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Physical to Biological Building
Blocks in Hand & Microsurgery

Physical to Biological Building
Blocks in Hand & Microsurgery

The Facts, The Face,
The Facility, The Field…
and The Future

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Contents

Abstract 1

Introduction 5

The Facts (And Figures) 8

The Face – the making of… 10

The Facilities – The Components of a Hand Unit 20

The Field of Hand and Microsurgery 25

The Future – Is Promising! 45

Conclusion 46

References 47

Biography 51

Acknowledgements 55

List of Inaugural Lectures 57

Index 71
ABSTRACT

The Hand is a truly remarkable instrument - an organ of perception (feel, touch and much more), performance (power grip and fine motor functions), perspiration (sweating assists us in handling items and reducing body temperature), presentation and even communication. Second to the face the most commonly presented part of the body is the hand, thus its appearance of normalcy is crucial. Many a time when we are unable to verbalise our thoughts, we convey our messages, knowingly or otherwise, through non-verbal hand gestures as well as body language. Meanwhile, in dance forms and miming the hands are essential aspects of communication. Similarly sign language is basically that – an entire language communicated via the hands! Anatomically, due to the high density of nerve fibres at the fingertip, digits also aid in stereognosis which enables the blind to “see” and the deaf to “hear” (Alpenfels EJ 1955). The fact that the hand is structurally positioned at the extreme end of the upper limb, to enable it to reach out approximately one metre away from the body, however, makes it extremely susceptible to injury.

Injury to the hand and wrist is devastating. All it takes is to imagine a day in one’s life without the right or even left hand. It becomes evident that a major portion of our lives and activities of daily living are dependent on us being able to have complete hand (and upper limb) function. In order for us to get through the day, there are numerous bimanual activities we perform without a thought. Even a minor papercut precludes us from continuing with these normally. Thus, hand injuries from the fingertip to the shoulder are functionally and emotionally distressing and need to be addressed immediately. Most importantly the injury or pathology needs to be treated right the first time.
Physical to Biological Building Blocks in Hand and Microsurgery

The Hand and Microsurgery field is a sub-specialty dealing with the treatment of conditions pertaining to the entire upper limb from fingertip to shoulder (Wikipedia). This includes both surgical and non-surgical management of congenital and paediatric conditions, trauma, infection, inflammation, haematological aspects, tumours, compression neuropathies, brachial plexus, the spastic hand, degenerative conditions and miscellaneous conditions such as Dupuytren’s and lymphatic anomalies.

This relatively new sub-specialty of surgery developed rapidly in the 20th Century. The works of various researchers, clinicians and surgeons in this area brought about a conglomeration of discoveries which in themselves were remarkable but integrated together provided immense opportunities and ginormous developments. The most significant contribution of Sterling Bunnell, the Father of Hand Surgery, I feel, came in the form of a deep understanding of the intricate anatomy of the hand and its connection to function. He pioneered meticulous techniques, characterised by careful, detailed dissection with an eye on precision, leading to outstanding results, which he practically demonstrated by sharing his surgical techniques around the country (Green SA 2013). Developments in the 1960s, both mechanical and technical, allowed small diameter vessels (of 1 mm or less) to be repaired, opening up a plethora of possibilities and enabling various fields to collaborate for the betterment of the inflicted patient. Thus candidates from the fields of Orthopaedics, Plastic and General Surgery all enter this highly specialised field with the same philosophy: to repair, reconstruct and even replace. Great emphasis is placed on regaining function by therapy both prior to and after surgical or even non-surgical treatment.

In the 70s and 80ss, as the field took off, anatomical discoveries of new flaps and arterial patterns and microsurgical refinement of the surgical application of these findings kept the momentum
Sharifah Roohi Syed Waseem Ahmad

going and the excitement building. The birth of Reconstructive
(Micro and even Supermicro – 0.3mm to 0.8mm diameter vessels)
Surgery brought about new developments with the advances in
transplantation medicine allowing amazing technical feats and
repair of the human body.

Another exciting area is that of biomedicine where the implant
sizes are getting smaller, from mini to micro, and moving from
surgical steel to Titanium and finally, bioabsorbable materials.
Incisions are also reducing in size, assisted by arthroscopic
equipment and innovative techniques. All are changing the way
surgery is performed and raising the expectation bar higher.

Currently however, we are moving slowly but surely to replacement
not by physical means but by biological means, mainly rebuilding
and regenerating lost tissue by chemical and biological options.

Developing countries have both embraced this field as well
found difficulties in implementing the finer aspects. Despite the
costs being high and the learning curve steep, this has not deterred
them. I feel that the excitement of discovering novel ways to tackle
previously “impossible” cases has allowed this field of surgery to
blossom.

I shall discuss the origins of this subject and how it made an entry
into our country (The Facts), both clinically as well as academically,
the progress at present in terms of manpower development and
what it takes to become a Hand Surgeon (The Face). This will
be followed by the development of the infrastructure required to
support it (The Facilities). The main essence will be examples of
cases that have been seen and what needs to be addressed (The
Field) as well as what I see for The Future in terms of prospects
for upcoming surgeons and of course, the patients.
INTRODUCTION

The Life of a Hand and Microsurgeon is an exciting one. Although the initial training is rigorous, to say the least, the field is wide and varied with never a dull moment. This young surgical specialty, being an amalgamation of general, plastic and orthopaedic surgery, had its origins in the 20th Century, during the First World War. Understanding its beginnings will help in understanding the efforts required in not only the making of a hand surgeon but also his surroundings.

The Historical Development of Hand and Microsurgery

Although vascular ligatures were first seen in the 1500s, the turn of the 20th Century (1900) is when Carrel and Guthrie are credited with performing transplantations of composite tissues and organs in experimental animals (Sade RM 2005). Together with the development of Heparin by McLean and Howell in 1916 (Wardrop D & Keeling D 2008), which enhanced the success rate of vascular repair, and the monocular microscope by Carl-Olof Siggesson Nylén (1921) and a binocular one by Holmgren (1922) followed by the microsurgical instruments plus sutures – the picture for microvascular repair comes together. The clinical applications thus exploded into neurosurgery, maxillofacial, hand and plastic surgery including numerous options for transplantations of tissues and organs (Tamai S 2009).

In 1908, a young surgeon in making, Sterling Bunnell, graduated from the San Francisco School of Medicine and became interested in tendon surgery. Sterling Bunnell submitted an article (Repair of tendons in the fingers) to the prestigious Surgery, Gynaecology & Obstetrics, which was revised 18 times and finally published in
1918. While serving in France during the “The Great War” as the Chief of Surgical Services, he was determined to find a solution to the high upper limb amputation rate. He went back to his clinic “The San Francisco Shoulder, Elbow & Hand Clinic” and worked tirelessly and exclusively on the upper limb. Between the two World Wars, Bunnell was prolific as a surgeon and as a writer, publishing ingenious solutions to challenges in hand surgery, developing innovative techniques and giving birth to a new species “The Hand Surgeon: Homo Chirurgimanus” (Green SA 2013). When WWII broke out, he was enlisted by General Kirk (the Army Surgeon General) to establish hand surgery and rehabilitation centres, so Bunnell decided to shut down his clinic. He undertook his task seriously and travelled across the USA personally imparting his techniques and ideas while at the same time, establishing nine Army hand centres (Green SA 2013). His trademark ideas of the structure of a hand unit or centre, the specific surgical methods, the training and staffing, all form the basis of our present day training and unit structure! That was the strength of the individualised training in creating the Homo Chirurgimanus, leaving a legacy of second generation hand surgeons in Boyes, Littler, Fowler, Phalen, Barsky and Platt. This is another tradition that holds strong till the present and which accounts for the high standards maintained in this special field.

**Reconstructive Microsurgery**

The advent of the operating microscope and the finer sutures that were swaged to the needle along with appropriate microsurgical instruments were the breakthroughs that led to the flood of ideas and innovative reconstructive techniques. Drs. Harold Kleinert and Morton Kasdan were the first to perform a successful anastomosis
in a digital (partial) amputation in 1963, followed by Harry Buncke in 1964 who reattached a rabbit’s ear. The commonality of vessel (of less than 1mm in diameter) repair allowed tissue transplantation and free flaps to blossom, including fibular transfers for maxillo-facial malignancies.

**Supermicrosurgery**

Once the microsurgical techniques were mastered and fluent, technological advances allowed even smaller diameter vessels (0.3mm to 0.8mm) to be joined safely without any adverse events (Badash et al 2018). Once used to salvage failing fingertip replantations, the techniques are now applied to lymphovenous and perforator anastomoses. Taylor and Palmer mapped out the perforator flaps for the whole body (1987) while Koshima et al. described the use of such perforator flaps (1989). Obviously a higher skill set level is required is such endeavours, as provided by extensive practice and training (Badash et al 2018).

**Setting up Centres**

The way to propagate Hand & Microsurgery is by setting up training centres run by dedicated and well-trained surgeons across the country, similar to the mould created by Bunnell over 75 years ago. Surgical expertise is acquired by apprenticeship and there are no shortcuts. If shortcuts are taken, disastrous outcomes will result for the public at large which will be difficult to contain. Deficits in the centres, in terms of qualified staff, inferior equipment or shoddy care, would translate into sub-standard results, and mistakes in Hand & microsurgery are unforgiving.
THE FACTS (AND FIGURES)

Malaysian Setting

Hand Surgery in Malaysia had its beginnings in the 1960s, in the form of treatments provided for patients with Leprosy. They were isolated from mainstream society in a leprosarium set up in a small town called Sungai Buloh, 15 minutes from the capital, which is now a part of greater Kuala Lumpur. Dr. K Thambyrajah (who had performed two fellowships with Mr. Guy Pulvertaft) and Dr. Daksinamoorthy worked together to treat mainly ulnar nerve palsies and perform Brand’s tailed tendon transfer using Palmaris Longus (T Sara Ahmad 2011). Luckily for them only 10% of the population or less do not have this tendon (SA Roohi 2007).

