of Witwatersrand University, Johannesburg.

Thanks are also due to Mr Clive Jeffrey for his excellent photography and Mrs Deirdre Keane for typing the manuscript.

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APPENDIX A

Institutions visited in 1984 under the auspices of The Centenary Fellowship of Medical Technicians (S.U.)

Department of Anatomy, Royal College of Surgeons, London, United Kingdom

Department of Anatomy, Guy's Hospital Medical School, London, United Kingdom

The Burrough's-Wellcome Museum, London, United Kingdom

The British Museum (Natural History), London, United Kingdom

Department of Anatomy and Cell Biology, St Mary's Hospital Medical School, London, United Kingdom

Department of Anatomy, St Thomas' Hospital Medical School, London, United Kingdom

Department of Anatomy and Histology, London Hospital Medical College, London, United Kingdom

Department of Anatomy and Embryology, University College London, London, United Kingdom

Department of Human Anatomy, University of Leicester, Leicester, United Kingdom

Department of Anatomy, University of Manchester, Manchester, United Kingdom

School of Anatomy, University of Edinburgh, Scotland

Laboratorium Voor Anatomieen en Embryologie, Rijksuniversiteit, Utrecht, Netherlands

Laboratorium Voor Anatomie, Rijksuniversiteit, Amsterdam, Netherlands

Anatomisches Institut der Universitat Dusseldorf, Dusseldorf, West Germany

Anatomisches Institut der Heidelberg, Heidelberg, West Germany

Faculte de medecine de Cochin, Port-Royal, Universite Rene Descartes, Paris, France

School of Anatomy, University of Witwatersrand, Johannesburgh, South Africa

APPENDIX B

UNIVERSITY OF SYDNEY

Department of Anatomy

List of Diseases Unacceptable for Cadaver Donation

Aids
Alzheimer's Disease
Amyotrophic lateral sclerosis
Ankylostomiasis
Anthrax
Arbovirus infections
Brucellosis
Campylobacter infections
Cholera
Creutzfeldt-Jakob Disease
Congenital Rubella Syndrome
*Dementia
Diphtheria
Ebola Virus Disease
Encephalitis
Food poisoning
Giardiasis
Hepatitis - Unspecified
Hepatitis - Viral Type A
Hepatitis - Viral Type B
Hydatid
Infantile Diarrhoea (diarrhoea of more than 48 hours duration in an infant under 2 years of age)
Lassa Fever
Legionnaire's Disease
Leprosy
Leptospirosis
Malaria
Marburg Disease
Measles
Meningococcal infections
Multiple sclerosis
Ornithosis
Pertussus (whooping cough)
Plague
Poliomyelitis
Q Fever
Rabies
Salmonella infections
higella infections
Tetanus
Trachoma
Tuberculosis (all forms)
Typhoid and Paratyphoid Fever
Typhus (all forms)
Vibrio Parahaemolyticus infections
Yellow Fever
Yersinia infection

*All forms of Dementia except Senile Dementia over the age of 70 years