From Stead to Singapore:
Building a new way to learn

C. Frank Starmer
Duke-NUS Graduate Medical School
Singapore &
Duke University
Our Objective: To embed Stead themes throughout Duke-NUS

- Everyone is a learner
- Learn through doing and explaining
- Know what you don’t know
- Reinforce learning with repetition
- Visual thinking / communication
- Identify patterns and deviations from patterns
- Team-based problem solving
- Extend brain memory with Internet memory
Gene’s marching orders.

Behind the scenes pot stirring by Gene: an excerpt from a note to Ellen

I have always admired Frank for his independence and his willingness to take new
ventures. along the way he has become a
super mentor and an inspirational for many
young people.

He was keen for grasping. I’ve urged him
to step up plan for the next thirty years. He
needs to find a liberal college where he can spend
the rest of his life inspiring young people. put him
to work. I will lead the clearing section.

Gene Stebb

April, 2003

Fortunately, Sandy Williams provided
something better than a liberal arts college: Duke- NUS GMS

Transforming Medicine, Improving Lives
An engineer in a clinical dept: The 30+ year Stead, Wyngaarden and Greenfield STP

- **1959-1965**: Undergraduate and MS EE student, worked for TelCom in Duke South
- **1961**: Henry McIntosh, Tommy Thompson, Bob Whalen and Jim Morris (Cardiac Cath Lab)
- **1963**: John Moore exposes me to quantitative neurobiology (Basic Science)
- **1965**: Gene “encouraged” me to leave. If I was “any good”, he would invite me back
- **1967**: Stead “People Chemistry” experiment, 1st PhD in the Dept of Medicine
- **1969-1980**: Built the IT infrastructure for the Cardiology Databank
- **1970**: Gene gave Ellen the keys to his place at Kerr Lake (Life Balance)
- **1971**: Established the Computer Science Dept (Computer Science)
- **1972-1977**: Learning medicine: Physical Diagnosis (Galen) + Osler rounds (Gene)
- **1975**: McNeer, Wallace, Wagner, Starmer, Rosati Circulation 51:410-413 (EBM)
- **1981-2005**: Joe Greenfield sent me to work with Gus Grant: Antiarrhythmic drugs
- **1985**: Starmer and Grant: Mol. Pharm 28, 348-356 (Basic Science)
- **1987-2002**: Collaborative research in USSR / Russia (Multiculture Lessons)
- **1993-94**: Visiting Prof at Indian Institute of Technology, Madras, India (Multiculture Lessons)
- **1997**: Completed Singapore Training Program
- **1998**: Fulbright – Univ Patras, Greece (Multicultural Lessons)
- **2006 - ?**: Unretired from Duke to execute Gene’s and Sandy’s marching orders

*Transforming Medicine, Improving Lives*
The Challenge

From March 2006

To March 2009

Transforming Medicine, Improving Lives
The surface agenda: Sandy’s marching orders

Pat Casey, Bob Kamei, Sandy Cook, Ed Buckley and you have 16 months to build a successful and competitive learning program from the ground up

We had to:

• Build learning spaces (large learning room, clinical practice rooms, laboratory, lounge)
• Implement the Duke curriculum: Adapting the Duke curriculum to the Singapore context: Team-based learning modeled on teaching rounds with Dr. Stead on Osler
• Recruit a faculty
• Become known to potential students
• Deal with uncertainty: Will there be applicants? Will there be completed applications. Will we recruit a world-class faculty? Can we build a learning strategy reflecting the way we would like to have learned? And finally, what about Naomi?
• Maintain balance: address the requirements of Ministries of Health, Education, Finance and Trade and Industry, A*STAR (Agency for Science, Technology and Research) and Duke
• Build a partnership with SingHealth (Singapore General Hospital and KK Women’s and Children’s Hospital)
• With SingHealth, develop the Outram academic campus
• Design, construct and debug our new building

Transforming Medicine, Improving Lives
The Stead themes: our hidden agenda:

- **A flat structure:** Everyone is a learner. Traditional students are junior learners, faculty are senior learners
- **A learner-centric pecking order:**
  - 1st Students
  - 2nd Everyone else
- **Internet-centric learning**
- **Crescendo-like transition** from university to medical school to housestaff to professional life
  - First weeks of school = Foundations, not Orientation
  - Developing young people, neither educating nor teaching
  - Team-based administration (Ranga’s influence, balanced score card)
  - Promote and enable flexible individual learning styles
    - Laptop neutral (Windows, Mac, Linux)
    - Open learning resources (Internet accessible)
    - Embrace portable media (USB disk, iPhone and iPod touch)
- Mastering MFU concepts (reduce exposure to the forgetting process)
- **Our internal objective:** To out-Duke Duke

*Transforming Medicine, Improving Lives*
Foundations of our program:

- Culture matters – encourage respectful questioning
- Team-based learning
- Ignite curiosity: a major driver of learning
- Engineering approach to problem solving
- Awareness of the neurobiology of learning and forgetting:
  - Drive the curricular content by a what-we-do model: Mastery of the 80% concepts and information we use daily – exposure to other 20%
  - Use Google and Internet resources as a memory extension
  - Learning episodes designed to avoid the forgetting curve
Characterizing forgetting

The time course of forgetting

Source: Hermann Ebbinghaus, Memory: A Contribution to Experimental Psychology, 1885

Transforming Medicine, Improving Lives
Studies of Learning and Forgetting

Ebbinghaus, Über das Gedächtnis (About memory), 1885

Repetition: reinforcing accurate recall of learned material

Retention is exponentially related to time, t, and strength, S:

$$R = e^{-\frac{t}{S}}$$
Learning with Gus: 
Cardiac Cells can learn and forget

Gold Standard Assay: Whole Cell Voltage Clamp

Cardiac Learning

Cardiac Forgetting

Transforming Medicine, Improving Lives

Our Program: Team LEAD (Learn, Engage And Develop)

Goals and Objectives

Independent /Team learning

In-class student teams
  - Readiness phase
  - Application phase

Peer evaluation

Overview

Initial Learning

Repeats 1 and 2

Feedback among team members
First year goals:

Fact and Concept Acquisition (memory)
- Traditional emphasis for medical schools
- Guided Independent learning
- Individual learning style

Information Processing (thinking)
- Making conceptual connections, solving problems, explaining to others, knowing what you don’t know
- TeamLEAD
## Osler Rounds = Team-based learning

<table>
<thead>
<tr>
<th></th>
<th>Osler Rounds</th>
<th>TeamLEAD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prework</strong></td>
<td>Patient assigned, perform Hx + PE. Books and journals to identify differential and prepare for Dr. Stead</td>
<td>Review faculty developed goals / objectives. Learning focused by module learning resources</td>
</tr>
<tr>
<td><strong>Readiness Phase</strong></td>
<td>IRA: Questions around the bedside.</td>
<td>IRA: Multiple choice questions</td>
</tr>
<tr>
<td></td>
<td>GRA: Discussion in the resident’s office (maybe a nickel on the blackboard)</td>
<td>GRA: Team reviews questions and submits consensus answers</td>
</tr>
<tr>
<td><strong>Application Phase</strong></td>
<td>Developing patient care plans</td>
<td>Applying learned concepts and material to questions derived from a clinical problem</td>
</tr>
<tr>
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</tr>
</tbody>
</table>
## Curriculum Overview

### Foundation Course: Learning Critical Thinking
- **Sub I**

### Practice Course 1
- **Aug**
- **Sept**
- **Oct**
- **Nov**
- **Dec**
- **Jan**
- **Feb**
- **Mar**
- **Apr**
- **May**
- **Jun**
- **Jul**
- **Aug**