University Malaya, under the headship of Professor P. Balasubramanian, started a microsurgical practice laboratory and the first wrist replantation was performed in 1983. Dato’ Dr. Abdul Hamid Abdul Kadir was the next to go on a fellowship to the UK (under Mr Campbell Semple) and subsequently, he moved to Universiti Kebangsaan Malaysia (UKM) where he too established a microsurgical laboratory and organised the first International Hand Course under the Malaysian Orthopaedic Association’s (MOA) banner in 1983. Meanwhile, Prof. Dato’ Dr. Tunku Sara Ahmad who went to Singapore and completed a two year fellowship in Hand Surgery, under the tutelage of Professor Robert Pho, returned to continue in University Malaya in 1988. The Malaysian Society for Surgery of the Hand (MSSH) was formed on 3rd March 1993 (3-3-93) with Dato’ Dr. Abdul Hamid as its first President.

In the meantime, Dato’ Dr. V. Pathmanathan completed a one year fellowship in Louisville, Kentucky and returned to start up the first Hand Clinic in General Hospital Kuala Lumpur in 1987. It went on to become the country’s first Hand and Microsurgery Department.
Sharifah Roohi Syed Waseem Ahmad

under the Ministry of Health (MOH) in 1998 (MSSH webpage). Dr. Ranjit Singh Gill was the second Malaysian to complete a fellowship in Louisville in 1996. The Hand Unit in GHKL was then extremely busy with trauma cases, with replantations being performed almost every day, and it can lay claim to training many an orthopaedic resident from UKM.

In 2000, feeling the need to have its own hand service, it was decided that Dr. Sharifah Roohi be tasked with setting up a Hand Unit in UKM. She thus became the third person to go to Louisville. She undertook two fellowships, one in Singapore and another in USA. Armed with the specific knowledge to set up the unit, she returned in June 2003 and set up the Hand Unit in UKM, which was officiated open on 16th November 2006. There have been two trained Hand Surgeons from that unit since, A/Professor Dr. Jamari Sapuan and A/Prof Dr. Shalimar Abdullah. It is a thriving unit and a good training ground for Orthopaedic residents.

In 2011-2012, while preparing for the 10th APFSSH congress, it was noted that there were less than 20 hand surgeons in the country. As the President of the MSSH, my hope was to have 50 by 2020 which seemed outrageous at the time. At present count, there are approximately 900 Orthopaedic surgeons in Malaysia, half of whom are in the public sector, bringing the ratio of orthopaedic surgeons to population to 1:36,000. Among these there are only 40 hand surgeons (about 4%), but there are still two and a half years left to December 2020, so we may still reach 50! The current hand surgeon to population ratio works out to 1:800,000, which explains why we have so much work to do. There are no official figures from the World Health Organisation (WHO) on this ratio, but I would think 1:200,000 is reasonable (10% of the total number of orthopaedic surgeons) for a developed country. That would mean 160 hand surgeons, quadruple the present number.
At present, there are three Universities with a full-fledged Hand Unit, performing emergency hand calls and elective cases. MOH also has three such units while the private sector has only two. We should aim to increase these basic building blocks, collaborate and amalgamate positive points in order to extend the borders covered by the centres. This will reduce complication rates and perhaps then we can concentrate on improving the quality of care.

THE FACE – THE MAKING OF…

The making of a hand surgeon is not an easy task. Similar to how we describe the different personalities of a physician and a surgeon, the candidate for hand surgeon has a particular personality. They are no mere mortals for they must have the stamina of a marathoner, the patience of a mother, the dexterity of a juggler and finally a dash of the temerity of a tightrope walker. As is obvious, we are not perfect in all these aspects, so we have to make do with what we have!

Of the above ingredients, the most important criteria is the intense desire to become a hand surgeon. I found that feeling in my fourth year of medical school when I met a patient who elicited my deepest sympathy. A 33 year old farmer, the father of a two year old girl, had a motorcycle accident and had a flail lower limb (sciatic nerve injury) with an open knee injury. The solution offered to him was an above knee amputation, which in his opinion was a death sentence to him, being a farmer and not being able to feel the earth beneath his feet. Although I was not aware of the field then I knew which direction I wanted to head towards. Thus the journey began…

It is a long and arduous journey, but one which was extremely worthwhile. Basic requirements to venture into the field are a medical degree followed by (in Malaysia) a postgraduate degree
in either Plastic or Orthopaedic Surgery. This will enable the candidate to either follow the 3 year fellowship programme (MOH) or University programmes which comprise one year fellowship overseas and two years of in-house training. Only three countries in the world offer Hand Surgery as a stand-alone residency programme – Singapore, Sweden and Finland, and it ranges from four to six years' duration.

In my case, I embarked on this journey with an intense focus on acquiring as much knowledge and skills as possible. During my residency, I took a month’s leave to extend my time in the Hand & Microsurgery unit in General Hospital by month and a half, during which time I managed to perform a few replantations and revascularisations successfully, giving me confidence to further my training in this field. Within two months of completing the posting, I passed the Fellowship examination and was chosen to set up the unit in UKM. My fellowship training and future were already planned out and thus I had a “fast-track” route to sub-specialisation. After my Masters and before I left for the Fellowship programme, I was tasked with running the Hand Clinic and theatre list for upper limb cases, preparing me further for what was to come.

Hand Surgery Fellowships: HRM Department, Singapore.

The six-month fellowship in the Hand & Reconstructive Microsurgery (HRM) Unit, National University Hospital (NUH), Singapore, consisted of two stints of three month rotations with Prof Robert Pho and Prof Lim Beng Hai, respectively. As Fellows, we were required to be on “hand call” approximately one in three and
we performed all the emergency cases that came in since the fellow was the seniormost “in-house” team member. The cases we worked on ranged from simple fingertip injuries (Figure 1) to complex trauma (Figure 2) requiring vascular or microvascular work.

**Figure 1** Fingertip injury in a five year old child.

**Figure 2** Scalloped section of brachial artery (yellow arrow) causing massive bleeding and hypovolemic shock.

There were teaching sessions 2-3 times a week and rounds on alternate days where the previous day’s emergency cases were discussed. These were great learning sessions for me. It was also compulsory to take the basic microsurgical skills course (Figure 3), with an examination at the end of the course (Figure 4).
Figure 3 The microsurgical lab.

Figure 4 The Rat femoral artery anastomosis.

The advanced course, though optional, was very useful, showing various flaps such as: Latissimus Dorsi, Rectus, Groin, Gracilis, Gastrocnemius, etc. (Figure 5,6).
During the entire six month period, I was involved in 233 cases, of which 168 were trauma cases.

There were 19 microvascular cases – either replantations, revascularisations or free flaps. There were a similar number of loco-regional flaps such as: Thenar, Moberg, Posterior Interosseous,
Groin etc. This gave me a good grounding on the coverage of fingertip injuries as well as coverage of defects around the hand. There were also a few memorable cases from which I learnt a lot. These included a degloving injury to the leg, foot and ankle (Figure 7), an osteosarcoma of the distal femur with autograft post-irradiation (Figure 8), heterotopic ossification at the elbow, necrotising fasciitis and a double toe-finger transfer (Figure 9).

**Figure 7** Degloving injury with comminuted ankle fracture, toe to finger transfer, osteosarcoma.

**Figure 8** Reconstruction of a distal femur osteosarcoma post-excision and irradiation.
The fellowship finale was a detailed end-posting presentation where stock was taken of all the activities, research done, papers to be written and surgical case involvements. The Fellow also had to comment on what they didn’t find useful and how things could be improved. This was a good session to bring things up a notch with each trainee.

Hand Surgery Fellowships: CMKI, Louisville, USA

The fellowship in Louisville started in 2002 and spanned a year's duration. It was more intense, for work started at 6:30am and ended at 8pm. There were many educational activities (morning lectures, pre- and post-operative rounds, the annual flap dissection workshop (Figure 10) and visiting faculty lectures and workshops) which were backed by supporting facilities, such as the microsurgical and cadaveric laboratories set up by the late renowned Professor Dr. Robert Acland, the rotation at Louisville University & Jewish Hospitals and the Indiana offices for clinical attachment. The new CMKI had its own 24-hour hand emergency centre – which was one of a kind (Figure 11).
All fellows (or consultants) were required to do an early morning presentation. Since there were 20 fellows and 10 consultants, each fellow ended up doing 6-8 presentations over the year. This, I found to be a great teaching tool together with the flap dissection workshop which was conducted in the cadaveric lab. The location was in the adjacent University of Louisville Anatomy complex and run by
the renowned late Professor Dr. Robert Acland. Embalmed bodies were kept for dissection and rotated every 6 weeks. A fellow could request for part of a body and use it for whatever they wanted to dissect it for (flaps, arterial supply, innervation etc). Similarly the compulsory microsurgical course which spanned over a week and was supervised by Dr. Robert Acland was considered one of the best in the world. Other teaching activities included various courses and conferences such as the Tri-state (Kentucky, Indiana and Ohio) Hand meeting, the American Society for Surgery of the Hand (ASSH) annual conference and the Synthes Hand course (Figure 12).

**Figure 12** The Indiana Hand course with Hill Hastings.

**Hand Surgery Attachments: Institut de la main 2005**

The American fellowship training is quite comprehensive but there are certain advantages in the European or British styles, especially for paediatric cases. A number of the American consultants were trained by famous European (paediatric / neuro) hand Surgeons, such as Allieu, Gilbert, Leclercq, Masquelet and Brunelli. The Europeans are ahead of their time in dealing with brachial plexus, congenital and spastic hand cases. Thus I took the opportunity to refine my tendon transfer techniques as well as learn the philosophy
of treatments for some congenital / paediatric cases two years after returning from my fellowships. This is a good way to update oneself and to keep abreast of trends around the world. It also assists us in myriad of ways, from broadening outlooks to widening contact bases and developing long-lasting friendships which are mutually beneficial. This visit also allowed me to develop contacts with some key people in the medical industry through which route I had the opportunity to bring their innovative products to our country.

