Automation: The Future of the Microbiology Laboratory?

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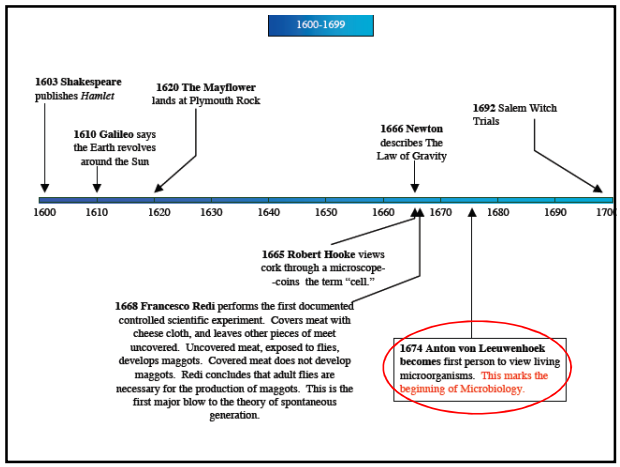
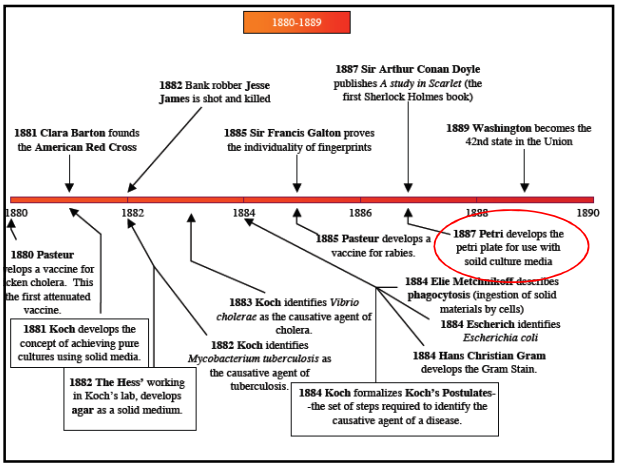




So what's changed??

- Microscopy is mostly unchanged …..
- Agar plates are still the main media for the majority of microbial culturing and the backbone of the bacteriology lab.
- Manual streaking of plates has not really changed since solid agar plates were first used
- Plate reading has not really changed over years– although you are not supposed to sniff plates anymore….but we know it happens
- Incubators while probably more reliable are essentially the same
- ID's based on sugars

Disc diffusion is still used in the vast majority of laboratories – if not all to some degree

The beginning of Automation

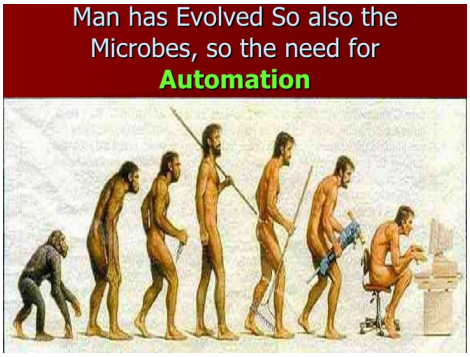
- The field started around mid-1960's
- Historically, automation largely bypassed the micro lab

In microbiology we've long had a culture--no pun intended--of having a laboratory that is very manual, and the human element is very important !

HISTORICAL IMPEDIMENTS TO AUTOMATION IN MICROBIOLOGY

1. Microbiology is too complex to automate
   - Diversity of specimen types
   - Complexity of collection devices
   - Different processing protocols
   - Complexity of media

2. No machine can replace a human in the microbiology laboratory
   - Human observation of organism growth on plates
3. Cost of automation
4. Microbiology laboratories are too small for automation



WINDS OF CHANGE

1. Industry changes
   - Increasing testing volumes
   - Improved health care/access
   - Ageing population
   - Emerging diseases / HIV
   - testing innovations
2. Infection control demands
   - growing challenges resulting from detection and identification of multidrug-resistant microorganisms