### Practice Course 2
- **Aug**
- **Sept**
- **Oct**
- **Nov**
- **Dec**
- **Jan**
- **Feb**
- **Mar**
- **Apr**
- **May**
- **Jun**
- **Jul**
- **Aug**

### Practice Course 3
- **Aug**
- **Sept**
- **Oct**
- **Nov**
- **Dec**
- **Jan**
- **Feb**
- **Mar**
- **Apr**
- **May**
- **Jun**
- **Jul**
- **Aug**

### Practice Course 4
- **Aug**
- **Sept**
- **Oct**
- **Nov**
- **Dec**
- **Jan**
- **Feb**
- **Mar**
- **Apr**
- **May**
- **Jun**
- **Jul**
- **Aug**

### Electives
- **Aug**
- **Sept**
- **Oct**
- **Nov**
- **Dec**
- **Jan**
- **Feb**
- **Mar**
- **Apr**
- **May**
- **Jun**
- **Jul**
- **Aug**

### Breaks
- **Aug**
- **Sept**
- **Oct**
- **Nov**
- **Dec**
- **Jan**
- **Feb**
- **Mar**
- **Apr**
- **May**
- **Jun**
- **Jul**
- **Aug**

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**Transforming Medicine, Improving Lives**
Internet-centric learning

Transforming Medicine, Improving Lives

Events for 11th of October, 2009

Announcements

- MOH Blog entry on American Residency model
- Gray announcements are not active
- Blue announcements are postdated (not active).

- MOH Blog entry on American Residency model

The Singapore Ministry of Health (MOH) has published a blog entry by Prof Chee Yam Cheng on the Minister for Health blog. He discusses the American residency system and the benefits it can bring. The links are as follows:

  - Prof Chee's entry on Minister for Health blog:
  - MOH Facebook page:
    http://www.facebook.com/pages/Singapore/Ministry-of-Health/154909330630

MOH would also like to welcome any comments, questions and suggestions from students in response to this entry. Students can post their comments, questions and suggestions to the MOH Facebook page (see link above).
Anywhere – anytime access

Transforming Medicine, Improving Lives

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**How To Utilize Your Year One Portable USB Hard Disk**

To all Year 1 students, you will be issued with a mini toy - **USB portable hard disks** from Duke-NUS Education Office in both Year 1, Semester 1 & 2. All the Year 1 course materials will be included in the hard disk with its respective course subjects as shown below:

<table>
<thead>
<tr>
<th>Year One Course Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester One</td>
</tr>
<tr>
<td>Molecules &amp; Cells</td>
</tr>
<tr>
<td>Normal Body</td>
</tr>
<tr>
<td>Practice Course 1</td>
</tr>
<tr>
<td>Semester Two</td>
</tr>
<tr>
<td>Brain &amp; Behavior</td>
</tr>
<tr>
<td>Body &amp; Disease</td>
</tr>
<tr>
<td>Practice Course 2</td>
</tr>
</tbody>
</table>

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**Contents** [hide]

1. Get Started
2. How To Rsync
3. How To Safely Remove The USB Hard Disk
4. How To Safe Keep Your USB Hard Disk
5. My Documents

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*Transforming Medicine, Improving Lives*
<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 AM - 12:00 PM RA # 5</td>
<td>8:30 AM - 11:00 AM Histology Lab # 3:</td>
<td>8:00 AM - 12:00 PM Practice Course</td>
<td>10:00 AM - 12:00 PM RA # 6</td>
<td>6:30 PM Chill-out session organised by the</td>
<td></td>
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<tr>
<td>LEAD Room - Level 2 - Duke-NUS new campus</td>
<td>Connective Tissue and Blood</td>
<td>LEAD Room - Level 2 - Duke-NUS new campus</td>
<td>LEAD Room - Level 2 - Duke-NUS new campus</td>
<td>Student Council (Venue: Student Lounge)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:00 PM - 6:30 PM TeamLEAD # 5: Genetics</td>
<td>LEAD Room - Level 2 - Duke-NUS new campus</td>
<td>12:30 PM - 1:30 PM College Meetings (Venue:</td>
<td>2:00 PM - 5:30 PM TeamLEAD # 6: Cell Cycle</td>
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<td></td>
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<tr>
<td>LEAD Room - Level 2 - Duke-NUS new campus</td>
<td>Duke-NUS Research Seminar</td>
<td>#03-15, #03-17, #03-18, #03-19)</td>
<td>LEAD Room - Level 2 - Duke-NUS new campus</td>
<td></td>
<td></td>
<td></td>
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<td>12:00 PM - 1:00 PM Duke-NUS Research</td>
<td>Amphitheatre - Level 2 - Duke-NUS new campus</td>
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<tr>
<td>Seminar</td>
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</table>