Hand Surgery Attachments: Institut de la main 2016

My next stint with this famous European institute was during my sabbatical and it was with a specific purpose: to brush up and improve my skill sets with paediatric cases. Professor Alain Gilbert is a maestro in paediatric hand and birth palsies. These are fairly “neglected” in Malaysia, primarily because they come more under the purview of the plastic trained surgeon rather than the orthopaedic trained surgeon. Further, since the majority of hand surgeons in Malaysia are orthopaedic trained, the conclusion is that this area is the less travelled path. Moreover, traditionally brachial plexus birth palsies are bogged with legalities. Thankfully this is on the decline but surgery is now giving marvellous results with the use of new products such as the nerve glue and nerve conduits.

Thus, while generally up to three years after MS Orth is considered sufficient Hand & Microsurgical training, I personally feel that a further one year fellowship overseas attachment is essential as they have adjunct teaching and training not found here. Ideally this should be considered only after acquiring some basic knowledge and practical skills. A two to six weeks attachment every two to three years is ideal to keep oneself updated in the various sub-divisions of hand surgery.
THE FACILITIES – THE COMPONENTS OF A HAND UNIT

The Hand Surgeon’s home is actually the workplace, and his home is where he “visits” when not at work! Thus the workplace must be made comfortable and the supporting facilities top notch to maximise efficiency and reduce wastage of time due to inferior or inadequate equipment. The mainstay of any decent Hand Surgery Unit or centre would comprise three parts: the clinic (with separate dressing rooms), the physiotherapy area and the operation theatre. All of these components cannot be compromised on and ideally should all be in one place or adjacent. Another very important component should be a decent rest area (Figure 13) where the exhausted surgeon can “hang out”, and where a 24-hour supply of some sort of food and beverage is available! This becomes very important when cases stretch from a couple of hours into a couple of days.

Figure 13  All the residents / fellows exhausted after a call. I had a couch in my room when doing active calls in my alma mater which proved to be invaluable.
The Operation Theatre

Obviously one of the most happening places is the theatre. The basic “furniture” in the theatre must thus be comfortable for the surgeon is going to spend hours here. Thus the operating table, the surgeon’s chair and the “hand table” must be in line with the surgeon’s specifications. My personal preference is a Stryker stool (Figure 14) and a 2 by 3 foot operating hand table which is translucent so radiographs can be taken easily. Lights must also be bright so that microscopic structures are easily seen.

Figure 14 The Stryker chair is height adjustable with enough padding on the seat to ensure comfort for long surgeries. Hand tables from Lojer are lightweight, easy to attach and can withstand weight even without a supporting leg which facilitates taking a radiograph tremendously.
Figure 15 The (Zeiss®) Operating microscope (left) is absolutely essential for microvascular work and sometimes necessary for nerve repair or schwannoma dissection. The mini C-arm (Orthoscan ®) eases work.

The operating microscope and mini C-arm (Figure 15) are essential to the functioning of a facility catering to emergency cases for the upper limb. Instruments need to be of good quality (Waldemaar LINK) and usually two major and two minor handsets should be in stock and kept sterilised. An electric drill specifically for the hand surgeon’s use is quite a basic requirement as are suture materials from 4/0 to 11/0 in various categories depending on the surgeon’s preference. Other big ticket items would include the tendon, bone and microsurgical sets (S&T, Stille or KLS Martin), which are a must in any good hand unit. A mini external fixation set would definitely come in handy, where my preference is the LINK Ellis set – which is versatile and easy to use (Roohi SA et al 2009 – poster presented in Poznan, Poland – Figure 16).
Last but not least on the wish list would be a wrist arthroscopy set, preferably from Carl Storz, who have one of the best camera systems in the world. With that the major items are covered while smaller items include Kirschner wires, rongeurs, cutters, pliers, the radiolucent “lead” hand from AREX® and finger tourniquets. These are the few other essential things that would be required in a new hospital set-up.

The Clinic

A lot of thought has to go into the layout of the Hand Clinic. It should be designed with the work-flow and the ease of patients in mind. If it is in a public hospital, many rooms would be required and the dressing area may be common and open in concept, separated by curtains. For private hospitals, physical rooms may be partitioned. I was involved in the planning (and construction) of some of the units in the country – the Hand Unit in UKM and the one in the Sunway medical centre among others. Structurally, they are very different but functionally, quite similar.
In both units there are three to four consultation rooms where patients are seen by the registrar or consultant. In Sunway, there are also four dressing rooms. In Louisville, each consultant had six rooms where the fellows saw patients in and the consultant rotated through. Each room would be supplied with its own small custom-made examination table and dressing materials.

**The Therapy Area**

The therapy area is by far the largest in terms of space, where a brightly-lit open space is inviting and if it has a view, even better. It is important that this area be comfortable and welcoming for the patients would spend anywhere from half an hour to two hours here every alternate day, either before or after surgery. A common therapy table encourages camaraderie and mutual support amongst the patients, although some may prefer privacy. A set of ADL (Activity of Daily Living) boards are very useful to have plus exercise bands, putty and the various tools of the trade. A separate area for splint-making should be set apart. This may be glass walled to allow patients to see their splints being made. It also allows the therapist to keep an eye on the patient while working on something in the room. This area has to be adjacent if not in the same setting as the clinic, so that the surgeon may call on the therapist to discuss options when referring the patient. A minimum of three therapists is good for a busy Hand Clinic. All hand therapists should be well-versed in both physiotherapy and occupational therapy. These go hand-in-hand and are inseparable.
THE FIELD OF HAND AND MICROSURGERY

First, I would like to clarify why the term Hand & Microsurgery is my personal preference – the hand is a small structure which is packed with 19 bones, with numerous ligaments holding them together, a gamut of nerves providing 2 point discrimination of less than 4mm at the fingertips and a myriad of vessels both volar and dorsal supplying the muscles and all the enveloping structures. As one can imagine, injury to these small diameter vessels and nerves (be it traumatic or iatrogenic) requires special repair techniques using the microscope, especially in the digits – one cannot live without the other – they literally go hand in hand!

The beauty of Hand Surgery is in the breadth of cases that we see, ranging from congenital to degenerative, a spectrum across all ages and pathologies, with never a dull moment in the day. I would like to share a few interesting cases I have seen over my past 20 years of experience in this field, which have been life learning lessons for me.

Congenital Cases

Congenital hand cases are challenging, to say the least, for the size of the hand and digit in millimetres is in single digits or sometimes even in fractions! Anaesthesia is also a concern in the very young, especially so if they have syndromic conditions where cardiopulmonary anomalies may be present and potentially life-threatening. We thus work with anaesthetists who are experienced with neonates and infants where the maturity of the lung is of concern, as may arise in patients with brachial plexus birth palsies where we may need to operate in the early window period of three to six months (Gilbert 1991). This category of patients who
are generally not covered by insurance tend to be seen in public hospitals, although coverage by some employers is in practice. Common (congenital) conditions in the hand (Figure 17) are polydactyly, syndactyly, symbrachydactyly, thumb hypoplasia & radial club hand, constriction bands, clinodactyly and camptodactyly (Chong AKS 2010). Macrodactyly (Figure 18) is not that common but is an extremely frustrating condition to treat with generally unsatisfactory results. Further, Clasped thumb may be confused with trigger thumb, which is contested as being congenital and thought of as being acquired.

**Figure 17** From L to R: polydactyly, syndactyly, clasped thumb and constriction band syndrome.

**Figure 18** Macrodactyly treated twice surgically, but recurred – this is the usual scenario. Further surgeries put the patient at risk of nerve damage. Wise to quit while ahead is my sentiment.
Thumb hypoplasia may occur on its own or with radial deficiency of the forearm (radial club hand) and in the more severe cases (“pouce flottant”) may require pollicisation (Figure 19). Convincing Malaysian parents of the necessity of this type of surgery is sometimes an uphill task. I have found that unless it is severe the child adapts quite well and is otherwise functionally competent.

![Figure 19](image)

**Figure 19** Using Buck-Gramcko’s incision to excise the thumb and transfer the index finger to become the ‘new’ thumb = pollicisation.

Something close to my heart that I have learnt in recent months is managing brachial plexus birth palsies – a challenging condition indeed, in terms of size, philosophical complexity as well as, technical expertise. Under the guidance of Professor Alain Gilbert and his team, we performed reconstructive surgeries on several complete palsies in infants as part of a voluntary team to Ho Chin Minh City Paediatric hospital, in Vietnam (Figure 20).
Figure 20 From L to R: After resection of the diseased segment of the lower trunk of the brachial plexus, nerve grafts are put in place carefully and fibrin glue used for repair. Results were good.

The Paediatric Hand

Most paediatric cases we see are trauma related, the most frequent being the notorious fingertip injury. The amputated fingertip is much cause for concern and panic! Often, dealing with the distressed parent is more difficult than handling the child. Thankfully in those less than five years old, there is good news – the amputated part can be sutured back without much deficit. The results are quite good, though it may take up to three months to be visible (Figure 21).

Figure 21 A 3 year old child with a complete amputation of her left ring finger. Simple suturing resulted in good “take” within five weeks.
Sharifah Roohi Syed Waseem Ahmad

The older child (more than age six) is treated like an adult, only the healing is much faster (Figure 22). The same technique is still used, but the subcutaneous fat is removed and the remaining “cap” sutured on. The results are just as amazing.

Figure 22  A 10 year old boy with a complete amputation. The subcutaneous tissue is excised, the nailbed is carefully approximated and a fine Kirschner wire is used to compress the bone fragments together (important). The nail plate is slotted in to keep the eponychial fold open.

