

CLIMATE CHANGE: DOES MEMORY IN CORAL DICTATE FITNESS IN A CHANGING WORLD?

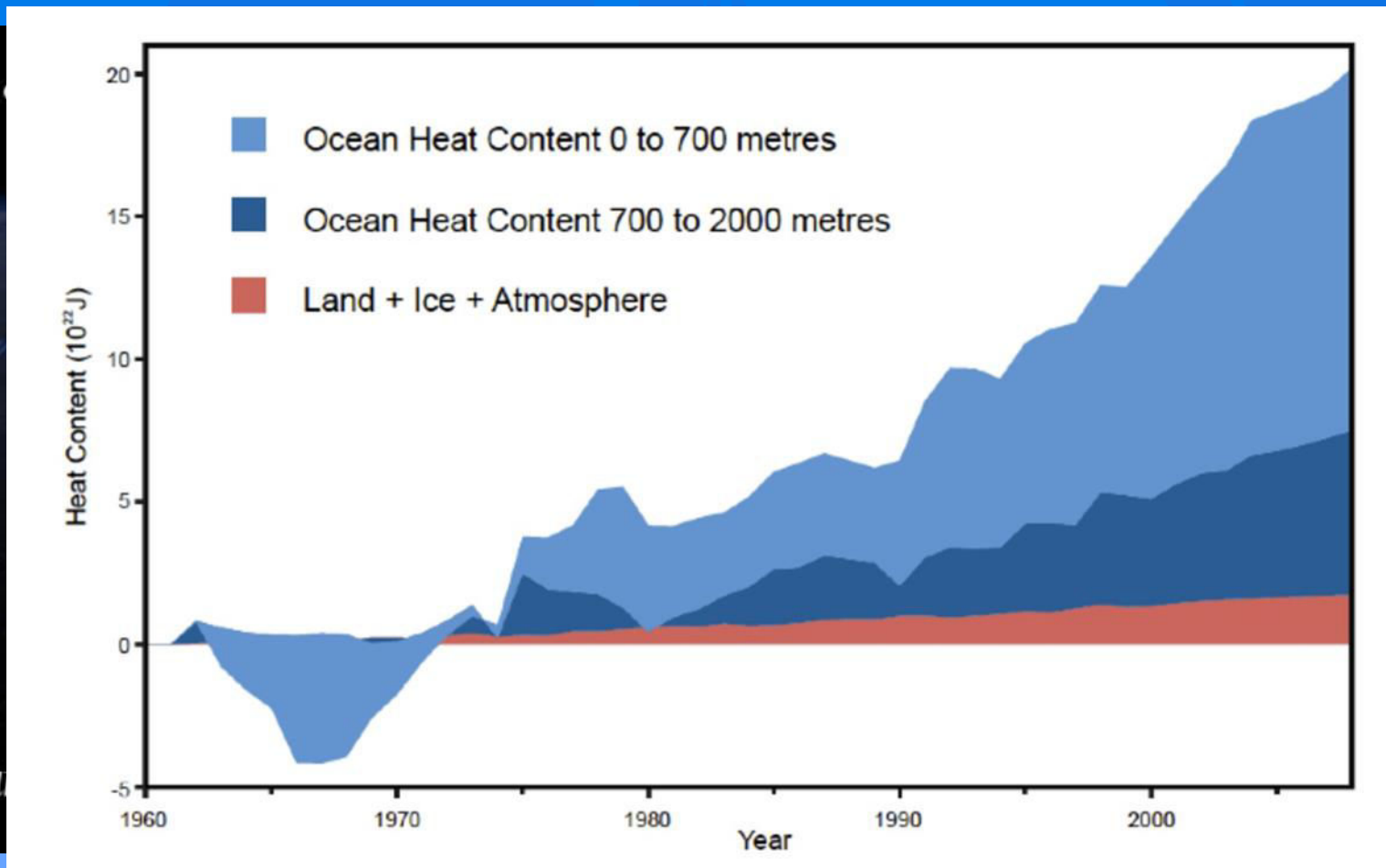
¹Kevin B. Strychar & ²Paul W. Sammarco

¹Annis Water Resources Institute of Grand Valley State University, Michigan, USA

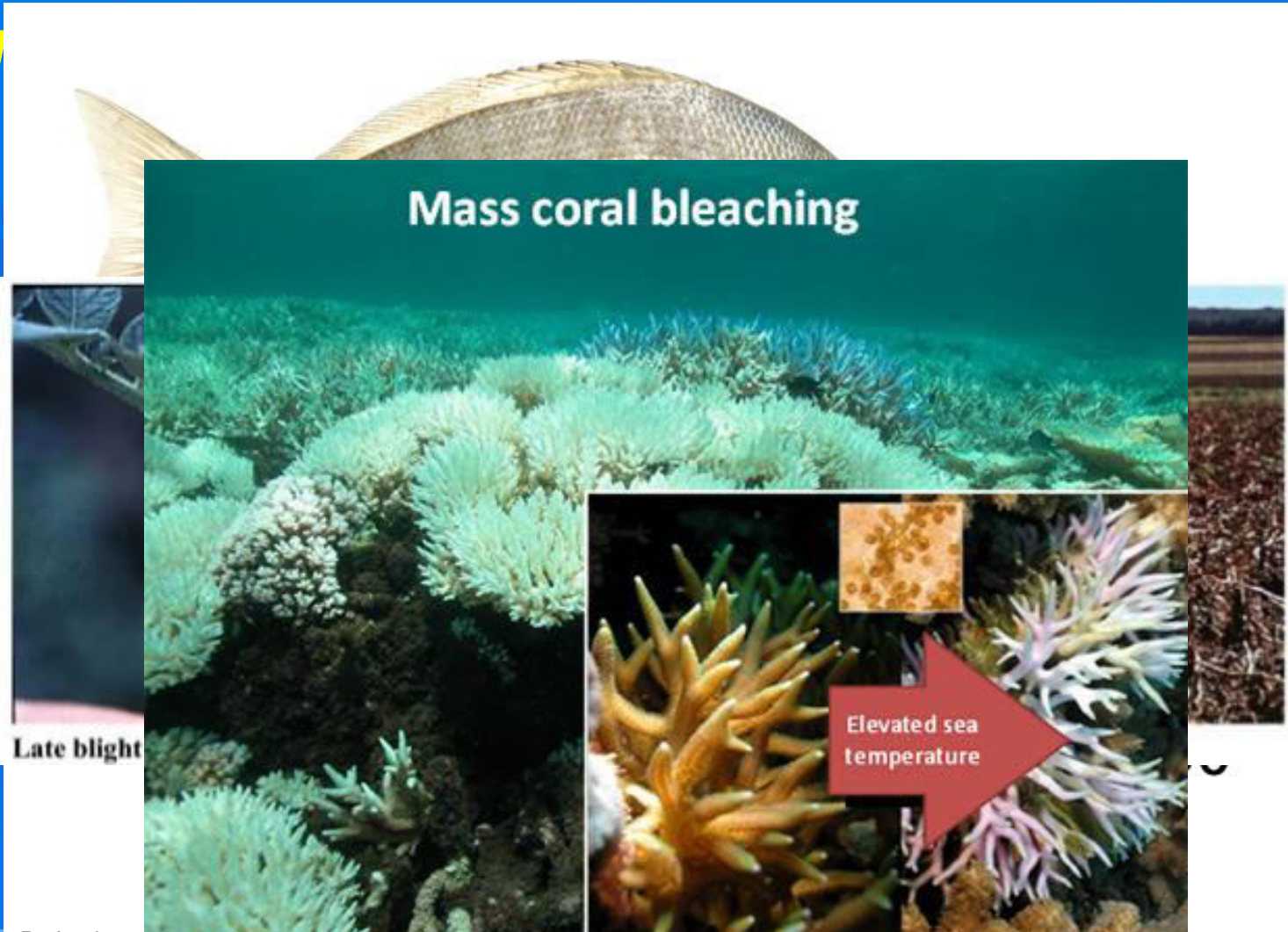
²Louisiana Universities Marine Consortium (LUMCON), 8124 Hwy. 56, Chauvin, LA 70344, USA