Adapted from the SuperCal Event Calendar

Calendar displays events listed in the sub categories and parent categories of the selected category.
Prework:

Learning resources and readings

1. In preparation for the TeamLEAD session, please review the video lectures & power point slides under the following topics:
   - Cytoskeleton in health and disease
   - Motor proteins in non-muscle disease
   - mRNA export and trafficking
   - Protein synthesis and protein degradation
   - Molecular mechanisms of protein folding and misfolding
   - Protein translocation: Protein quality control-ERAD
   - Protein trafficking: Protein sorting
   - Endocytosis and endocytosis

2. Research Articles: These are the studies that the applications section will focus on. Please read these papers carefully in advance of class and bring along a copy of each.


TeamLEAD #2: Getting around the cell - Time and Space

Duke-NUS Graduate Medical School Singapore

Category: TeamLEAD
Venue/Location: LEAD Room - Level 2, Duke-NUS new campus
Faculty: David NG - Primary instructor
Members: Marc FIVAZ - Primary instructor
Date: Thursday, August 20, 2009 - 1:30 PM - 5:00 PM

Description: Learning Objectives

- Protein folding
  1. Proficiency to describe principles that determine the three-dimensional fold of a protein.
  2. Critically evaluate different models of how proteins fold.
  3. Compare and contrast the different molecular mechanisms for how misfolded proteins can cause certain diseases.

- Translocation and quality control
  1. Describe the biophysical and biochemical basis for protein misfolding
  2. Appreciate the different fates and cellular consequences of misfolded proteins.
  3. Understand the cellular response to misfolded proteins and the mechanisms used by cells to cope with protein misfolding.

Event Materials

- CYTOSKELETON
  - Cytoskeleton
    - C0803131303n1006g8d0270c00805064194.mov
    - C0803131303n1006g8d0270c00805064194.mp3
    - 16_1.mov
    - 16_1.mp3
    - 16_1.wmv
    - EndowCell2000Cytosk2008V1(2).ppt
    - EndowCell2000Cytosk2008V1.ppt

- CYTOSKELETON in health and disease
  - C0803210009n10069b0270c00803144194.mov
  - C0803210009n10069b0270c00803144194.mp3
  - VBennett_2008.ppt

- Davis Ng Compulsory Readings
  - Chlor et al.pdf
  - Quan et al.pdf

USB disk access
TeamLEAD Module: Readiness
Individual Assessment
Individual assessment: Answers entered with an audience response unit
Individual assessment: Review responses
Green = correct, red = incorrect
TeamLEAD Module: Readiness

Team assessment
Team readiness: Record answers
Scratch-off answer pad
TeamLEAD Module: Application
Team problem solving
Application (1 – 2 hour problem)
Consensus answers to application questions
Body and Disease: Application learning with Doyle Graham
How are we doing?