The incredible healing capacity in children often results in rapid healing but the position of the union may not be ideal. Most times this may not be an issue since remodelling takes care of that too, but in certain cases such as with displaced articular fractures, especially involving the distal radio-ulnar joint (DRUJ), or near the proximal interphalangeal joint (PIPJ), corrective osteotomy and fixation may be required. We have seen teenagers presenting with DRUJ disruption and instability years after the initial trauma (Figure 23).
Figure 23 Buckling of the dorsal cortex with increasing volar angulation is a bad sign that needs correction. Note far right that the volar cortex is in correct vertical alignment. L DRUJ instability.

As a rule, non-union is not frequently seen in Paediatric fractures, much less so after surgical intervention – 2-5% after plate osteosynthesis – as cited by Looi CSK et al. (2017). If it does occur, however, a few pointers to uphold are: meticulous handling of tissue, perfect bone graft opposition with host bone, drilling of recipient medulla followed by rigid fixation. In one case we used the anterior tibial cortex as a strut graft to bridge the Ulna non-union (Figure 24: Looi CSK et al. 2017).
Paediatric hand injuries that were seen frequently in the emergency room of an urban hospital consisted of tendon injuries (24%), amputations (20%), laceration wounds (16%) and fingertip injuries (16%) (Shalimar, A. et al. 2007). In a two year review of all paediatric hand injuries, half were found to occur in the home setting while almost 20% were due to motor vehicle accidents with an increased incidence observed during school holidays (Figure 25).

**Figure 24** From L to R: Bone gap of more than 6cm bridged with Tibial strut graft. Union finally seen.

**Figure 25** Peaks are seen for the months of March, June and December. The types of injuries are shown in the pie chart.
Meanwhile an interesting trend of festive-related injuries is also seen in our country. While we are aware of firecracker injuries sustained to the hand and face of children, sugarcane extraction machine injuries are also seen, particularly during the fasting month of Ramadan. Children assisting their parents who sell sugar cane juice in the Ramadan bazaar are particularly likely to sustain this devastating injury which results in a mangled hand which is beyond repair and susceptible to *Pseudomonas infection* (Ahmad SR 2015). Education and prevention are the best solutions and this has been highlighted in the newspapers (Figure 26: Star On line 2014).

![Figure 26 Sugarcane accidents in bazaars. A mangled hand due to the sugarcane machine.](image)

**Trauma to the Hand and Upper Limb**

This forms by far the largest segment of cases seen in hospitals, either directly after the event or later when the patient realises it is something more major. The topic is very vast and there are extensive descriptions of fractures, but much less on ligamentous injuries of the digits. A detailed description of the latter has been given in
Sharifah Roohi Syed Waseem Ahmad

the book by Ian Trail and Andrew Fleming in the chapter Acute Thumb and Finger Instability (Figure 27: Roohi SA and Caroline Leclercq 2015).

An unusual but interesting form of injury is that sustained due to the use of paint guns and, less frequently, hand nail guns (Figure 28). The former is extremely toxic and may even result in amputation of the digit if not treated promptly. A thorough washout of the digit must be undertaken to remove as much paint as possible from the finger.

Figure 27  Chapter in the book by Ian Trail and Andrew Fleming.

Figure 28  Although this looks minor, looks can be deceiving for the inside paints a different picture! The nailgun injury is harmless in this case.
Another area of trauma that is oft overlooked but is extremely important is \textit{Crush Injuries of the Hand} as opposed to the crush syndrome (Roohi SA, Pho RWH 2018). All trauma has some amount of crush involved, be it a sharp knife or a blunt force trauma. The former has a greater pressure applied (Force per unit area) due to its sharp infliction. A printing press would have greater element of crush since a high force is applied over a wider area causing “burst lacerations”. Care must be taken during debridement for the muscle is usually not viable and has to be excised to prevent infection from occurring (Figure 29).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{crush_injury.png}
\caption{Crush injury due to printing press. It is imperative that the ink staining is removed prior to assessment of circulation as well as muscle viability.}
\end{figure}

The other form of crushing that is not visible is that which occurs in a degloving injury – the skin and subcutaneous tissue are sheared off by a rotational force applied in opposing direction (roller injury), avulsing the blood vessels and causing severe ischaemia (Figure 30).
One of the most oft seen in the emergency section is amputations of the limb – fortunately this is rare (Figure 31). Swift action is required to salvage a major amputation since the muscle is not able to withstand loss of blood supply (warm ischaemia time of 2 hours).

Figure 30  A degloving injury caused by rollers resulting in Volkmann’s ischaemic contracture.

Figure 31  A 17 year old sustained a complete amputation of his right arm at the proximal humeral level. He was immediately rushed into the operating room within half an hour of arrival. The limb was saved and he regained good function after 1 year.
Adult Brachial Plexus injuries are serious cause for concern. They still occur too often and are mainly due to motorcyclists having accidents at high speeds. Associated injuries may include bilateral first rib fractures (Ismail I et al. 2017), vascular injuries and other limb fractures (Figure 32). Having treated a patient with 13 fractures in one limb along with a complete brachial plexus injury, it can be a taxing journey! The sad part is that no matter how good the reconstructive surgery, the functionality is never the quite the same. Perhaps future advances in regenerative therapy may improve outcomes.

Figure 32 A young male motorcyclist with extensive bruising over the left anterior chest wall highly suggestive of a brachial plexus injury and first rib fractures. The cervical x-ray shows the latter as well as a transverse process fracture of C7.
Infection

There are many types of infections that we see in our daily practice but here I would like to highlight some that are unusual and difficult to diagnose, because they are easily missed. First and foremost is Tuberculosis of the hand and wrist (Roohi SA 2010). Those that present with signs of inflammation are not as challenging as those who do not. For example, a patient presented vague pains over the left wrist for over 5 years. A plain x-ray revealed a lytic lesion in the distal Radius and Ulna (Figure 33). Chemotherapy was commenced after curettage.

Figure 33 A 50 year old well-travelled male presented with pain and mild swelling over his left wrist. Massive amounts of synovitis and tissue removed at surgery revealed tuberculosis infection.

Dangerous bacterial infections to note are necrotising fasciitis (Figure 34) and diabetic flexor tenosynovitis. Both have a high chance of causing loss of limb and life. We have studied Diabetic Hand Infections in a University and government hospital and found that 80% of the patients had it in their dominant hand and that a big number (40%) end up with amputations, mainly because they present late (Balakrishnan V 2006 Thesis).
Figure 34 From L to R: Skin and subcutaneous tissue is lost at a rapid rate. Early debridement managed to salvage the limb. Flexor tenosynovitis showing splaying of the digits and flexed posture of the ring finger (affected) which also needed urgent drainage and where consent must always be taken for future amputation. This conveys the seriousness of the condition.

Viral warts are another entity that are missed or misdiagnosed. Most are fairly easily treated with local salicylate application but some require surgical excision (Figure 35).

Figure 35 Usually a “kissing” lesion of the viral wart is seen.
Tumours

There are numerous bony and soft tissue tumours in the hand and upper limb. I shall touch on some interesting cases that I have come across in my practice. In 2003 upon returning from my fellowships, we were confronted with a patient with a highly aggressive malignant peripheral nerve sheath tumour (Figure 36: MPNST). The tumour was excised twice but recurred rapidly and the patient passed on within a year. Lesson to be learnt is to treat these with extreme caution and respect.

Figure 36 Extreme pain and swelling of left arm with recurrence. Large tumour was excised. Second surgery was a gleno-humeral disarticulation. Patient died a year after initial diagnosis.

The second case was also a malignant tumour (Acral Myxoid Inflammatory Fibroblastic sarcoma) of the right (dominant) thumb but with a better outcome (Figure 37). An amputation was carried out after an incisional biopsy was done and although we tried to save the thumb, the tumour was very aggressive and had already infiltrated the bone, and thus had to be excised. She is now eight years post-op and recurrence free.
The third type of tumour is not as severe as the previous ones but is very often missed leading to delayed diagnosis and significant morbidity in terms of pain and discomfort. This is the glomus tumour that occurs at the periphery of digits and usually resides in the fingernail (Figure 38). Pin point pressure at the discoloured area elicits pain and is pathognomonic of it.

**Figure 38** Vague bluish discoloration and lytic lesion on x-ray. The nail plate is elevated and the tumour removed in toto.
Last but not least, I would like to highlight vascular tumours; for example the huge dorsal soft tissue swelling on the left thumb of an eight year old boy. The defect post-excision was so big that a flap needed to be designed to cover it (Figure 39). Another example is a venous malformation in the left forearm of a 10 year old girl – the infiltration was so extensive that the ulna had to be excised and a one bone forearm created (Figure 40).

**Figure 39** A large vascular tumour for which a rotation flap sufficed post-excision.

**Figure 40.** Excision of a venous malformation which had ‘eaten into’ the distal ulna. This was excised and the proximal end fixed to the distal radius – creation of an ‘ulnius’.
A Tumour can also mimic common hand conditions such as carpal tunnel and trigger finger! In one instance a metastasis from an adenocarcinoma settled in the wrist and caused carpal tunnel which was not relieved post release (Roohi SA 2011). Upon open release, the tumour was found! In another patient, the triggering was found to be due to a giant cell tumour and a “recurrence” after percutaneous release prompted open release (Rahimawati, N. 2010). Thus recurrence with minimal incisions may be deceiving. It may not be due to inadequate release but due to another cause.

**Reconstructive Surgery**

This area of Hand & Microsurgery seems to be declining due to the rising cost of microsurgical reconstruction. The long and demanding hours that need to be put in and the (monetary) rewards in the private and now financially driven public sector have pressured its demise. As for my practice, I used to perform at least one free flap every month, at times two. However, I have not done any in the last 6 months.