Introduction: Climate change

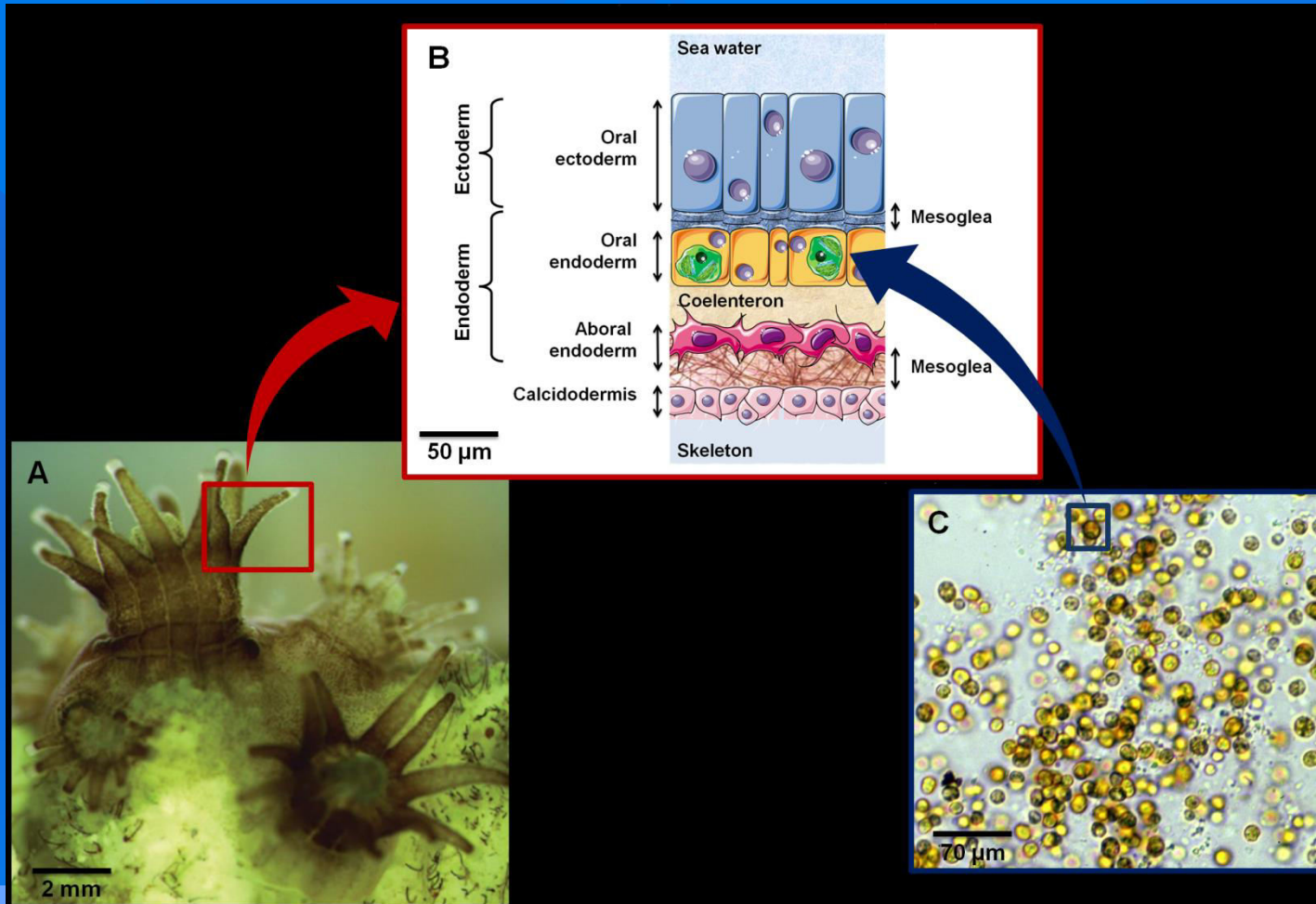


Introd



By far the greatest impact from global warming has been in the seas and oceans, where changes in heat content, oxygen levels and other biogeochemical properties have devastated marine ecosystems. Globally, the average body size of fish has declined by up to 24 per cent compared with 2000. About half of this shrinkage has come from changes in distribution and abundance, the remainder from changes in physiology. The tropics have been the worst affected regions. (<http://www.futuretimeline.net/21stcentury/2050-2059.htm>)

Introduction: coral



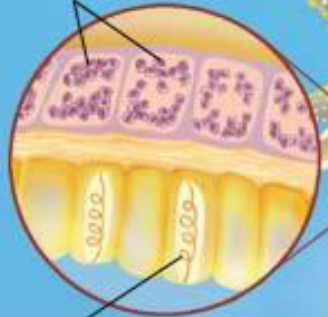
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Introduction: coral

Anatomy of a Coral Polyp

tentacles with
nematocysts
(stinging cells)

zooxanthellae



nematocyst



TOTALLY HUNGRY

“THAT LOOKS YUMMY.”