Stead-inspired TeamLEAD vs the world?
<table>
<thead>
<tr>
<th>Rank</th>
<th>School</th>
<th>Biology</th>
<th>Physical Sciences</th>
<th>Verbal Reason</th>
<th>MCAT Total</th>
<th>GPA</th>
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<td>12</td>
<td>12</td>
<td>11</td>
<td>35</td>
<td>3.86</td>
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<td>2</td>
<td>Washington U</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>37</td>
<td>3.89</td>
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<tr>
<td>3</td>
<td>Univ of Penn</td>
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<td>12</td>
<td>11</td>
<td>35</td>
<td>3.82</td>
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<td>4</td>
<td>Duke Univ</td>
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<td>11</td>
<td>35</td>
<td>3.81</td>
</tr>
<tr>
<td>5</td>
<td>U of Michigan</td>
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<td>12</td>
<td>11</td>
<td>35</td>
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<td>6</td>
<td>Yale Univ</td>
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<td>11</td>
<td>35</td>
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<td>UC SF</td>
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<td>8</td>
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<td>Duke-NUS</td>
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<td>9</td>
<td>31</td>
<td>3.5</td>
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<td>95</td>
<td>Albany Med Col</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>30</td>
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NBME Comprehensive Basic Science Exam (CBSE)

Max

61.0

Min

61.1

66.3

Mean

Range H

Range L

Duke-NUS Y1 2008

Duke-NUS Y1 2009
Thank you

Curiosity
Teamwork
A frank macro photo
Passion
Tenacity

www.duke-nus.edu.sg
Backup Slides
## Academic Background

### Class of 2011

<table>
<thead>
<tr>
<th>Undergraduate Degrees</th>
<th>Engineering (5)</th>
<th>Pharmacy/Pharmacology (4)</th>
<th>Computer Science (2)</th>
<th>Chemistry (1)</th>
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<td>Biology/Life Sciences (14)</td>
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<td>Engineering (5)</td>
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<td>Pharmacy/Pharmacology (4)</td>
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<tr>
<td>Computer Science (2)</td>
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<tr>
<td>Chemistry (1)</td>
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### Class of 2012

<table>
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<th>Undergraduate Degrees</th>
<th>Engineering (11)</th>
<th>Pharmacy/Pharmacology (3)</th>
<th>Computer Science (2)</th>
<th>Chemistry (1)</th>
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<td>Biology/Life Sciences (29)</td>
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<td>Engineering (11)</td>
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### Class of 2013

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<th>Chemistry (1)</th>
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<td>Biology/Life Sciences (37)</td>
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<tr>
<td>Engineering (11)</td>
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<tr>
<td>Chemistry (3)</td>
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### Higher Degrees

<table>
<thead>
<tr>
<th>Higher Degrees</th>
<th>Masters Degree (4)</th>
<th>PhD (1)</th>
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<tr>
<td>Biopsychology &amp; Cognitive Science (1)</td>
<td>Nutrition (1)</td>
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<tr>
<td>Dentistry (1)</td>
<td>Statistics (1)</td>
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<table>
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<th>Masters Degree (7)</th>
<th>PhD (2)</th>
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<td>Masters Degree (8)</td>
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<tr>
<td>PhD (1)</td>
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</tbody>
</table>
Peer Evaluation
(Approximately 10% Team Grade)

- Rating of team members: 1, 2, 3 (only 2 3s permitted) 3%

- Self evaluation of feedback (quality and quantity) 3%
  - 0  Zero feedback or not constructive
  - 1  Some feedback but not constructive
  - 2  Constructive feedback to some but not all
  - 3  Constructive feedback to all team members

- Self reflection on feedback received (given to advisors) – for submitting some reflection and on time. 4%
Greatest Challenge: Cross-cultural communication

Problem: How to locate a person / printer / network connection?
### PBL does not scale well