Some of the free flaps I have done and feel are useful are: the lateral arm flap, the antero-lateral thigh flap, the toe to finger transfer and the groin flap. I will show the thigh flap for an amputation at the wrist level which was done secondarily after the patient was received 24 hours post-trauma (Figure 41).
Figure 41  A: A 30 year old Army captain had a roll over injury in his car and hit a metal divider which all but severed his right hand at the radio-carpal level. He was sent in 24 hours later. Revascularisation, Debridement and tendon repair were performed at 24 hours post-trauma and held with Kirschner wires. An external fixator was destroyed by infection and the thenar muscles became necrotic. However, the thumb ray was only amputated after a delay in consent of 5 days. B, C: A free lateral thigh flap was performed to cover the defect and D: the battle with infection was finally won a year later. E: He felt “functional” although he had lost his thumb and did not want a pollicisation.

Local and rotational flaps can be extremely helpful too. Other than the usual, the “cap reattachment” for fingertip injuries (Figure 42) and the Ostrowski flap (Figure 43) are the most useful to have in one’s armamentarium.
Figure 42  The collage is self-explanatory. Meticulous technique is essential.

Figure 43  This flap specifically designed for the first web-space is simple yet ingenious.

Research

My research has been in varied areas, from epidemiology (the prevalence of the Palmaris tendon in the Malaysian population – SA Roohi 2007 and Epidemiology of Distal Radius Fractures in a District Hospital & Their Treatment – Poster MOA 2009) to anatomy (The role of Flexor Carpi Radialis in the anatomy of the
Sharifah Roohi Syed Waseem Ahmad

Distal Radius Fracture – awaiting publication) to finding out what affects vascular repair and the haemodynamics of blood vessel primary repair and vein graft (end to end and end to side) together with researchers from the University of Perlis (MN Rahman et al. 2012, 2013). It also includes studies on possibilities of veins being used as neural conduits (Hassan NH et al 2012) and Sciatic nerve repair with Olfactory ensheathing cells (Tan CW et al. 2013). In terms of regenerative medicine, the use of heparan sulfate was extremely useful in collaboration with Professor Denis Barritault from the University of Paris (Ahmad SR, 2015 and another journal article accepted for publication in Clinical Case Reports by Wiley.

The current research work has yielded some very exciting results on the use of stem cells in fracture healing on goat tibiae. Results will be published soon, so keep an eye out for them!

THE FUTURE – IS PROMISING!

Presently, treatment in Orthopaedic surgery is mainly by physical means: reduction of fractures, repair of nerves and vessels and coverage with flaps. Even these areas have shown rapid development with the discovery of innovative flaps and advances such as supermicrosurgery and perforator flaps.

In terms of equipment we will be seeing a torrent of new items from the big machines to the smallest cannulated screw in absorbable materials. The titanium plates may be replaced by vanadium or some other alloy and their sizes will gradually get smaller and more refined. As the distal radius plates acquire a lower profile and great tensile strength, it eliminates the need for bone graft, but the surgeons may not be ready to let that go just yet. Or perhaps there may be alternatives to the traditional bone graft?
Perhaps in the future we may not even need bone grafts – we may develop enhancers to hasten the rate of healing in terms of cellular therapy. Indeed fracture healing has already been sped up in countries like Korea with the use of various applications of stem cells.

I do believe the use of biologics is going to be the next leap forward. Regenerating agents like heparan sulfate and glycosaminoglycans are also in the forefront and showing encouraging results. We shall just have to wait and see.

CONCLUSION

Hand & Microsurgery is an exciting area of medicine which is growing by leaps and bounds. It gives the practitioner a variety of possible areas to practice, to suit the individual, and allows an array of cases in one’s portfolio so that it is always exciting.

The developments in this area, in mechanical, chemical and biological terms, are mind-boggling and we have not even touched on the neuro-medical area, in terms of prostheses. With neuro-modulation, the possibilities for amputees and paraplegics are incredible. It is indeed an exciting time to be in.
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Physical to Biological Building Blocks in Hand and Microsurgery


BIOGRAPHY

Roohi Waseem was born in Assunta Hospital, Petaling Jaya. Her late Father, Syed Waseem Ahmad was a Professor of Economics at University Malaya while her mother taught domestic Science and was subsequently a homemaker. Roohi attended primary schools in Kuala Lumpur (Alice Smith School), Boston (Runkell School) and Karachi (Karachi Grammar School), and Secondary schools in Kuala Lumpur (Garden School) and Karachi (St. Joseph’s College), adding a varied flavour to her education. She speaks five languages (English, Malay, Urdu, French and German) and was the top student in her Secondary School, enabling her to further her studies in Singapore (National Junior College). She was accepted to Princeton, Yale and Aga Khan Universities but decided that she wanted to pursue medicine closer to home. She was accepted into Universiti Kebangsaan Malaysia (UKM), and graduated with an M.D., amongst the top ten, in 1990.

Dr. Sharifah Roohi did her housemanship in HKL in General Surgery, Orthopaedics and Obstetrics & Gynaecology and was subsequently posted to Pahang, Kuantan, where she requested to be in Internal Medicine, thinking that she might want to pursue Emergency Medicine. She was then posted to Bentong for four years where she saw first-hand and learned in depth about the country’s health service. She even managed to pick up enough Cantonese to elicit a patient’s medical history and lived life in the slow (but enjoyable) lane! Not one to stay idle for long, she got involved in a nationwide research programme on drug resistance in Malaria (Lokman et al.), which landed her her first publication. Not being where the action was however propelled her to resign and work in the Emergency department for a while to gain experience, after which she applied to rejoin her alma mater.
After some trials, she joined the four year UKM Orthopaedics Master’s programme in June 1996. While in HKL, after undergoing her Hand & Microsurgery rotation, she qualified as a top student in the FRCS (Edinburgh) examinations held in UM in 1998. A unique situation resulted whereby she was taken in as a lecturer in early 1999, while still in the third year of her Masters, which she completed in 2000, ranking among the top three. She has the distinction of being one of only two women in the whole country holding both the FRCS and a Masters of Surgery in Orthopaedics postgraduate degrees.

She was targeted to establish the Hand Unit in UKM which was a challenging task. In order to be better able to do this, she embarked on training at the Hand & Reconstructive Microsurgery Unit, Orthopaedics department, National University Hospital, Singapore for six months, training under Professor Dr. Robert Pho Wan Heng and Associate Professor Dr. Lim Beng Hai. After a two month break she flew to Louisville, Kentucky, to the Mecca of Hand Surgery: the Christine M. Kleinert Institute, where she completed a one year clinical fellowship in Hand & Microsurgery. There she trained under 10 senior consultants: Drs Kleinert, Kutz, Atasoy, Tsai, Wolff, Breidenbach, Scheker, Gupta, McCabe, and Shatford, and two new ones: Napolitano and Özyurekoglu, who had just joined. It was a packed fellowship with trauma calls and elective surgeries with working hours from 6:30 in the morning to 8pm at night, a good bed of preparation for what was soon to come.

Upon her return to Kuala Lumpur, she set up the Hand Unit in the department of Orthopaedics & Traumatology in HUKM (the first to be officially established in a University) and started a marathon of daily calls for the next three and a half years! It compressed the learning curve of 10 years into a short span of three years, which manifested in her being the top candidate for the International
Federation of Societies for Surgery of the Hand (FESSH), European Examination, which was opened up to the world for the first time in June 2008.

In November 2006, Sharifah Roohi joined FPSK, UPM, as an Associate Professor and was soon tasked to set up the Masters in Surgery (Orthopaedics) programme. Shifting through mountains of documents and with a reliable partner in crime, Dr. Zanariah Othman, the final document was made ready in 2012, about the same time that Dr. Roohi was made Head of the Department of Orthopaedics. In August of 2013, she was promoted to full Professor. In 2015, the first batch of Masters students were taken in and presently they are in their final year.

During her tenure as the Head, she developed the Department of Orthopaedics from less than 10 members to 14 and established seven sub-specialty units. During this time, she was also actively involved in the Library committee, the Ethics Board, the HPUPM committee and the Curriculum committee, amongst others. She is an international member of many professional bodies and is licensed to practice in four countries. She held the post of Honorary Secretary of the Malaysian Orthopaedic Association in 2007 as well as currently (2018). She was the President of the Malaysian Society for Surgery of the Hand (MSSH) from 2010 to 2015 and chaired the Asian Pacific Federation of Societies for Surgery of the Hand (10th APFSSH) Congress held in Kuala Lumpur in October 2014. She has been a keynote and plenary speaker in international as well as national conferences and has travelled world-wide as an invited speaker. She is also well known in lecturing and conducting courses in and around the country. She has authored many articles in books and journals, totalling about 50 and is a reviewer for more than 10 journals (international and national). She has held various grants and has collaborated with many national and international companies,
institutions and universities. In 2016, during her sabbatical she undertook a two month attachment with the Institut de la main in Paris ending with a charity mission to Ho Chin Minh City, Vietnam, as part of a voluntary team of surgeons and anaesthetists, to perform operations on the paediatric population with birth palsies and defects. Prof. Dr. S. Roohi has also been a member of the esteemed Malaysian Medical Council and is presently a member of the Writing Group for the National Orthopaedic Curriculum Committee.

Dr. Roohi loves to travel but when she is not working (very rarely) she enjoys staying at home and relaxing with a good book in hand (pun intended). Her pillar of strength is her mother who has been her gladiator whilst her late father was her champion. She looks forward to many more productive years with several interesting projects in mind – both charitable and profitable!
ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious, the Most Merciful, the Most Knowledgeable…

Alhamdulillah, all praise to Allah for enabling a healthy, active and meaningful journey of life… and allowing me to share my experience in the form of this lecture and book.

The publication of this book would not be complete without acknowledging the tremendous amount of effort that went into it as well as in the preparation of the Inaugural Lecture. Firstly, I would like to thank Dr. Zanariah Othman and Prof. Dr. Azhar Md Zain for taking me in and giving me the opportunity to serve in UPM. I have had a good twelve years which did not feel like work! I would also like to thank the past (and present) Heads of Department of Orthopaedics: Dato’ Dr. Selva Kumar, Dr. Zanariah and Prof. Manohar Arumugam for all the suggestions, help and advice extended.