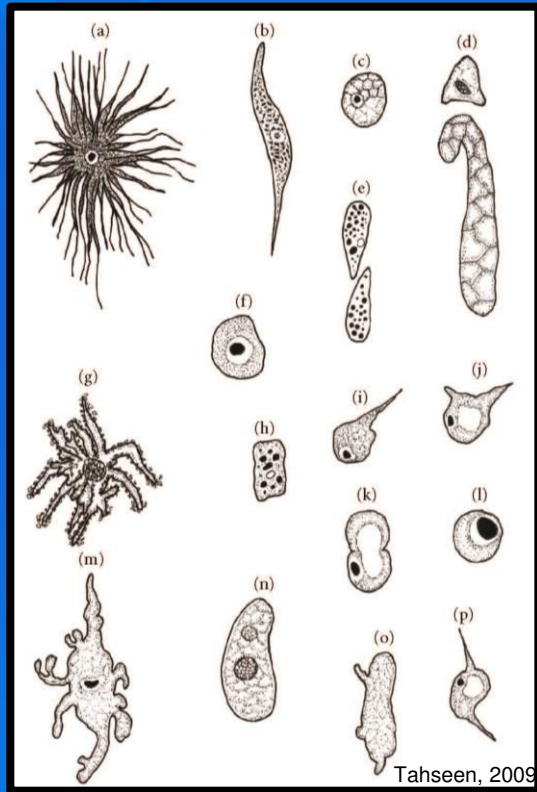


PHAGOCYTIC CELLS

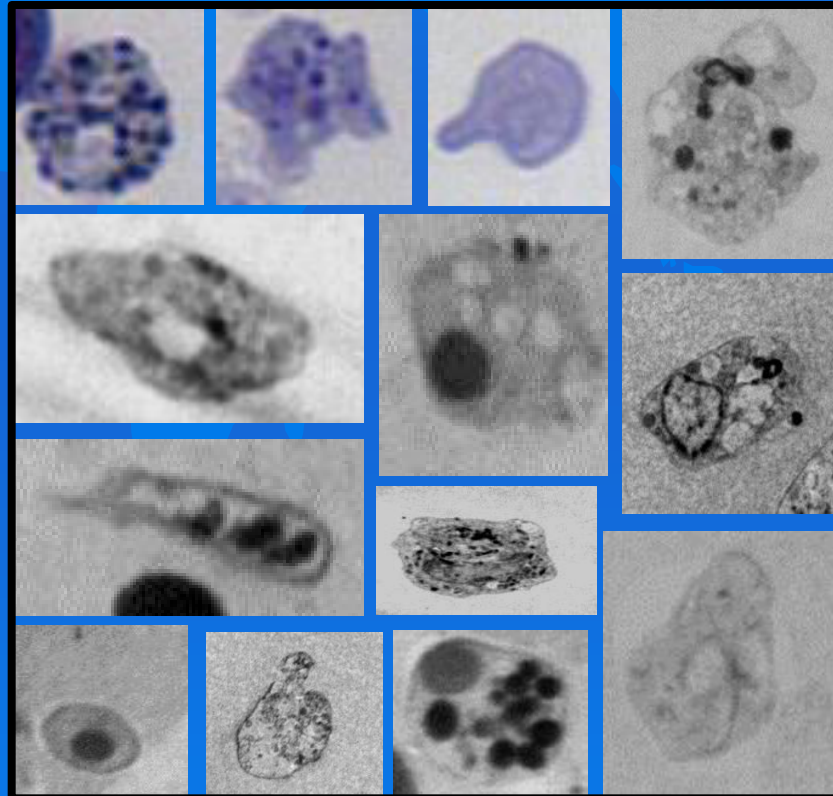
#JUSTCELLYTHINGS



Introduction: coral phagocytes



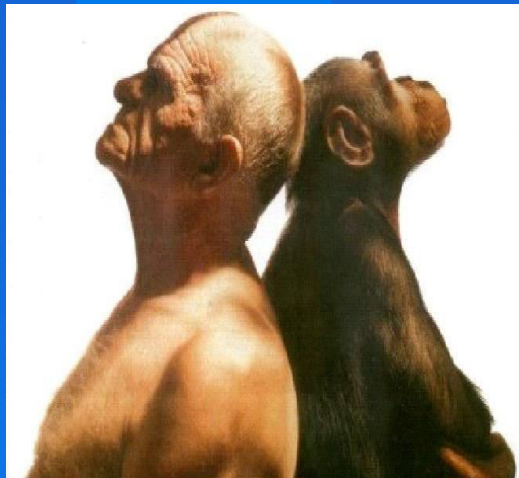
Tahseen, 2009





Hypotheses

1. Too many symbionts?
2. No symbionts?
3. Hard vs. Soft vs. Gorgonian



Better heat resistance
Better disease resistance
Better fitness

Coral immune systems

Apoptosis – Aponecrosis - Necrosis

↓
programmed

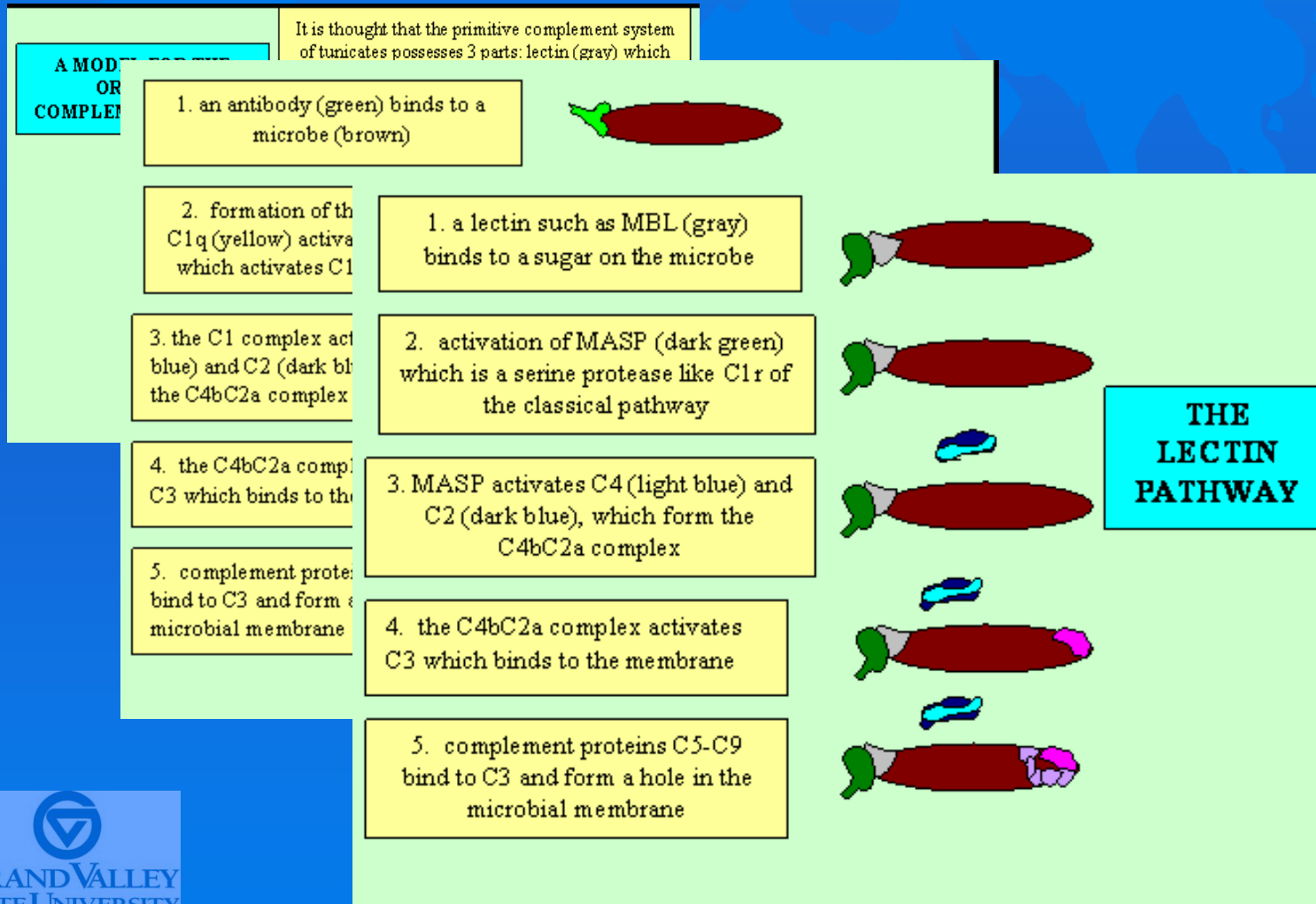
↓
traumatic

Types of Programmed Cell Death (PCD)

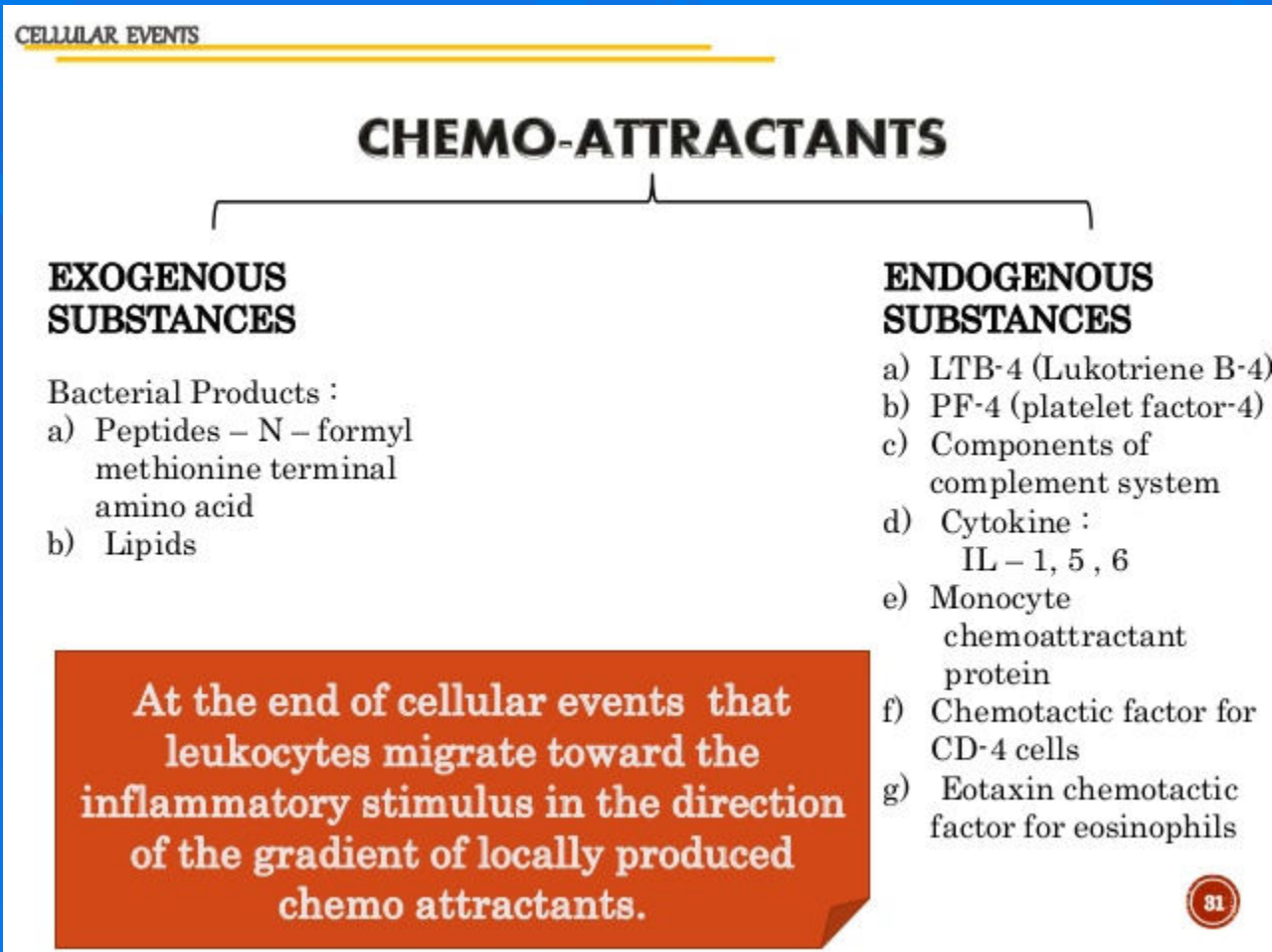
- Apoptosis
 - Autophagic
 - Caspase-independent
 - Anolkis
 - Aponecrosis
- = PCD



Complement

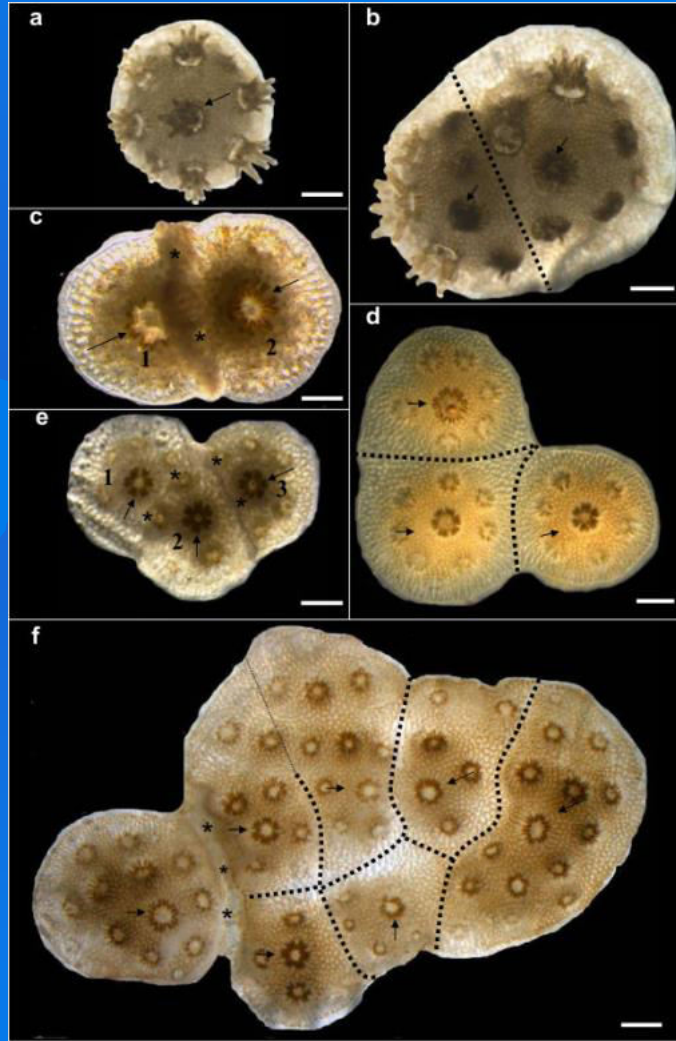


Complement components?





