Peter’s scientific excursions into how animals deal with their environment inspired other labs around the world to take up his pioneering ideas and study the details of many specific systems. His insights brought integration to a vast field of comparative and medical research.

www.kenstoreylab.com
The Dawn of Comparative Physiology

1865: Claude Bernard

“There are also experiments in which it is proper to choose certain animals which offer favorable anatomic arrangements or special susceptibility to certain influences. This is so important that the solution to a physiological or pathological problem often depends solely on the appropriate choice of the animal for the experiment so as to make the result clear and searching.”
Comparative Biochemistry Unfolds

1920: A. Krogh ~ Nobel Prize
Mid-1900’s ~ Viking Physiologists
   P. Scholander
   K. Schmidt-Nielsen
   K. Johansen
A Canadian ~ F. Fry
Biochemistry ~ F. Lippman
   H. Krebs
   O. Warburg
Comparative Textbook ~ E. Baldwin
Comparative Biochemistry

Enzymology

Metabolic Regulation

Comparative Physiology

Environmental Adaptation

Family, Alberta

B. Clayton

Mentors

Alpha Helix

Intellectual Acquisitiveness
THE WRITTEN RECORD

Molecular Archeology

1) Publishing from 1961 - 2002
   * Publishing “Arc” virtually non-existent.
   * Started with Review Articles, Synthesis Chapters and Field-leading research contributions.

2) 1970 - 1980 114 papers
    1980 - 1990 98 papers
    1990 - 2000 113 papers
   * Science, Nature, PNAS, major journals of Biochemistry, Physiology, Comparative studies, Review Series, etc.

3) Over 200 collaborators as co-authors

4) Early Work 1970-1985 dominated by graduate student work
   Later (thru 1990’s) more integrative: larger groups, collaborations

5) THE BOOK! *Strategies of Biochemical Adaptation*
   * Right Place, Right Time
   * UNIQUE, VISIONARY (not compilation of data)
   * Synthetic → Drove investigations in the whole field

6) Oxygen-related studies → Central “Lake” of ideas to which Peter always returned
A. Fossil Hunting

• Earliest papers - (1961) O₂ debt in fish
  - CHO metabolism (aerobic) in lobsters
  - Canadian Journals (Biochemistry, Zoology)!

• Era of temperature 1964 - 1970
  - fish models (many species)
  - blueprint for approach to metabolism set out

• Temperature paradigm abandoned (1970-71)
  - Framework of approach to metabolism/adaptation kept

• Brief Pressure Phase:
  - Helix Galapagos
  - Helix Hawaii
PWH: The Published Record

B. Era of Oxygen

* Initial Approaches *
- Branch points: PEP branchpoint.
- Phospho-regulation (Oyster)
- Decreased metabolic rate (Turtle)
- Brain as Model (Turtle)
- Diving (Anoxia) (Turtle, Porpoise)

* Overall *
- Most studies were “informed by oxygen”

- Themes (Revisited)
- Frameworks (Expanded)
- Concepts (Elaborated Upon)
THE SHADOWY BEGINNINGS OF O₂ STUDIES

THE BRAIN TRUST:
- PWH as BRAINS
- Starts with:
  - 4 JBC Articles
  - 2 Major Reviews
  - 2 Synthesis Articles in “Science”

ROLE OF ~ Models: Turtle on desk
- Oyster in cold room
- Dolphin in Vancouver aquarium

- Helix: Amazon 1967
- Galapagos 1969 - 70
- Hawaii 1973
THE HUGE EXPLOSION OF CREATIVITY & CHANGE IN EARLY - MID 70’s

A TEMPERATURE LAB SUDDENLY CHANGES:

• Sudden “speciation”
  - Into Anoxia (oyster, turtle)
  - Into Pressure (cul-de-sac)
  - Into Diving (O₂ limitation)
  - Exercise (O₂ and anaerobic capacity)
  - High O₂ (squid, bees)