I would also like to express my sincerest gratitude to Prof. Dr. Norlijah Othman who guided me throughout my tenure as a Head of Department and from whom I learnt a lot! A note of thanks too to Prof. Dato’ Dr. Abdul Jalil Nordin as well as the present Dean, Prof. Dr. Zamberi Sekawi, for all the encouragement and tremendous support shown.

To my fellow colleagues in the department, I would not be where I am today without your support and encouragement. To the administrative staff, I cannot even begin to thank you for all your immeasurable assistance over the years, especially not forgetting Puan Noraida and Puan Zuraida, both of whom are no longer with the department.
Most importantly, to my teachers and Professors near and far from UKM, UM, Singapore, France and the USA, I have learned so much from all of you, I appreciate your time, effort and commitment sincerely, may Allah swt grant you the rewards. Special mention to my local mentors in Hand Surgery: Dr. Ranjit Singh Gill and Dato’ Dr. V. Pathmanathan as well as Sister Foong Shin Har – I would not be where I am today without the knowledge and experience imparted by you.

To my students, undergraduate (UKM, UPM and Monash) and postgraduate (in UPM, UKM, UniMAP), I record my heartfelt appreciation and gratitude for your invaluable contributions in research and publications. To my collaborators in the Veterinary Faculty, I salute you and admire your dedication in treating those who cannot speak. You have taught me much in humility, service and kindness in care. To my international collaborators and the medical industry, without which we would not be able to do some of our best work, a big thank you. As for my patients, I would not be where I am today if you had not come to me for treatment – thank you for putting your trust, your health and your life in my hands.

Finally, I would like to thank my Mom, Samdani Waseem binti Noorullah, who patiently awaits my return from work and encourages me every step of the way. To my late father, Syed Waseem Ahmad who encouraged me to study and study and continue to further my studies… may Allah swt bless you and reserve a place for you in Jannah. We are all learners in this life: let us live, love and learn to leave a legacy.
LIST OF INAUGURAL LECTURES

1. Prof. Dr. Sulaiman M. Yassin  
   The Challenge to Communication Research in Extension  
   22 July 1989

2. Prof. Ir. Abang Abdullah Abang Ali  
   Indigenous Materials and Technology for Low Cost Housing  
   30 August 1990

3. Prof. Dr. Abdul Rahman Abdul Razak  
   Plant Parasitic Nematodes, Lesser Known Pests of Agricultural Crops  
   30 January 1993

4. Prof. Dr. Mohamed Suleiman  
   Numerical Solution of Ordinary Differential Equations: A Historical Perspective  
   11 December 1993

5. Prof. Dr. Mohd. Ariff Hussein  
   Changing Roles of Agricultural Economics  
   5 March 1994

6. Prof. Dr. Mohd. Ismail Ahmad  
   Marketing Management: Prospects and Challenges for Agriculture  
   6 April 1994

7. Prof. Dr. Mohamed Mahyuddin Mohd. Dahan  
   The Changing Demand for Livestock Products  
   20 April 1994

8. Prof. Dr. Ruth Kiew  
   Plant Taxonomy, Biodiversity and Conservation  
   11 May 1994

9. Prof. Ir. Dr. Mohd. Zohadie Bardaie  
   Engineering Technological Developments Propelling Agriculture into the 21st Century  
   28 May 1994

10. Prof. Dr. Shamshuddin Jusop  
    Rock, Mineral and Soil  
    18 June 1994

11. Prof. Dr. Abdul Salam Abdullah  
    Natural Toxicants Affecting Animal Health and Production  
    29 June 1994

12. Prof. Dr. Mohd. Yusof Hussein  
    Pest Control: A Challenge in Applied Ecology  
    9 July 1994

13. Prof. Dr. Kapt. Mohd. Ibrahim Haji Mohamed  
    Managing Challenges in Fisheries Development through Science and Technology  
    23 July 1994

14. Prof. Dr. Hj. Amat Juhari Moain  
    Sejarah Keagungan Bahasa Melayu  
    6 August 1994

15. Prof. Dr. Law Ah Theem  
    Oil Pollution in the Malaysian Seas  
    24 September 1994

16. Prof. Dr. Md. Nordin Hj. Lajis  
    Fine Chemicals from Biological Resources: The Wealth from Nature  
    21 January 1995

17. Prof. Dr. Sheikh Omar Abdul Rahman  
    Health, Disease and Death in Creatures Great and Small  
    25 February 1995
Physical to Biological Building Blocks in Hand and Microsurgery

18. Prof. Dr. Mohamed Shariff Mohamed Din
   Fish Health: An Odyssey through the Asia - Pacific Region
   25 March 1995

19. Prof. Dr. Tengku Azmi Tengku Ibrahim
   Chromosome Distribution and Production Performance of Water Buffaloes
   6 May 1995

20. Prof. Dr. Abdul Hamid Mahmood
    Bahasa Melayu sebagai Bahasa Ilmu-Cabar dan Harapan
    10 June 1995

21. Prof. Dr. Rahim Md. Sail
    Extension Education for Industrialising Malaysia: Trends, Priorities and Emerging Issues
    22 July 1995

22. Prof. Dr. Nik Muhammad Nik Abd. Majid
    The Diminishing Tropical Rain Forest: Causes, Symptoms and Cure
    19 August 1995

23. Prof. Dr. Ang Kok Jee
    The Evolution of an Environmentally Friendly Hatchery Technology for Udang Galah, the King of Freshwater Prawns and a Glimpse into the Future of Aquaculture in the 21st Century
    14 October 1995

24. Prof. Dr. Sharifuddin Haji Abdul Hamid
    Management of Highly Weathered Acid Soils for Sustainable Crop Production
    28 October 1995

25. Prof. Dr. Yu Swee Yean
    Fish Processing and Preservation: Recent Advances and Future Directions
    9 December 1995

26. Prof. Dr. Rosli Mohamad
    Pesticide Usage: Concern and Options
    10 February 1996

27. Prof. Dr. Mohamed Ismail Abdul Karim
    Microbial Fermentation and Utilization of Agricultural Bioresources and Wastes in Malaysia
    2 March 1996

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    Soil Physics: From Glass Beads to Precision Agriculture
    16 March 1996

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    Sustained Growth and Sustainable Development: Is there a Trade-Off 1 or Malaysia
    13 April 1996

30. Prof. Dr. Chew Tek Ann
    Sharecropping in Perfectly Competitive Markets: A Contradiction in Terms
    27 April 1996

31. Prof. Dr. Mohd. Yusuf Sulaiman
    Back to the Future with the Sun
    18 May 1996

32. Prof. Dr. Abu Bakar Salleh
    Enzyme Technology: The Basis for Biotechnological Development
    8 June 1996

33. Prof. Dr. Kamel Ariffin Mohd. Atan
    The Fascinating Numbers
    29 June 1996

34. Prof. Dr. Ho Yin Wan
    Fungi: Friends or Foes
    27 July 1996

35. Prof. Dr. Tan Soon Guan
    Genetic Diversity of Some Southeast Asian Animals: Of Buffaloes and Goats and Fishes Too
    10 August 1996
36. Prof. Dr. Nazaruddin Mohd. Jali
   Will Rural Sociology Remain Relevant in the 21st Century?
   21 September 1996

37. Prof. Dr. Abdul Rani Bahaman
   Leptospirosis-A Model for Epidemiology, Diagnosis and Control
   of Infectious Diseases
   16 November 1996

38. Prof. Dr. Marziah Mahmood
   Plant Biotechnology - Strategies for Commercialization
   21 December 1996

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   Market Relationships in the Malaysian Fish Trade: Theory and Application
   22 March 1997

40. Prof. Dr. Suhaila Mohamad
   Food and its Healing Power
   12 April 1997

41. Prof. Dr. Malay Raj Mukerjee
   A Distributed Collaborative Environment for Distance Learning Applications
   17 June 1998

42. Prof. Dr. Wong Kai Choo
   Advancing the Fruit Industry in Malaysia: A Need to Shift Research Emphasis
   15 May 1999

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   Avian Respiratory and Immunosuppressive Diseases- A Fatal Attraction
   10 July 1999

44. Prof. Dr. Sariah Meon
   Biological Control of Plant Pathogens: Harnessing the Richness of Microbial Diversity
   14 August 1999

45. Prof. Dr. Azizah Hashim
   The Endomycorrhiza: A Futile Investment?
   23 October 1999

46. Prof. Dr. Noraini Abdul Samad
   Molecular Plant Virology: The Way Forward
   2 February 2000

47. Prof. Dr. Muhamad Awang
   Do We Have Enough Clean Air to Breathe?
   7 April 2000

48. Prof. Dr. Lee Chnoong Kheng
   Green Environment, Clean Power
   24 June 2000

49. Prof. Dr. Mohd. Ghazali Mohayidin
   Managing Change in the Agriculture Sector: The Need for Innovative Educational Initiatives
   12 January 2002

50. Prof. Dr. Fatimah Mohd. Arshad
   Analisis Pemasaran Pertanian di Malaysia: Keperluan Agenda Pembaharuan
   26 January 2002