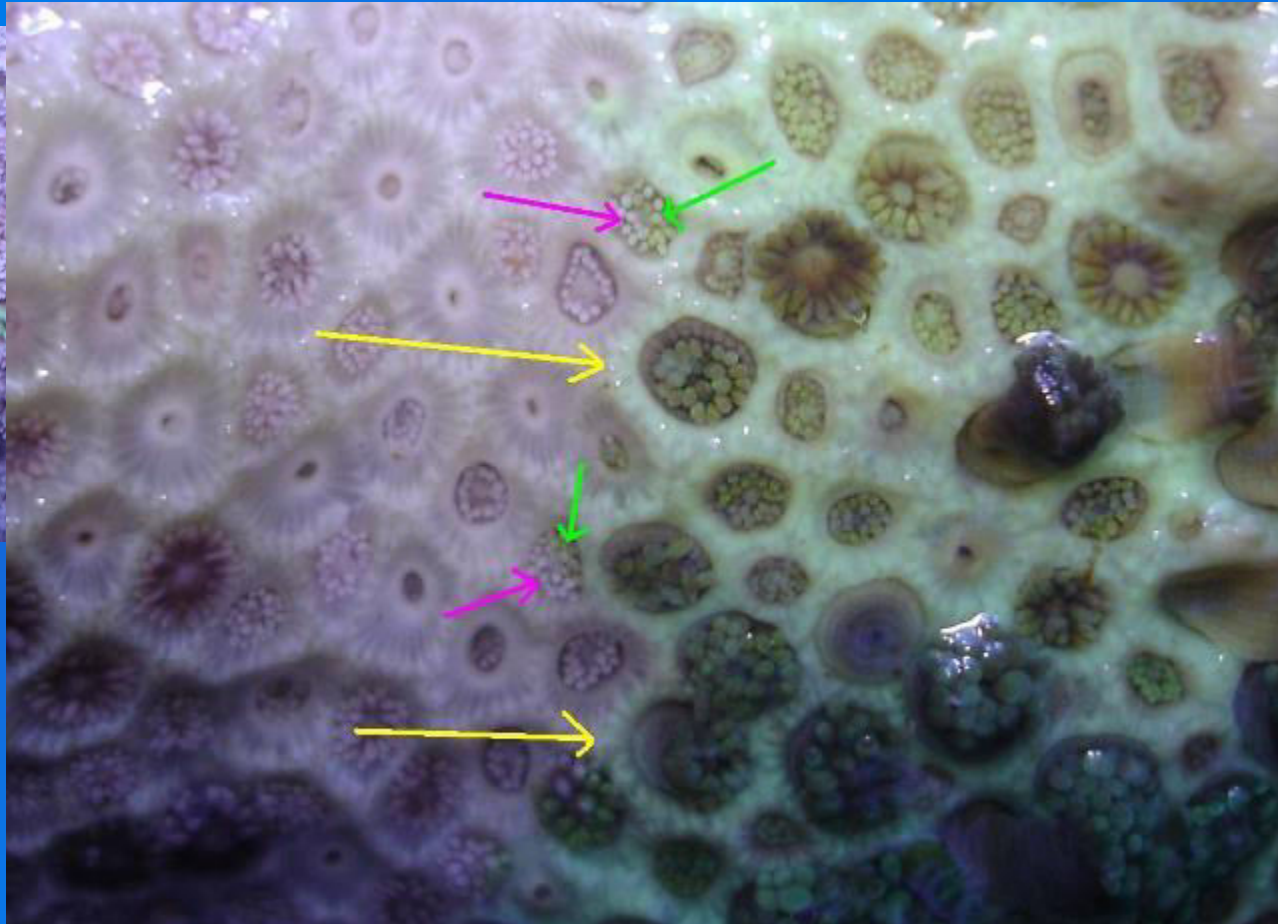
Allorecognition



Stylophora pistillata; http://openi.nlm.nih.gov/detailedresult.php?img=2391163_1471-2148-8-126-1&req=4

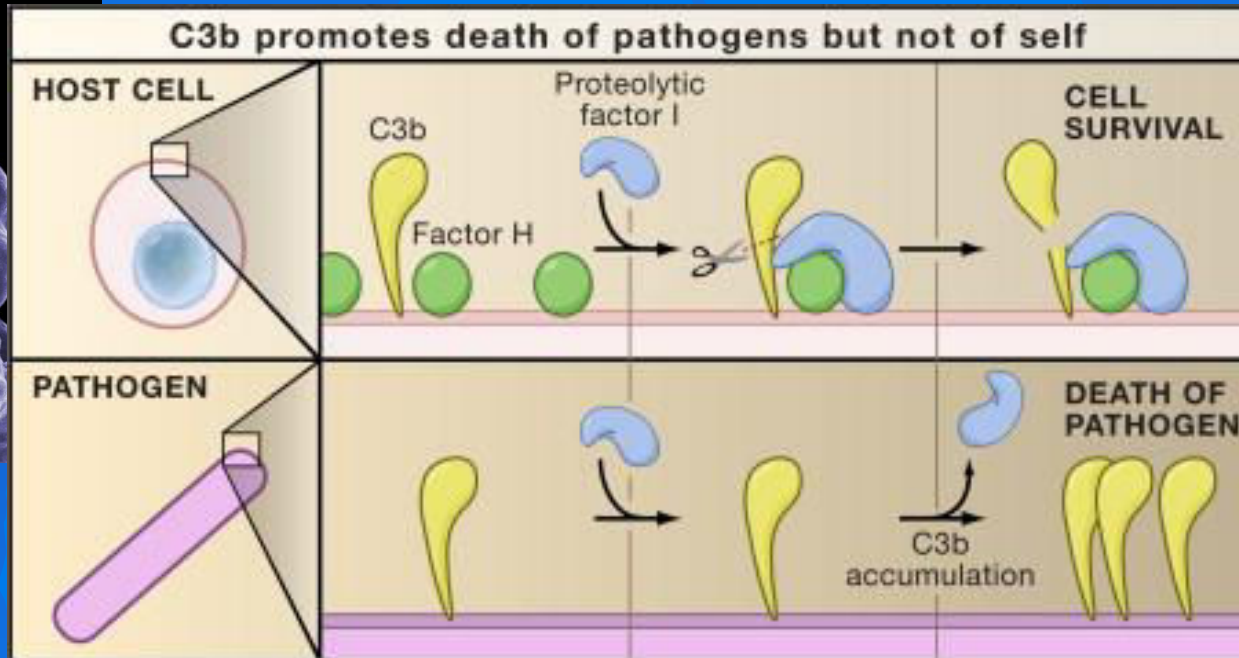
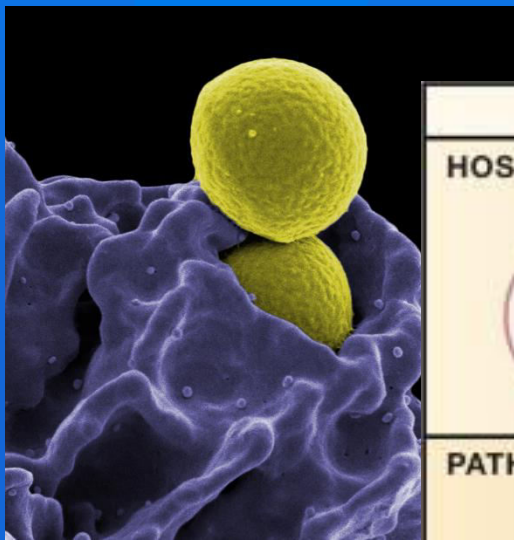


Allorecognition



<http://www.reefkeeping.com/issues/2006-02/nftt/index.php>

Self vs. not-self

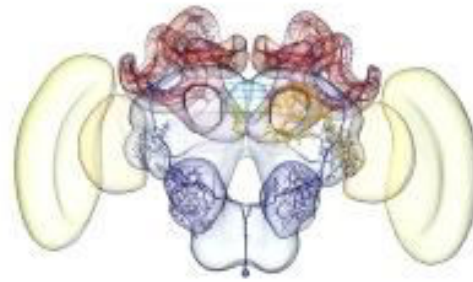


Boehm, T. 2006. Quality control in Self/nonself discrimination. Cell. 125: 845-858. doi:10.1016/j.cell.2006.05.017



Memory?

Invertebrate Learning and Memory



Edited by Randolph Menzel and Paul R. Benjamin



Summary

Antigen Receptors

Mechanism of diversity

Antigen specificity

Immune memory

Innate and adaptive immunity

Innate Immunity
 Non pathogen specific Immune response
 Immediate response
 No memory of pathogenecity
 Both in vertebrates and Lower Organisms.

Adaptive Immunity
 Pathogen specific Immune response.
 Delayed response .
 Memory of pathogenecity.
 Only in Higher Organisms and Vertebrates.