• Maintenance of directions *emerging from* O₂ for rest of career:
  - Exercise (muscle metabolism, anaerobic scope)
  - Mitochondria (O₂ metabolism)
  - Diving (aerobic dives)
  - Metabolic Arrest (starts with anaerobic models)
  - High altitude (oxygen limitations)

• Expansion of areas from a single point source
Hypoxia: The Models

- Turtles
- Oysters
- Porpoise (dive)
- Fish:
  - Air breathing
  - exercise
  - environ. hypoxia
- Squid (NOT!)
- Bees (NOT!)
- Nautilus
- Octopus
- Seals
- Goldfish
- Elite Athletes
- Highlanders
- Greyhounds
- Horses
- Lungfish
- Turtles

REVIEWS

1970s: Animal Models
1980s: Metabolic Arrest
1990s: Human & Animal Model Systems
2000s: Health, Disease
THE “WHY” OF A CREATIVE BURST

Punctuated equilibrium

A. Synthetic Intuition
   * the PWH approach

B. Constancy of Concept
SYNTHETIC INTUITION

Something Old, Something New, Something Borrowed, Some Glue.
SYNTHETIC INTUITION

FILTER
~ Transducer
~ Organizer
~ *Revamp*
~ IDEA LENS

IDEAS IN
~ Ecology
~ Physiol. Ecology
~ PHYSIOLOGY
~ Metabolism
~ Methods of Biochemistry
~ Molecular Biology
~ Genetics

IDEAS OUT
~ Metabolic Arrangement
~ Reorganization of Metabolism
~ Adaptive Change at Pathway Level
~ Integration: multi-levels of Biological Organization
### SYNTHETIC INTUITION COMPONENTS

**IDEAS IN**
- Literature search
- Helix
- Visits to Colleagues
- UBC itself
- PHONE (1970)
- EMAIL (1990)
- Visitors
- His own lab data
- Student Excitement

#### TRANSDUCER COMPONENTS

<table>
<thead>
<tr>
<th>IDEAS: PWH as throughput</th>
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<tbody>
<tr>
<td>DATA: His Work</td>
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<tr>
<td>* PWH work as “Model”</td>
</tr>
<tr>
<td>* PWH data “overturned”</td>
</tr>
<tr>
<td>COST-BENEFIT</td>
</tr>
<tr>
<td>* money (!)</td>
</tr>
<tr>
<td>* students</td>
</tr>
<tr>
<td>* collaborators</td>
</tr>
<tr>
<td>* teaching vs research</td>
</tr>
<tr>
<td>* university ‘service’</td>
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</tbody>
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**OTHER**
- STABILITY of non-research life 1970 onwards!
- Excellent writing skills
- NSERC-type $$
  * Biggest fish in Canada
  * THE BOOK!
- Never “Circle the Wagons”.


SYNTHETIC INTUITION

1) A new mix of ideas leads to a new field:

- Physiology
- Biochemistry
- Diverse Models
- Comparative Biochemistry

2) Any new set of data reorganizes itself through Peter and returns as UNIQUE

3) Salvage Solutions from Chaos:
   - Hawaii: fish (NOT), Amazon,
   - Thesis Ideas, *DATA KNOTS*

4) Time Vampire: “Students Match Projects”

5) Ideas versus GOOD Ideas

6) Sink-or-Swim
Student Wrangling

- I got PhD with 7th project I started
  - Topics
    a) Temperature and tuna (!)
    b) Crabs and molting - *gluconeogenesis*
    c) $\alpha$-KGDH (regulate TCA cycle)
    d) DIVING: TURTLES (Porpoise)

- He let me SINK / SWIM
- Thesis as ‘minor’ portion of SCIENCE done!
- Idea for final PhD: WRONG! Yet brilliant.
- I suggest crazy things: He said YES !!!!!!
- ~ bees, oyster, squid, porpoise
- Integration: “Optimize” student function.
  ~ diving review article
  ~ Helix trip although junior
  ~ Students work for THEMSELVES
The Creative Burst: B
Progression and Constancy