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   23 March 2002

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   13 April 2002
<table>
<thead>
<tr>
<th>No.</th>
<th>Author</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Prof. Dr. Maisom Abdullah</td>
<td>Productivity Driven Growth: Problems &amp; Possibilities</td>
<td>27 April 2002</td>
</tr>
<tr>
<td>55</td>
<td>Prof. Dr. Wan Omar Abdullah</td>
<td>Immunodiagnosis and Vaccination for Brugian Filariasis: Direct Rewards from Research Investments</td>
<td>6 June 2002</td>
</tr>
<tr>
<td>56</td>
<td>Prof. Dr. Syed Tajuddin Syed Hassan</td>
<td>Agro-ento Bioinformation: Towards the Edge of Reality</td>
<td>22 June 2002</td>
</tr>
<tr>
<td>57</td>
<td>Prof. Dr. Dahlan Ismail</td>
<td>Sustainability of Tropical Animal-Agricultural Production Systems: Integration of Dynamic Complex Systems</td>
<td>27 June 2002</td>
</tr>
<tr>
<td>58</td>
<td>Prof. Dr. Ahmad Zabaidi Baharumshah</td>
<td>The Economics of Exchange Rates in the East Asian Countries</td>
<td>26 October 2002</td>
</tr>
<tr>
<td>59</td>
<td>Prof. Dr. Shaik Md. Noor Alam S.M. Hussain</td>
<td>Contractual Justice in Asean: A Comparative View of Coercion</td>
<td>31 October 2002</td>
</tr>
<tr>
<td>60</td>
<td>Prof. Dr. Wan Md. Zin Wan Yunus</td>
<td>Chemical Modification of Polymers: Current and Future Routes for Synthesizing New Polymeric Compounds</td>
<td>9 November 2002</td>
</tr>
<tr>
<td>61</td>
<td>Prof. Dr. Annuar Md. Nassir</td>
<td>Is the KLSE Efficient? Efficient Market Hypothesis vs Behavioural Finance</td>
<td>23 November 2002</td>
</tr>
<tr>
<td>62</td>
<td>Prof. Ir. Dr. Radin Umar Radin Sohadi</td>
<td>Road Safety Interventions in Malaysia: How Effective Are They?</td>
<td>21 February 2003</td>
</tr>
<tr>
<td>63</td>
<td>Prof. Dr. Shamsher Mohamad</td>
<td>The New Shares Market: Regulatory Intervention, Forecast Errors and Challenges</td>
<td>26 April 2003</td>
</tr>
<tr>
<td>64</td>
<td>Prof. Dr. Han Chun Kwong</td>
<td>Blueprint for Transformation or Business as Usual? A Structurational Perspective of the Knowledge-Based Economy in Malaysia</td>
<td>31 May 2003</td>
</tr>
<tr>
<td>65</td>
<td>Prof. Dr. Mawardi Rahmani</td>
<td>Chemical Diversity of Malaysian Flora: Potential Source of Rich Therapeutic Chemicals</td>
<td>26 July 2003</td>
</tr>
<tr>
<td>66</td>
<td>Prof. Dr. Fatimah Md. Yusoff</td>
<td>An Ecological Approach: A Viable Option for Aquaculture Industry in Malaysia</td>
<td>9 August 2003</td>
</tr>
<tr>
<td>67</td>
<td>Prof. Dr. Mohamed Ali Rajion</td>
<td>The Essential Fatty Acids-Revisited</td>
<td>23 August 2003</td>
</tr>
<tr>
<td>68</td>
<td>Prof. Dr. Azhar Md. Zain</td>
<td>Psychotheraphy for Rural Malays - Does it Work?</td>
<td>13 September 2003</td>
</tr>
<tr>
<td>70</td>
<td>Prof. Dr. Jinap Selamat</td>
<td>Cocoa-Wonders for Chocolate Lovers</td>
<td>14 February 2004</td>
</tr>
</tbody>
</table>
Sharifah Roohi Syed Waseem Ahmad

71. Prof. Dr. Abdul Halim Shaari
   High Temperature Superconductivity: Puzzle & Promises
   13 March 2004

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   Oils and Fats Analysis - Recent Advances and Future Prospects
   27 March 2004

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   24 April 2004

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   Tapping the Power of Enzymes-Greening the Food Industry
   11 May 2004

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   The Spider Mite Saga: Quest for Biorational Management Strategies
   22 May 2004

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   The Education of At-Risk Children: The Challenges Ahead
   26 June 2004

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   Agricultural Robot: A New Technology Development for Agro-Based Industry
   14 August 2004

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   Insect Diseases: Resources for Biopesticide Development
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   23 April 2005

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   Helping Malaysian Youth Move Forward: Unleashing the Prime Enablers
   29 April 2005

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   In Search of an Early Indicator of Kidney Disease
   27 May 2005

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   Smart Partnership: Plant-Rhizobacteria Associations
   17 June 2005

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   1 July 2005

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   Materials Science and Technology: Past, Present and the Future
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   Enhancing Career Development Counselling and the Beauty of Career Games
   12 August 2005

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   Engineering Agricultural Water Management Towards Precision Framing
   26 August 2005

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   Bioremediation-A Hope Yet for the Environment?
   9 September 2005

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   23 December 2005
Physical to Biological Building Blocks in Hand and Microsurgery

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1 February 2008

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22 February 2008
Sharifah Roohi Syed Waseem Ahmad

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Biochemistry of Xenobiotics: Towards a Healthy Lifestyle and Safe Environment
1 August 2008

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Penjagaan Kesihatan Primer di Malaysia: Cabaran Prospek dan Implikasi dalam Latihan dan Penyelidikan Perubatan serta Sains Kesihatan di Universiti Putra Malaysia
8 August 2008

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Memanfaatkan Teknologi Maklumat & Komunikasi ICT untuk Semua
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Role of Media in Development: Strategies, Issues & Challenges
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24 October 2008

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9 January 2009

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Leadership Theories, Research & Practices: Farming Future Leadership Thinking
16 January 2009
Physical to Biological Building Blocks in Hand and Microsurgery

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   *Waste Management, What is the Choice: Land Disposal or Biofuel?*  
   23 January 2009

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   *Freshwater Fish: The Overlooked Alternative*  
   30 January 2009

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   *The Chemistry of Nanomaterial and Nanobiomaterial*  
   6 February 2009

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   *Engineering Agricultural: Water Resources*  
   20 February 2009

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   *Crop Breeding: Exploiting Genes for Food and Feed*  
   6 March 2009

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   *Money Demand*  
   27 March 2009

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   *In Search of Small Active Molecules*  
   3 April 2009

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   *Volunteerism: Expanding the Frontiers of Youth Development*  
   17 April 2009

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   *Industrializing Biotechnology: Roles of Fermentation and Bioprocess Technology*  
   8 May 2009

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   *Mechanics of Tillage Implements*  
   12 June 2009

135. Prof. Dr. W. Mahmood Mat Yunus  
   *Photothermal and Photoacoustic: From Basic Research to Industrial Applications*  
   10 July 2009

136. Prof. Dr. Taufiq Yap Yun Hin  
   *Catalysis for a Sustainable World*  
   7 August 2009

137. Prof. Dr. Raja Noor Zaliha Raja Abd. Rahman  
   *Microbial Enzymes: From Earth to Space*  
   9 October 2009

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   *Materials, Energy and CNGDI Vehicle Engineering*  
   6 November 2009

139. Prof. Dr. Zulkifli Idrus  
   *Poultry Welfare in Modern Agriculture: Opportunity or Threat?*  
   13 November 2009

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   *Managing Phosphorus: Under Acid Soils Environment*  
   8 January 2010

141. Prof. Dr. Abdul Manan Mat Jais  
   *Haruan Channa striatus a Drug Discovery in an Agro-Industry Setting*  
   12 March 2010

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   *Problematic Soils: In Search for Solution*  
   19 March 2010

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   *Family Purchase Decision Making: Current Issues & Future Challenges*  
   16 April 2010
Sharifah Roohi Syed Waseem Ahmad

144. Prof. Dr. Mohd Adzir Mahdi
   Lightspeed: Catch Me If You Can
   4 June 2010

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   Designer Genes: Fashioning Mission Purposed Microbes
   18 June 2010

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   A Stroke of Hope, A New Beginning
   2 July 2010

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   Going Hyperspectral: The "Unseen" Captured?
   16 July 2010

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   Concurrent Engineering for Composites
   30 July 2010

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   Google the Earth: What’s Next?
   15 October 2010

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   Haute Couture: Molecules & Biocatalysts
   29 October 2010

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   Poultry Vaccines: An Innovation for Food Safety and Security
   12 November 2010

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   Fern of Malaysian Rain Forest
   3 December 2010

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   Preparing Malaysian Youths for the World of Work: Roles of Technical and Vocational Education and Training (TVET)
   14 January 2011

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   Are there "Magic Bullets" for Cancer Therapy?
   11 February 2011

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   Biopharmaceuticals: Protection, Cure and the Real Winner
   18 February 2011

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   Genetic Manipulation in Farmed Fish: Enhancing Aquaculture Production
   25 March 2011

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   Coastal Biodiversity and Pollution: A Continuous Conflict
   22 April 2011

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   Energy Crisis 2050? Global Scenario and Way Forward for Malaysia
   10 June 2011

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   Managing Plant Under Stress: A Challenge for Food Security
   15 July 2011

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   Does Genetic Polymorphisms Affect Health?
   23 September 2011

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   Wonders of Glass: Synthesis, Elasticity and Application
   7 October 2011

162. Prof. Dr. Azizah Osman
   Fruits: Nutritious, Colourful, Yet Fragile Gifts of Nature
   14 October 2011
163. Prof. Dr. Mohd. Fauzi Ramlan  
*Climate Change: Crop Performance and Potential*  
11 November 2011

164. Prof. Dr. Adem Kiliçman  
*Mathematical Modeling with Generalized Function*  
25 November 2011

165. Prof. Dr. Fauziah Othman  
*My Small World: In Biomedical Research*  
23 December 2011

166. Prof. Dr. Japar Sidik Bujang  
*The Marine Angiosperms, Seagrass*  
23 March 2012

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*Air Quality and Children’s Environmental Health: Is Our Future Generation at Risk?*  
30 March 2012

168. Prof. Dr. Zainal Abidin Mohamed  
*Where is the Beef? Vantage Point from the Livestock Supply Chain*  
27 April 2012

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*Genetic Characterisation of Animal Genetic Resources for Sustainable Utilisation and Development*  
30 November 2012