Innate Immunity

Non pathogen specific Immune response

Immediate response

No memory of pathogenecity

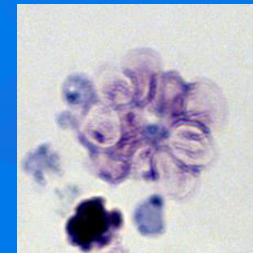
Both in vertebrates and Lower Organisms.



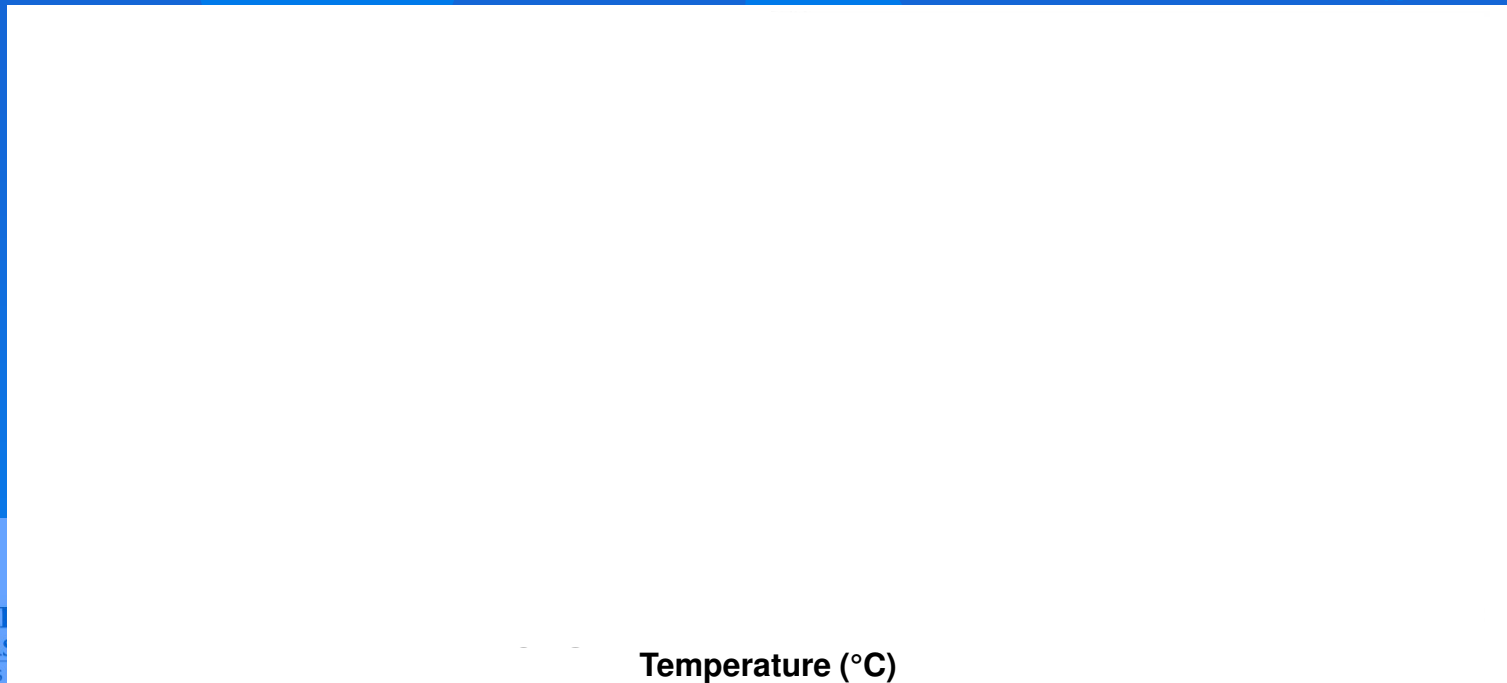
Results

Fluorescent conjugates

1. Apoptosis and Necrosis;
2. Phagocytosis fluorometric assays;
3. Pattern-recognition receptor (PRR) probes: FLS2
 - flagellin protein in bacteria



Swarming?

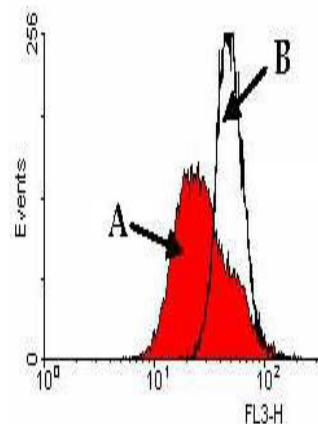


Results

Fluorescent conjugates

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4. Caspases

Figure 3. Cytometric analysis of *Montastraea cavernosa* cells using CaspaTag assay kit. Note the increased expression of caspase proteins after exposure to heat stress at 34°C for 12 hr (B) vs the incubated control at 26°C for 12 hr (A).



Class of Proteins	Function
Activators	
Caspase 2	Initiates apoptosis
Caspase 3	Metamorphosis
Caspase 8	Initiates apoptosis
Caspase 9	Initiates apoptosis
Effector Caspases	
Caspase 6	Induces apoptosis
Caspase 7	Induces apoptosis
Cytokine Processors	
Caspase 1	Inflammation



Summary

Innate vs Adaptive Immunity (reprise)

Innate

(Phagocytosis, Inflammation)

- ***Nonspecific***
 - Defends against *any* pathogen upon *first* exposure
 - Responds to:
 - infectious agents
 - chemical irritants
 - tissue injury
 - burns

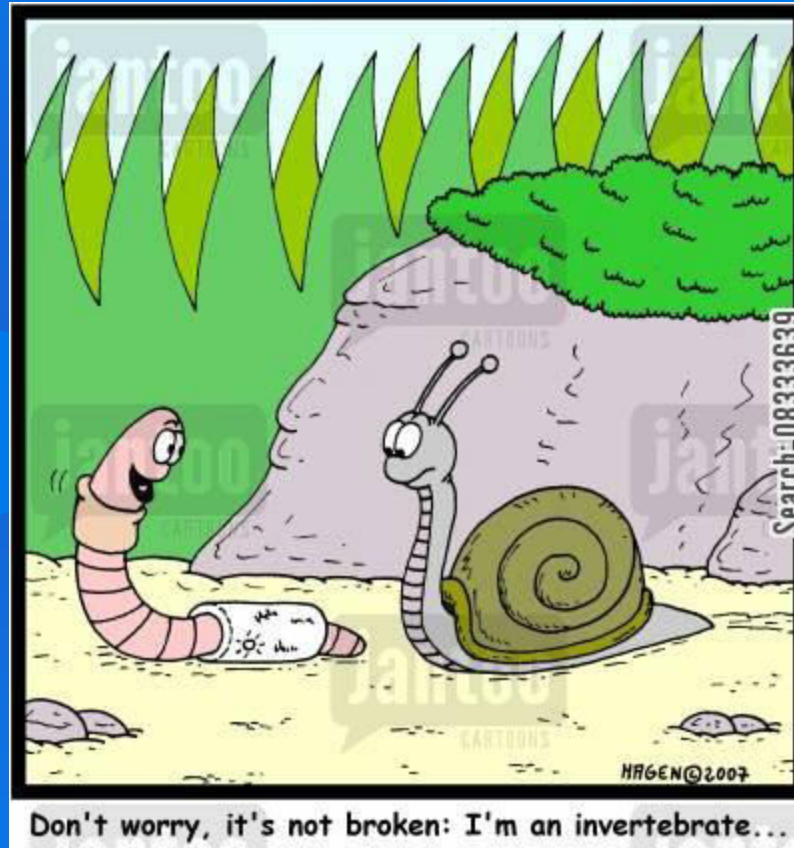
Adaptive

(Lymphocytes)

- ***Specific***
 - Responds to specific pathogens on 2nd or later exposure
 - Comes into play *after* nonspecific responses have begun.

Tuffery, 2010

Questions?



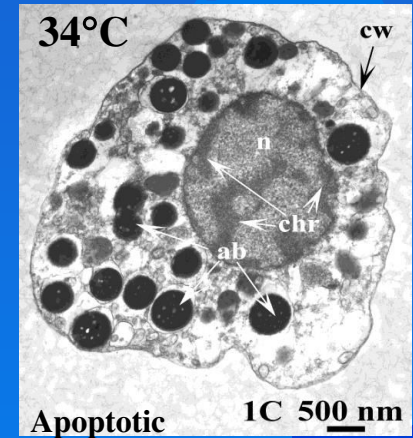
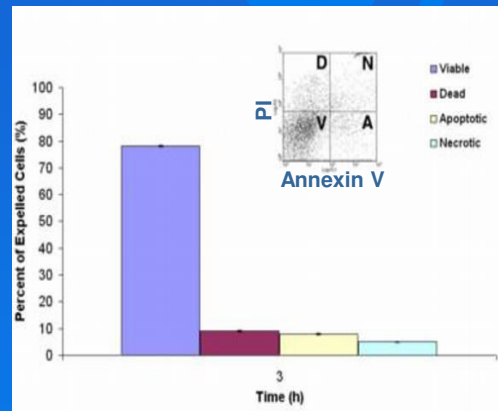
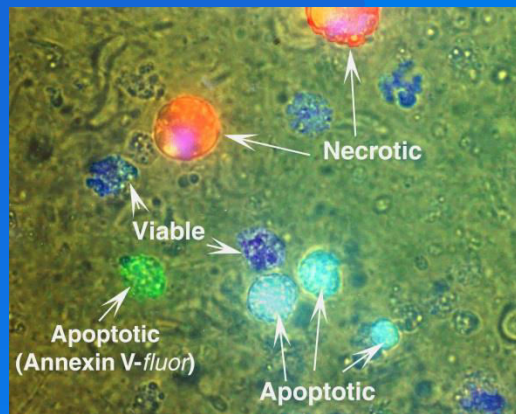


"Holy great mother of God, I've been cloned!"