WINDS OF CHANGE

3. Growing scarcity of skilled technologists
4. Quality issues
   - The trend toward increasingly shorter lengths of stay for hospital inpatients has led to increased demand for more rapid turnaround times for infectious disease assays thereby improving patient care
   - The(24/7) microbiology laboratory is becoming much more common, and automation that can shorten turnaround time is being viewed more favourably

WINDS OF CHANGE

5. New Technologies
   - MALDI-TOF procedures are highly amenable to automation because they are technically relatively simple and reproducible protein based spectral identification of bacteria
     - Identifications available in literally minutes – not hours
     - Tiny amount of bacterial growth needed – not affected by media or incubation conditions
     - spotting of target plates and extraction of proteins can be standardized for most organisms
     - also facilitates rapid id of yeast
     - Minimal cost per test, virtually no consumables, can be performed with minimal staffing
     - Suppliers : BD/Bruker, BioMerieux

REQUIREMENTS FOR AUTOMATION

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- **Flexibility** acknowledges that one size will not fit all and incorporates an open, expandable architecture that can be adapted to a laboratory's available space and potential future growth. Moreover, flexibility will also require that automation systems embrace diversity of equipment manufacturers.
- It is important to appreciate that automation does not remove decision making for the microbiology technologist; rather, if **facilitates** decision making and eliminates wasteful activities.
- Automation **interface** with existing LIS
- Accuracy, capacity, manufacturer's technical support, modularity and costs

Automation

- Automated urine analysers
- Plate streakers
- Blood cultures
- Automated ID
- Automated susceptibility testing
- Automated molecular platforms,eg. Gene xpert

1. Specimen processors
2. Total Lab Automation

Specimen Processors

The four currently available specimen processors :

- the Innova processor (BD Diagnostics, Sparks, MD)
- the InoqulA full automation/manual interaction (FA/MI) specimen-processing device (BD Kiestra B.V., Drachten, Netherlands)
- the Previ Isola automated plate streaker (bioMérieux, Inc., Hazelwood, MO)
- the walk-away specimen processor (WASP; Copan Diagnostics, Murrieta, CA)

Each of the 4 instruments is capable of automating the processing of a variety of liquid-based specimens.

Innova specimen processor.

Bourbeau P P , and Ledeboer N A J. Clin. Microbiol. 2013;51:1658-1665

Journal of Clinical Microbiology

InoqulA specimen processor.

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Previ Isola specimen processor.

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WASP.

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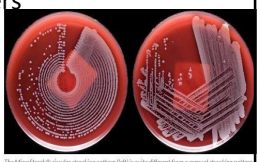
Specimen Processors

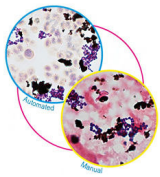
Pre-analytical – Plate Streakers
- Universal decapping
- Select appropriate media
- Loads the samples
- Spreading the inoculum to obtain isolated single colonies following incubation

Automatic loop changer/ cleaner or two loops



Automated gram stainer

- Not all systems include Gram stain preparation
- standardization of initial specimen processing
- Improved slide quality
- Diminished wastage
- substantial cost savings



Microbiology Total Laboratory Automation(TLA) Solutions

Putting specimens on a track – with no human intervention until plate reading time– and even then its not like you know it…
Hands Off Microbiology!!

The Players

"The 3 Solutions"

Kiestra | FMLA | WASP

BD | Biomerieux | Copan

Kiestra TLA system.

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FMLA system.