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*The Good The Bad & Ugly of Food Safety: From Molecules to Microbes*  
7 December 2012

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*My Colourful Sketches from Scratch: Molecular Imaging*  
5 April 2013

172. Prof. Dr. Norljiah Othman  
*Lower Respiratory Infections in Children: New Pathogens, Old Pathogens and the Way Forward*  
19 April 2013

173. Prof. Dr. Jayakaran Mukundan  
*Steroid-like Prescriptions English Language Teaching Can Ill-afford*  
26 April 2013

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*Photothermals Affect Our Lives*  
7 June 2013

175. Prof. Dr. Rahinah Ibrahim  
*Design Informatics*  
21 June 2013

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*Natural Products from Malaysian Rainforests*  
1 November 2013

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*The Many Facets of Statistical Modeling*  
22 November 2013

178. Prof. Dr. Paridah Md. Tahir  
*Bonding with Natural Fibres*  
6 December 2013

179. Prof. Dr. Abd. Wahid Haron  
*Livestock Breeding: The Past, The Present and The Future*  
9 December 2013

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*Exploring Biodiversity & Fisheries Biology: A Fundamental Knowledge for Sustainable Fish Production*  
24 January 2014

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*Competitiveness of Beekeeping Industry in Malaysia*  
21 March 2014
Sharifah Roohi Syed Waseem Ahmad

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Food and Wealth from the Seas: Health Check for the Marine Fisheries of Malaysia
25 April 2014

183. Prof. Datin Dr. Rosenani Abu Bakar
Waste to Health: Organic Waste Management for Sustainable Soil Management and Crop Production
9 May 2014

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Poultry Viruses: From Threat to Therapy
23 May 2014

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Tracing the Untraceable: Fingerprinting Pollutants through Environmental Forensics
13 June 2014

186. Prof. Dr. -Ing. Ir. Renuganth Varatharajoo
Space System Trade-offs: Towards Spacecraft Synergisms
15 August 2014

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Transformasi Kesihatan Wanita ke Arah Kesejahteraan Komuniti
7 November 2014

188. Prof. Dr. Tan Chin Ping
Fat and Oils for a Healthier Future: Makro, Micro and Nanoscales
21 November 2014

189. Prof. Dr. Suraini Abd. Aziz
Lignocellulosic Biofuel: A Way Forward
28 November 2014

190. Prof. Dr. Robiah Yunus
Biobased Lubricants: Harnessing the Richness of Agriculture Resources
30 January 2015

191. Prof. Dr. Khozirah Shaari
Discovering Future Cures from Phytochemistry to Metabolomics
13 February 2015

192. Prof. Dr. Tengku Aizan Tengku Abdul Hamid
Population Ageing in Malaysia: A Mosaic of Issues, Challenges and Prospects
13 March 2015

193. Prof. Datin Dr. Faridah Hanum Ibrahim
Forest Biodiversity: Importance of Species Composition Studies
27 March 2015

194. Prof. Dr. Mohd Salleh Kamarudin
Feeding & Nutritional Requirements of Young Fish
10 April 2015

195. Prof. Dato' Dr. Mohammad Shatar Sabran
Money Boy: Masalah Sosial Era Generasi Y
8 Mei 2015

196. Prof. Dr. Aida Suraya Md. Yunus
Developing Students’ Mathematical Thinking: How Far Have We Come?
5 June 2015

197. Prof. Dr. Amin Ismail
Malaysian Cocoa or Chocolates: A Story of Antioxidants and More...
14 August 2015

198. Prof. Dr. Shamsuddin Sulaiman
Casting Technology: Sustainable Metal Forming Process
21 August 2015

199. Prof. Dr. Rozita Rosli
Journey into Genetic: Taking the Twists and Turns of Life
23 October 2015
<table>
<thead>
<tr>
<th>No.</th>
<th>Prof. Name &amp; Title</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>Prof. Dr. Nor Aini Ab Shukor</td>
<td>Physical to Biological Building Blocks in Hand and Microsurgery</td>
<td>6 November 2015</td>
</tr>
<tr>
<td>201</td>
<td>Prof. Dato' Dr. Ir Mohd Saleh Jaafar</td>
<td>The Un(Straight) Truth About Trees</td>
<td>13 November 2015</td>
</tr>
<tr>
<td>202</td>
<td>Prof. Dr. Maznah Ismail</td>
<td>Advancing Concrete Materials and Systems: The Search Continues</td>
<td>29 April 2016</td>
</tr>
<tr>
<td>203</td>
<td>Prof. Dr. Habshah Midi</td>
<td>Germinated Brown Rice and Bioactive Rich Fractions: On Going Journey from R&amp;D to Commercialisation</td>
<td>29 April 2016</td>
</tr>
<tr>
<td>204</td>
<td>Prof. Dr. Mansor Ahmad @ Ayob</td>
<td>Amazing Journey to Robust Statistics Discovering Outliers for Efficient Prediction</td>
<td>6 May 2016</td>
</tr>
<tr>
<td>205</td>
<td>Prof. Dr. Fudziah Ismail</td>
<td>Exploring Efficient Numerical Methods for Differential Equations</td>
<td>23 September 2016</td>
</tr>
<tr>
<td>206</td>
<td>Prof. Dr. Noordin Mohamed Mustapha</td>
<td>Meandering Through the Superb Scientific World of Pathology: Exploring Intrapolations</td>
<td>30 September 2016</td>
</tr>
<tr>
<td>207</td>
<td>Prof. Dr. Mohd. Majid Konting</td>
<td>Teaching for Quality Learning: A Leadership Challenge</td>
<td>21 October 2016</td>
</tr>
<tr>
<td>208</td>
<td>Prof. Dr. Ezhar Tamam</td>
<td>Are University Students Getting Enough Interethnic Communication and Diversity Engagement Experiences? Concerns and Considerations</td>
<td>11 November 2016</td>
</tr>
<tr>
<td>209</td>
<td>Prof. Dr. Bahaman Abu Samah</td>
<td>Enhancing Extension Research using Structural Equation Modeling</td>
<td>18 November 2016</td>
</tr>
<tr>
<td>210</td>
<td>Prof. Dr. Wen Siang Tan</td>
<td>Fighting the Hepatitis B Virus: Past, Present &amp; Future</td>
<td>9 December 2016</td>
</tr>
<tr>
<td>211</td>
<td>Prof. Dr. Mahmud Tengku Muda Mohamed</td>
<td>Postharvest: An Unsung Solution for Food Security</td>
<td>20 January 2017</td>
</tr>
<tr>
<td>212</td>
<td>Prof. Dr. Sherina Mohd Sidik</td>
<td>Mental Health in the Community-Malaysia: A 20-Year Journey of a Family Medicine Consultant</td>
<td>27 January 2017</td>
</tr>
<tr>
<td>213</td>
<td>Prof. Dr. Zaidon Ashaari</td>
<td>Low Density Wood: From Poor to Excellent</td>
<td>10 February 2017</td>
</tr>
<tr>
<td>214</td>
<td>Prof. Ir. Dr. Mohd Zainal Ab. Kadir</td>
<td>Lightning: A Bolt from the Blue</td>
<td>17 February 2017</td>
</tr>
<tr>
<td>215</td>
<td>Prof. Datin Dr. Rozi Mahmud</td>
<td>No Less Than a Woman: Improving Breast Cancer Detection and Diagnosis</td>
<td>17 March 2017</td>
</tr>
<tr>
<td>216</td>
<td>Prof. Dr. Jegatheswaran Ratnasingam</td>
<td>The Malaysian Furniture Industry: Charting its Growth Potential</td>
<td>7 April 2017</td>
</tr>
<tr>
<td>217</td>
<td>Prof. Dr. Loh Teck Chewn</td>
<td>Animal Feed: The Way Forward</td>
<td>21 April 2017</td>
</tr>
<tr>
<td>218</td>
<td>Prof. Dr. Luqman Chuah Abdullah</td>
<td>Rigid Ceramic Filters: Numerical Simulation of The Pressure &amp; Velocity Distributions</td>
<td>5 May 2017</td>
</tr>
</tbody>
</table>
219. Prof. Dr. Lai Oi Ming  
Diacylglycerols: Healthy Fats of the Future  
19 May 2017

220. Prof. Dr. Rozumah Baharudin  
Parenting: What Matters Most?  
25 May 2017

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20 Oktober 2017

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9 Mac 2018

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Repair, Reconstruction, Replacement and Reduction of Musculoskeletal Disorders & Limb Injuries  
16 Mac 2018

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Aplikasi Ujian Psikometrik dalam Bimbingan dan Kaunseling Kerjaya: Sejahtera Mana Impaknya?  
13 April 2018

226. Prof. Dr. Zamberi Sekawi  
Living Dangerously in a Virus World: Losing End?  
20 April 2018
INDEX

Adult Brachial Plexus injuries 36
amputations 35

bioabsorbable materials 3
biomedicine 3
brachial plexus birth palsies 27

cap reattachment 43
congenital hand 25
constriction bands 26
crush injuries 34

degloving injury 34

fingertip 28
fingertip injuries 31
firecracker 32
flexor tenosynovitis 37
free flaps 42

glomus 40

hand and microsurgery 2
hand clinic 23
hand infections 37
hand nail guns 33
hand therapists 24

Local 43

machine injuries 32
macrodactyly 26
malignant tumour 39
maxillo-facial 7

necrotising fasciitis 37
non-union 30

Ostrowski flap 43

paint guns 33
perception 1
performance 1
perspiration 1
pollicisation 27
polydactyly 26
pouce flottant 27

radial club hand 26, 27
Reconstructive Surgery 42
rotational flaps 43

stereognosis 1
sugarcane extraction 32
Supermicro 3
symbrachydactyly 26
syndactyly 26

therapy Area 24
thumb hypoplasia 27
tuberculosis 37
tumour 40
tumours 39

vascular tumour 41
viral warts 38