- Concepts, Approaches, Directions, Technologies -- all progressed
  1960 → 2002
- There was a constancy of the “intellectual lens” through which
  Peter saw science
*1970 - 1975: α Helix, BREENDA, Hawaii (sabbatical), Alaska, Baby Literature, Students
Molecular Mechanisms of Temperature Adaptation

A symposium presented at the Berkeley meeting of the American Association for the Advancement of Science
27–29 December 1965

Edited by
C. Ladd Prosser

Organization of Metabolism during Temperature Compensation

Peter W. Hochachka

Often it has been stated that a living organism is, in large measure, a kind of bag filled with a concentrated mixture of many hundreds of different enzymes, and that each enzyme is a highly effective cata-
Fig. 7. Schematic representation of control of enzyme synthesis during thermal compensation. The repressor system on the left can be considered as a black box that regulates only one set of structural genes specifying LDH subunits. The control of another set (shown as the D-E system) is independent of the state of thermal compensation. The inducible LDH subunits assemble into LDHs that are regulatory. Not all of the isozymes formed are indicated in the diagram.
Going malignant: the hypoxia-cancer connection in the prostate

P.W. Hochachka, J.L. Rupert, L. Goldenberg, M. Gleave, and P. Kozlowski
Made from 372 citations on Web of Science; compiled in VosViewer 1.6.5
PETER HOCHACHKA AND OXYGEN
“ The Hypoxia Society”

ADVENTURES IN OXYGEN METABOLISM
The Scientist is not a person who gives the right answer, He’s the one who asks the right Question.  
-- C. Levi-Strausse

A Science is any discipline in which the fool of this generation can go beyond the point reached by the genius of the last generation.  
-- Max Gluckman
Supervisors say the darndest things
Peter’s Favorite Student

Source of many “personal communications”?
“If you teach poorly enough for long enough, they stop asking”
~ Advice to me as I headed off to Duke
“My lab is full”

>> Said to KBS when asked about taking Ken into his lab.

---15 minutes of discussion later---

“Take that desk”

>> Said to KBS when Peter discovered that Ken had a scholarship that paid both salary and research expenses.
“Very Interesting, very interesting”

--Peter, dismissing an idea
“Unless you are the PACKLEADER the view never changes”

--Referring to non-lead dogs in a dog sled team.
“They were the longest (two) years of my life”

-- Referring to the two years of Ken: 1972 - 1974
Favourite Phrases

• Reptilian scales fell from my eyes
• Knuckle-draggers
• Like water off a duck’s back
A Life of Science Adventure

Mentors

Knut Schmidt-Neilsen, Ladd Prosser, Kjell Johansen, UBC giants [ex. Bill Hoar], Fred Fry, Hans Krebs, A. Helix, Earl Stadtman, DUKE [Zoology], JM Teal, M Telfored
DO YOUR WORK, THEN STEP BACK.
THE ONLY PATH TO SERENITY.
- “Tao Te Ching” by Lao Tzu
Hawaii – Kona Expedition 1973
Hawaii – an Alpha Helix tale

- Kona Coast
- 25 foot waves between islands
- Follow-Up trip to consolidate “wins”
Hawaii
Biochemistry at Depth

PRESSURE EFFECTS ON BIOCHEMICAL SYSTEMS OF ABYSSAL AND MIDWATER ORGANISMS: THE 1973 KONA EXPEDITION OF THE ALPHA HELIX

Edited and Organized by
P. W. Hochachka

Department of Zoology, University of British Columbia, Vancouver 8, Canada

Comp. Biochem. Physiol. B 52(1), 1975

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And if you don’t find fish.....