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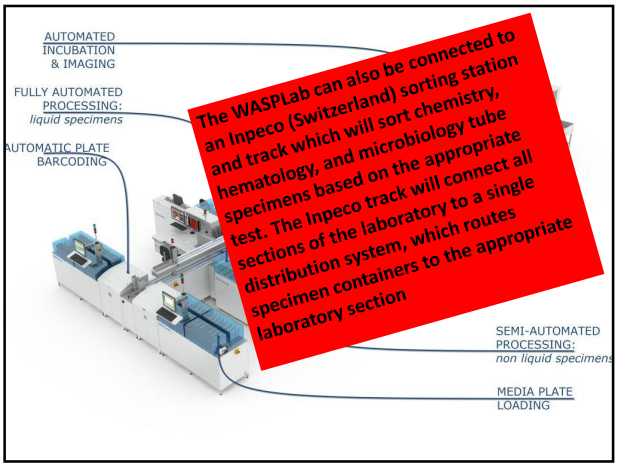
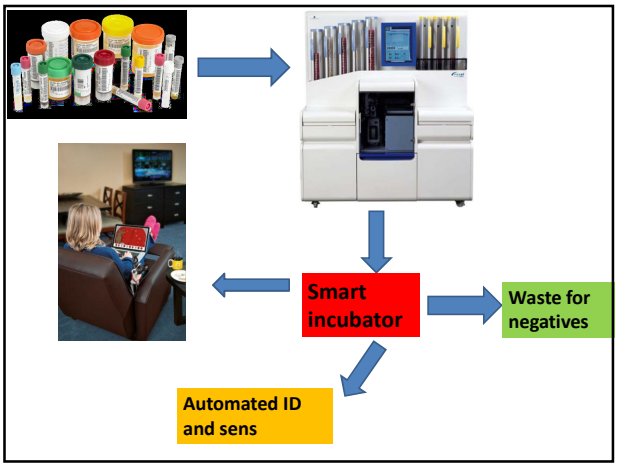


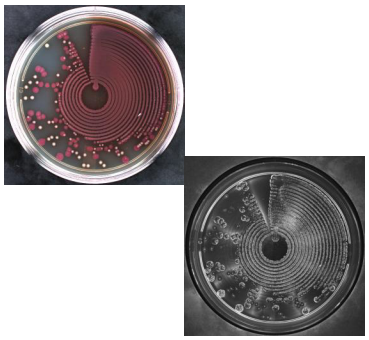


- ✓ Can facilitate different specimen holders
- ✓ Liquid and non-liquid specimens
- ✓ Sample centrifugation/ vortex / agitation
- ✓ Automatic gram slide prep
- ✓ Allows for different media streaking as per protocol; includes bi-plates
- ✓ Automatic bar coding of plates (side labelling)
- ✓ Automatic broth inoculation
- ✓ Sent to incubator; plate sorting according to incubation conditions

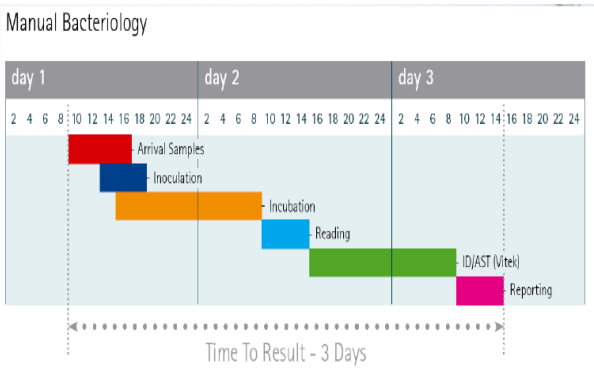
- There is continuous incubation of plated media at a constant and uniform temperature
- Plate reading can be performed when incubation is adequate on a plate and is not tied to a traditional lab work schedule
- Automated incubators with digital reading stations
- Automated storage and incubation
- When plates are required for workup, they can be efficiently retrieved, obviating the need to handle multiple stacks of plates
- Conveyor/track systems to move plates to and from incubators, digital cameras to capture plate images at specified intervals
- High quality imaging, plate image records are retained, which facilitates review of growth both over time and between different specimens
- Improved traceability
- improvement in the quality of supervisory culture review and enhance the training of new technologists