Methods



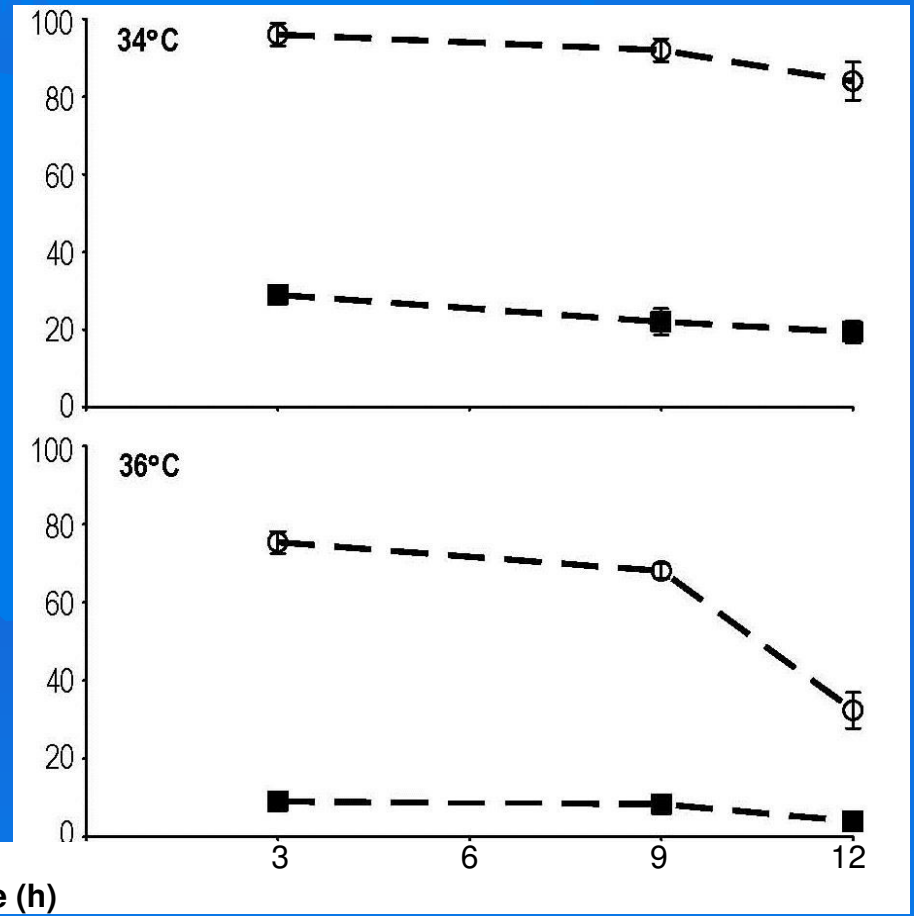
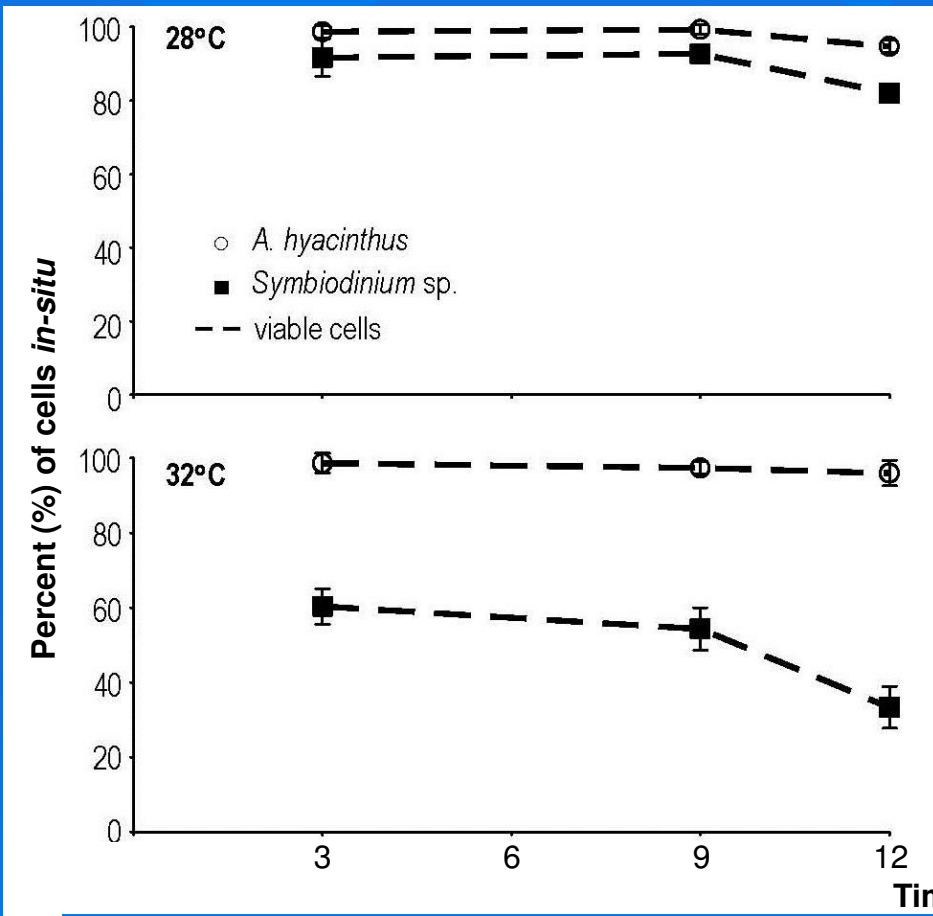
Methods