Biochemistry at Depth

PRESSURE EFFECTS ON BIOCHEMICAL SYSTEMS OF ABYSSAL AND MIDWATER ORGANISMS: THE 1973 KONA EXPEDITION OF THE ALPHA HELIX
Honolulu, 1975
Kewalo Marine Lab
Pacific Biosciences Research Center
Balancing
- Time away limited
- Family focus
The Helix: Crucible

Up the Amazon – Paddles did NOT help
• Rescued from the river
• Small boys & Fish
• Science in context
• Amazon connection
• Nature’s richness
• Peter’s projects have legs
• Soccer with the kids
• Floating houses & pet pigs

• 24/7 research. Intense
• Longest day: 28 h → from animal to purified enzyme (1 band on SDS-PAGE)
No caimans were harmed
• Electric eel delivered
• Babysitting the pirarucu
• Escape of the walking catfish

“Reptilian scales fell from my eyes”  PWH

Several hundred pictures of the black vs white water taken!
Two that I know of:
U Victoria
U Alberta

Academic Accomplishment = job offers
* If I have to hold their hands now, how will they become independent scientists

* “Fas-SKIN-nating”

* UBC visitors – Nobels [Skou] & others

* Field Trip Great Co-Scientists
  - You inherit his friends.  - You inherit his enemies

* My first external PhD external examiner wanted to fail my thesis.  He ‘went away’.
Ken, the tortoise, suddenly realizes that it is *NOT* going to turn out like in the fable
Peter: Prankster

- Woods Hole: GDH
- Eating the deep sea shrimp
- The lava, the data & the pancakes
My one R-rated Story:
Ken and Peter walk into a bar......... Our fantasy
The first one elevated him into the stratosphere
One Trial Writer:  
Paper + Selectric + calling out to Jeremy for facts =  
Lead article in science, grant proposal, book chapter.  

~ Pristine
Well thumbed volume – well before the internet

NOT in the Book:

- key flip, whistling on his way home
- phoning at 6 am [bored when alone]
- made my courses go away
- Comprehensive exam in Zoology !!
- predicted the exact results of my thesis before it started
- My actual thesis project created from a turtle paced on my desk
- Used phrase “a whirl-wind entered my lab’ in describing me…. and also for EVERY subsequent student in their letter of recommendation.
- Like water off a duck’s back!
In the field; In the lab
Lone rider on a Horse – the Way it Was

* We don’t know what the answer will be – we just explain
* When you do transcription factors – don’t just say TA-DA
* New technology will come and change our ideas
Our only meeting before I joined Peter’s lab. Helga was the gateway for my transfer to Zoology. [I have still never taken a Biology Course of any kind]
The World was his oyster. He worked with Janet ON oysters!

Picked Jan out of a line-up and stole her
Learning in various modes
Knut Schmidt-Nielsen: A giant that Peter made my faculty colleague

The influence of a good teacher on students & colleagues often goes on for longer than the teacher could ever have anticipated and frequently never ends.
Froze the first frog as a scientist

Kjell Johansen – Viking and Physiologist
Ladd Prosser: Grand Old Man
On the ice with Warren Zapol

Fig. 4. Seal research team (1977) at Byrd Statue of McMurdo Station. Left to right standing: Jesper Qvist, M.D., Sir Graham C. (“Mont”) Liggins, M.D., Ph.D., Peter Hochachka, Ph.D., Thomas R. Wonders. Seated (left to right): Paul Wankowitz, Michael T. Snider, M.D., Ph.D., Warren M. Zapol, M.D., Robert C. “Bob” Schneider, M.D.
Highlanders -- at Sea Level
Lake Louise Biochemical Adaptation Symposium 1987

Lake Louise – the Gathering in the Snow
Alpha Helix: Home away from home
Alpha Helix: Amazon 1976
Peter’s group in 1992 – Vera Val

Peter in Caxambu, Brazilian FASEB 1998 - VeraVal
A Group that Peter made uniformly successful.
- he optimized his lab’s *opportunities*
- opportunities presented......outcomes expected
- repeated over many decades.
Did you have a SoundTrack?

Our time: Rolling Stones, The Who, Fleetwood Mac
“They say you die twice. One time when you stop breathing and a second time, a bit later on, when somebody says your name for the last time.” - Banksy
Picture Gallery

Many thanks for photos supplied by: Brenda Hochachka, Tom Moon, Brian Murphy, Dave Jones, Jean-Michel Weber, Mike Guppy

Thanks to Jan Storey for photo layout.

These pictures and more are available at:

cc