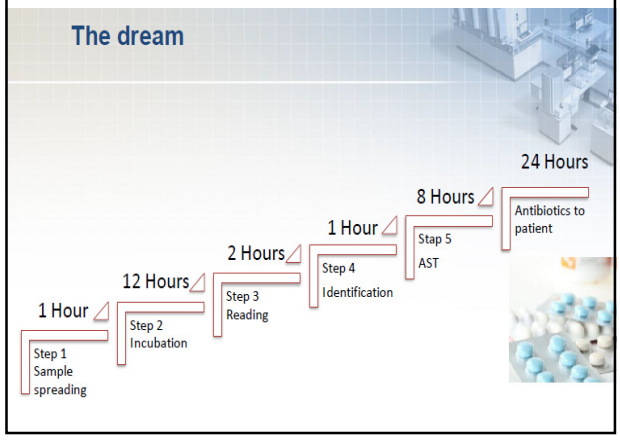
Smart Incubator System

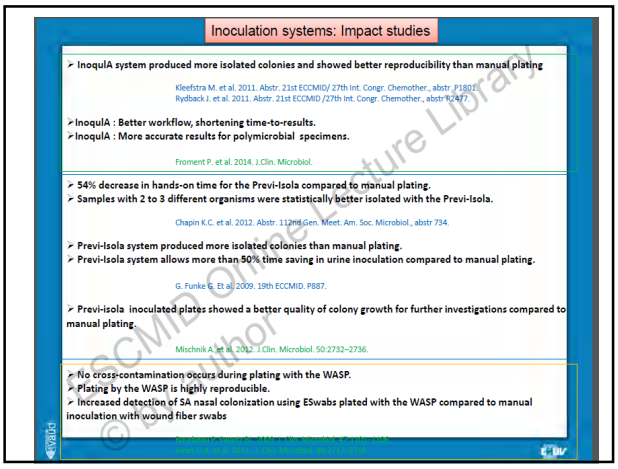
- SIS will get rid of negatives plates in a totally automated fashion (could represent a significant # of plates)
- SIS will allow an early warning of positives, pre-sorting them out, and making it immediately available for technicians to keep with the ID/AST processes -time to results will dramatically decrease
- With a fully automated microbiology lab, the proposal is that the concept of shifts will vanish – no matter the time the sample arrives to the lab, it will be moved along the workflow chain –including Identification and AST on a 24/7 basis



Traditional microbiology	Automated microbiology	Impact
Specimens processed in batches	Specimens processed on receipt in lab	Eliminates multiple handling steps and processing delays
Technologists select and inoculate media according to processing protocols	Automated programmed media selection and specimen inoculation	Decreased processing errors; reproducible inoculation of media; improved isolation of colonies
Inoculation of media with predetermined specimen volumes and streaking pattern	Inoculation of media with user-defined range of specimen volumes and streaking patterns	Specimen volumes and streaking patterns selected for optimal recovery of isolated colonies
Manual transfer of inoculated plates to incubator	Automated transfer of inoculated plates to incubator	Elimination of delays from inoculation of media to placement in incubator
Manual stacking of inoculated plates in incubator	Automated placement of plates in incubator slots	Improved circulation of incubator air; elimination of time required to find and retrieve inoculated plates
Manual examination of inoculated plates	Automated imaging of plates at user-defined intervals	Creation of progressive images of colony growth; ability to differentiate plates with growth from negative cultures; plates remain in incubator maximising culture growth
Written/electronic record of work	Electronic/digital record of work	Digital image library optimises processing of specimen by multiple technologists; decreases workflow inefficiencies; improves quality control of processing
Plates examined at workstation	Plates examined at workstation, in reading room, or remotely	Permits plates to be examined in a distraction-free area and review of plates remotely by expert microbiologists
Processing cultures determined by schedule of technical staff	Processing cultures determined by schedule of culture growth	Shortest time to results; maximum staffing efficiency







While the benefits of microbiology automation can often be inferred, well-performed studies are needed to accurately assess the financial, operational, and clinical impacts of incremental or total laboratory automation in microbiology laboratories. Such studies will be necessary to define the true, rather than perceived or hoped-for, value of front-end and total laboratory automation in clinical microbiology.

Concerns?

- Cost-benefit
- Comfort levels with new technology – you want to see the raw data
- Downtime
- Space
- Loss of skills
- Loss of job opportunity

Modular, piecemeal approach to automation

3 trends will drive laboratory automation's future

- Smaller, more-flexible analysers
- Automation based on next generation technology
- Powerful software for centralised lab management
- Internet based , real time service

Thanks for listening!