<table>
<thead>
<tr>
<th>Center of Instruction</th>
<th>TBL</th>
<th>PBL</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student/Faculty mix</strong> (faculty direct what is learned in prework, students determine what is learned in class)</td>
<td>Student</td>
<td>Student (students determine what questions need to be answered to solve clinical problem)</td>
<td>Teacher (faculty determine what is to be learned)</td>
</tr>
<tr>
<td><strong>Size of learning groups</strong></td>
<td>Teams of 6-7 students, but all teams in single room, (learning occurs from other teams)</td>
<td>Groups of 6-7 each meeting by themselves (learning mostly within own team, limited learning from other Teams + mentor)</td>
<td>Entire class in a room</td>
</tr>
<tr>
<td><strong>Engagement in class</strong></td>
<td>Active</td>
<td>Active</td>
<td>Passive</td>
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<tr>
<td></td>
<td>TBL</td>
<td>PBL</td>
<td>Lecture</td>
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<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Scalability in larger</td>
<td>Moderate (can be done in larger classes)</td>
<td>Difficult to scale up, requires more faculty as class size increases</td>
<td>Easy to increase class size without additional faculty</td>
</tr>
<tr>
<td>class size</td>
<td></td>
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<tr>
<td>Learning skills</td>
<td>Student/Faculty mix (faculty direct what is learned in prework,</td>
<td>Student (students determine what ?s need to be answered to solve</td>
<td>Teacher (faculty determine what is to be learned)</td>
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<tr>
<td></td>
<td>students determine what is learned in class)</td>
<td>clinical problem)</td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>Facilitator and Expert</td>
<td>Facilitator and Expert</td>
<td>Expert</td>
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<tr>
<td>Student preparation</td>
<td>Well prepared</td>
<td>Limited preparation</td>
<td>Limited preparation</td>
</tr>
<tr>
<td>before class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside homework</td>
<td>Preparation only, no homework</td>
<td>Extensive group activities required</td>
<td>No homework routinely</td>
</tr>
</tbody>
</table>
1st year curriculum

- 4 Integrated Courses
- 2 Longitudinal Courses
- Instructional strategy uniquely Duke-NUS

<table>
<thead>
<tr>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
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</thead>
<tbody>
<tr>
<td>Molecules &amp; Cells (6.5 wks)</td>
<td>Brain &amp; Behav (4 wks + Chinese NY)</td>
<td>Body &amp; Disease (20 wks)</td>
<td>Body &amp; Disease</td>
<td>Practice course 1</td>
<td>Investigative Methods and Tools</td>
<td>Normal Body (11.5 wks)</td>
<td>Vascular Biology</td>
<td>Molecular Biology</td>
<td>Pathology</td>
<td>Pharmacology</td>
<td>Neurology</td>
<td>Surgery</td>
</tr>
</tbody>
</table>

Transforming Medicine, Improving Lives
Neurophysiology: Learning Models

Repetition-dependent long term potentiation

From http://web.bvu.edu/faculty/ferguson/Course_Material/Gen_Psy_New/Modules_18_19_Memory/Default.htm

Transforming Medicine, Improving Lives
Focusing Curiosity:
Water: Liquid and Vapor Phases (physical process)
Focusing Curiosity:
Spider Mating (behavior)

Miagrammopes

Transforming Medicine, Improving Lives
Repeat visits to the same place: an opportunity to observe behavior over time.

*Nephila philipes: Mating tools*
Argyrodes flavescens: a kleptoparasite
Water vapor condensation: morning dew

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Some thoughts about learning

• Repetition is the first law of learning

• We can’t learn everything: we forget what we infrequently use

• Curiosity fuels my learning and passion (because its fun)

• When I can focus my curiosity, I’m more likely to find something interesting

• Repeated observations accelerates recognizing patterns

• Detecting deviations from expected patterns = curiosity

• Learning without subsequent use or as fuel for thinking is probably pointless
2: Refine focus. Repeated observations enables temporal pattern recognition

Lap after lap – braking as they approach turn 18 (Bay Bleachers)

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3: Look for temporal patterns

Red machine – usual pattern

Blue machine – usual pattern

Red machine – deviation from expected pattern

Oops – pattern broken

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Brake fire limited to red machine

Oops – brake fire infected Hamilton

4: Learning opportunity: What is the overheating mechanism?

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