Results

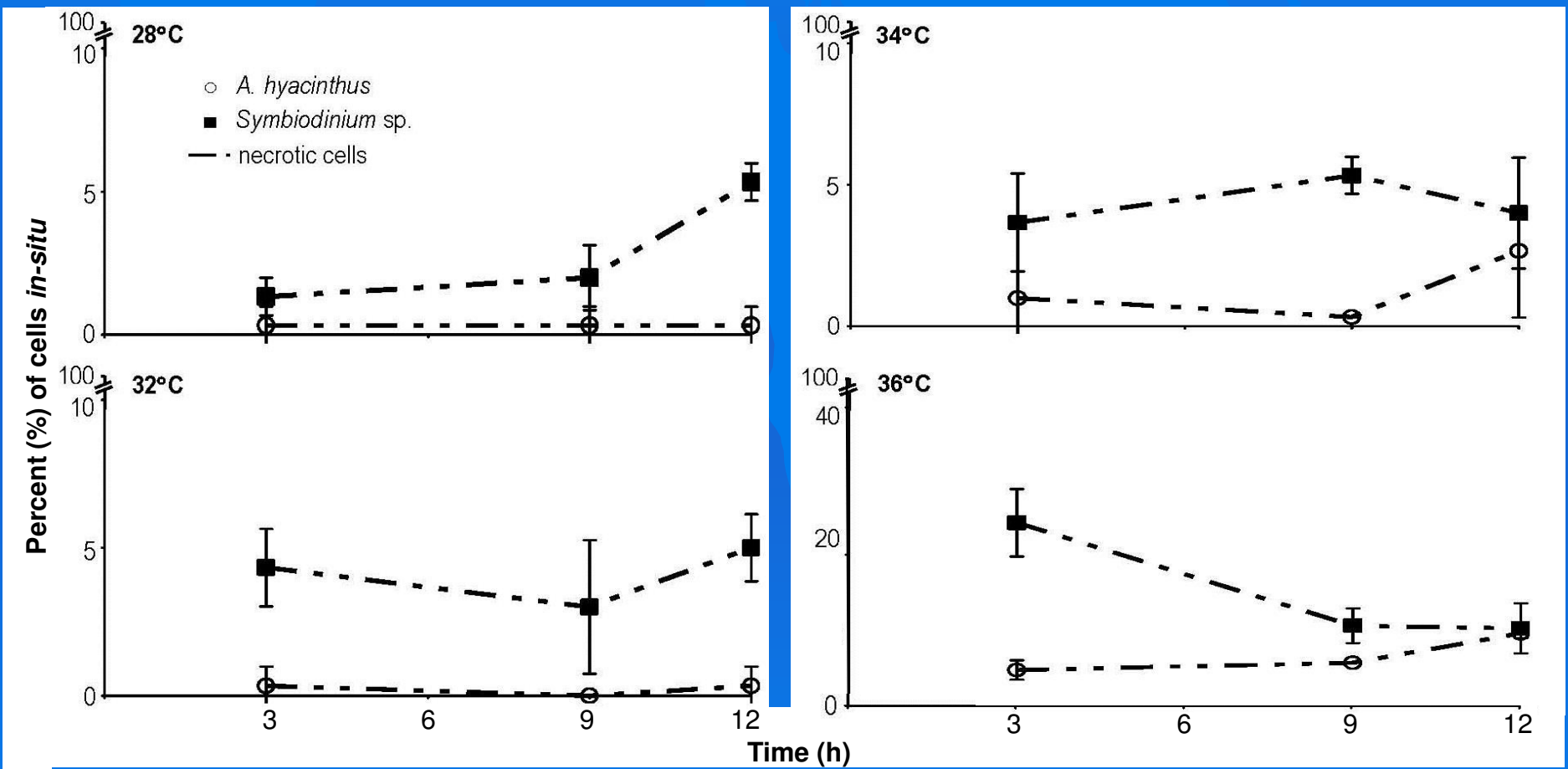
Viable Cells





Results

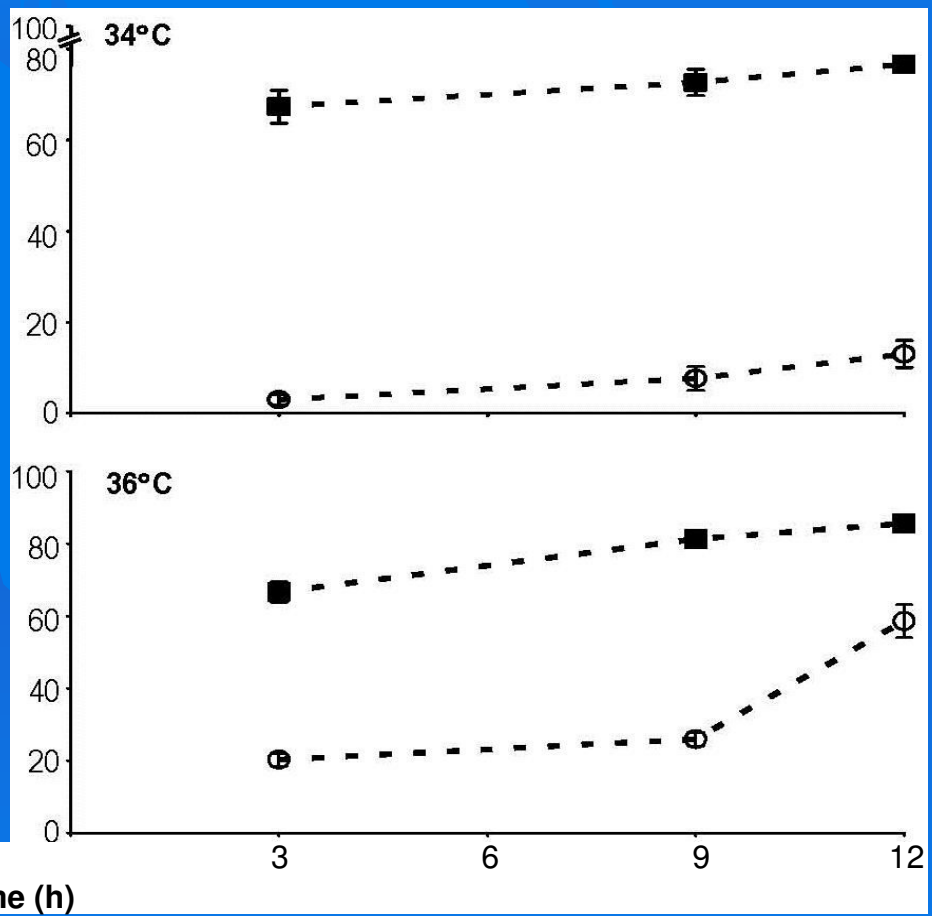
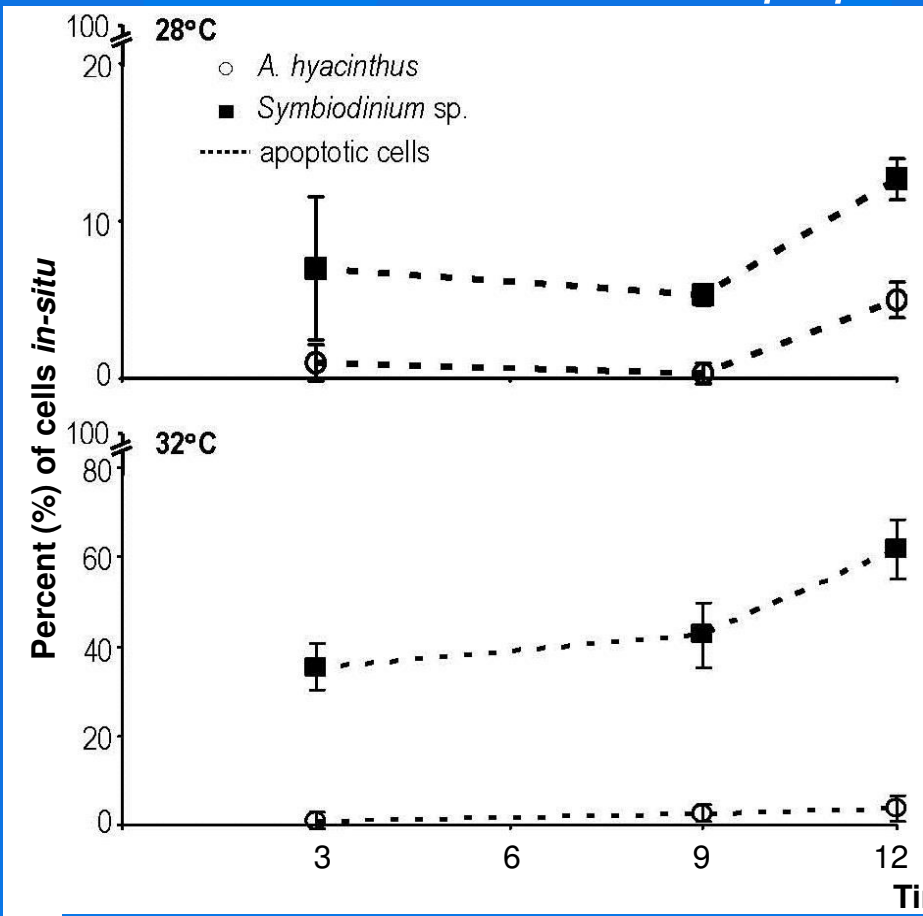
Necrotic cells





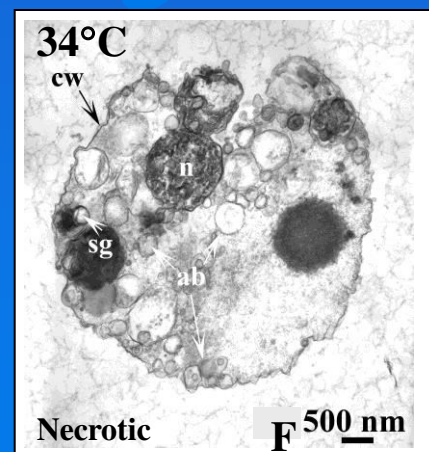
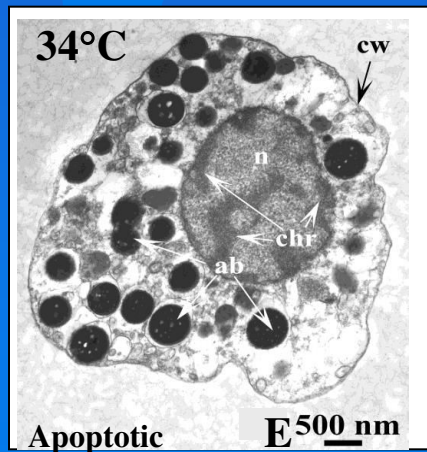
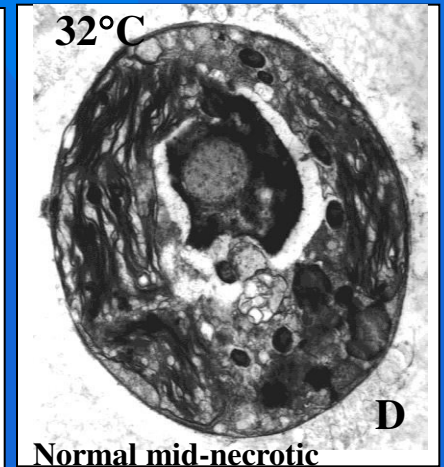
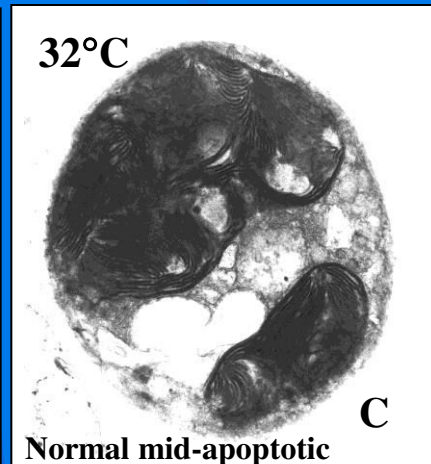
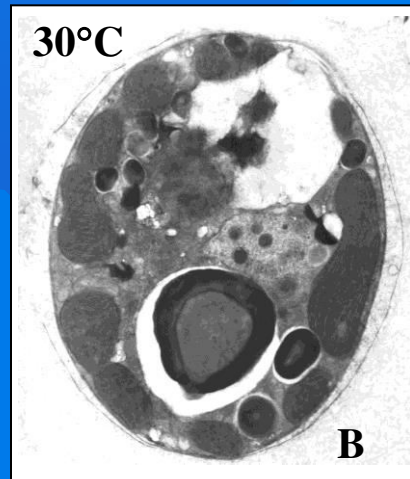
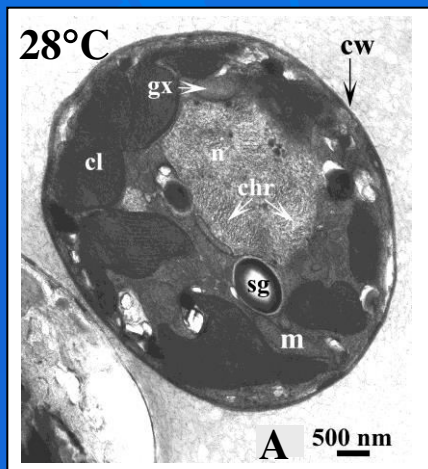
Results

Apoptotic Cells



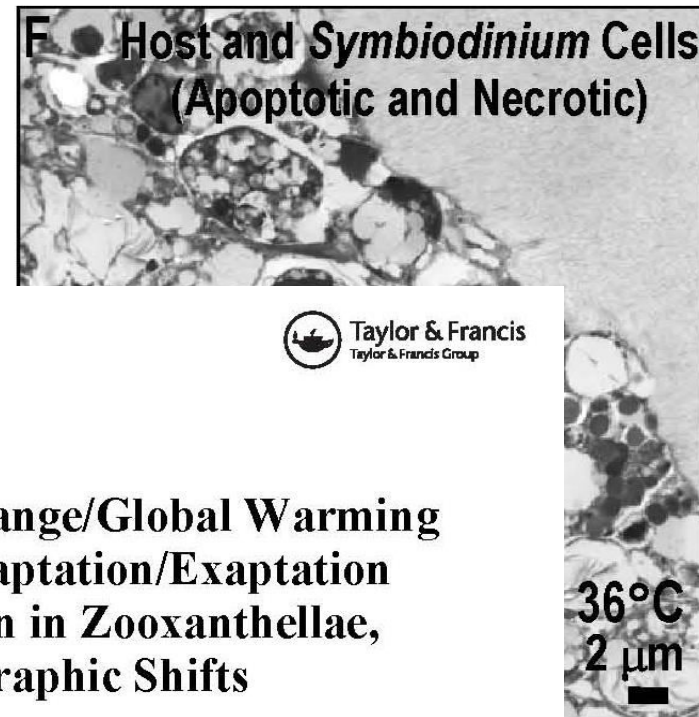
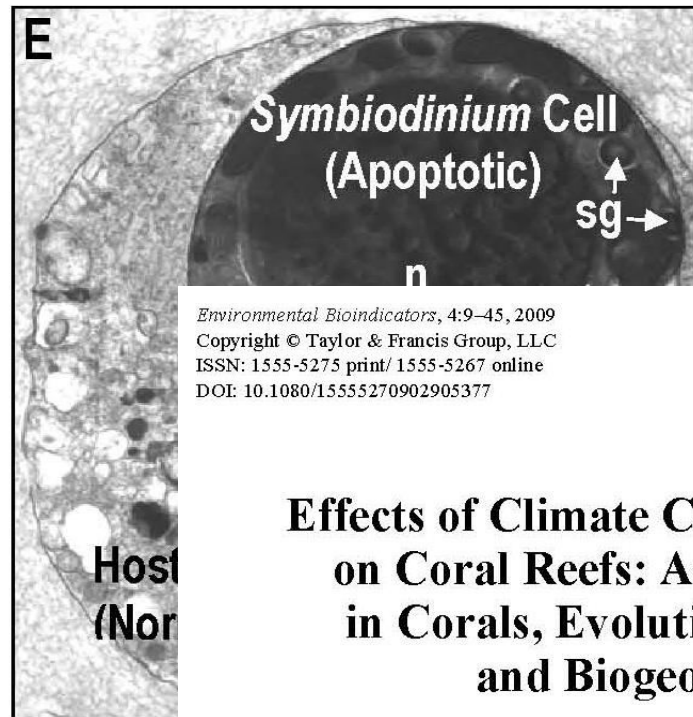
Results

Apoptosis of *Symbiodinium* from host *Acropora hyacinthus*



Results

Apoptosis of host *Acropora hyacinthus*



Environmental Bioindicators, 4:9–45, 2009
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DOI: 10.1080/15555270902905377



Effects of Climate Change/Global Warming on Coral Reefs: Adaptation/Exaptation in Corals, Evolution in Zooxanthellae, and Biogeographic Shifts

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¹Louisiana Universities Marine Consortium (LUMCON), Chauvin, La

²Department of Life Sciences Texas A&M University, Corpus Christi, Texas

Summary



Exaptation in corals to high seawater temperatures: Low concentrations of apoptotic and necrotic cells in host coral tissue under bleaching conditions

Kevin B. Strychar^{a,*}, Paul W. Sammarco^b

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Responses to High Seawater Temperatures in Zooxanthellate Octocorals

Paul W. Sammarco^{1*}, Kevin B. Strychar²

¹ Louisiana Universities Marine Consortium, Chauvin, Louisiana, United States of America, ² Annis Water Resources Institute, Grand Valley State University, Muskegon, Michigan, United States of America

PLOS ONE | www.plosone.org

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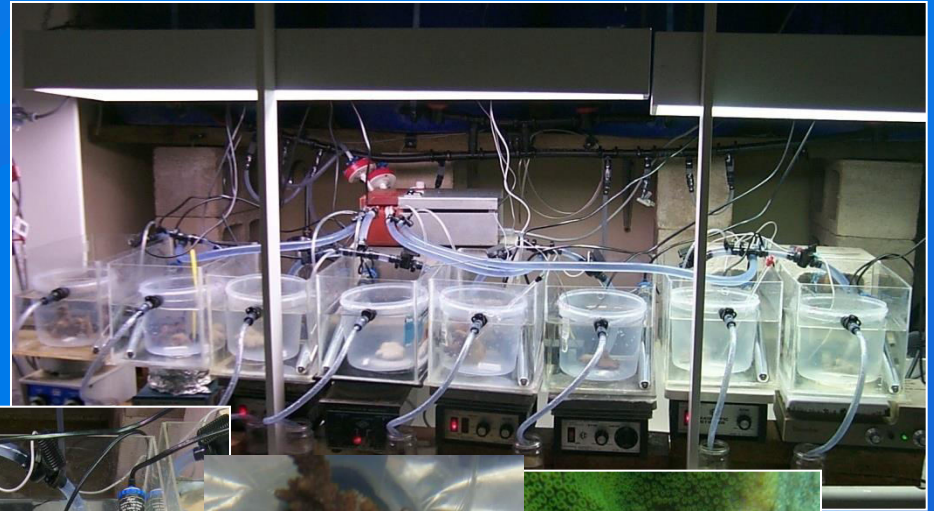
February 2013 | Volume 8 | Issue 2 | e54989

Next step: in progress

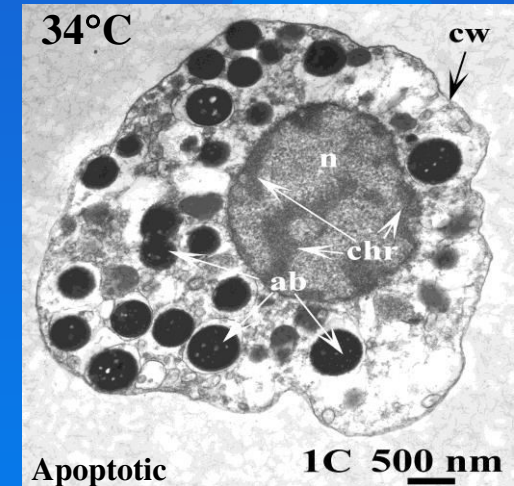
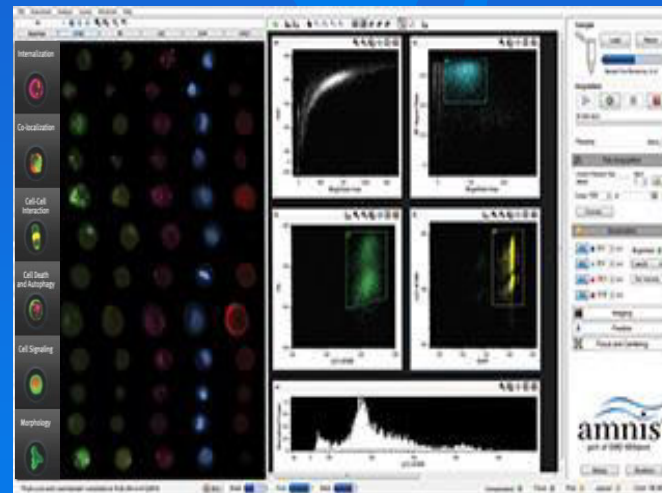
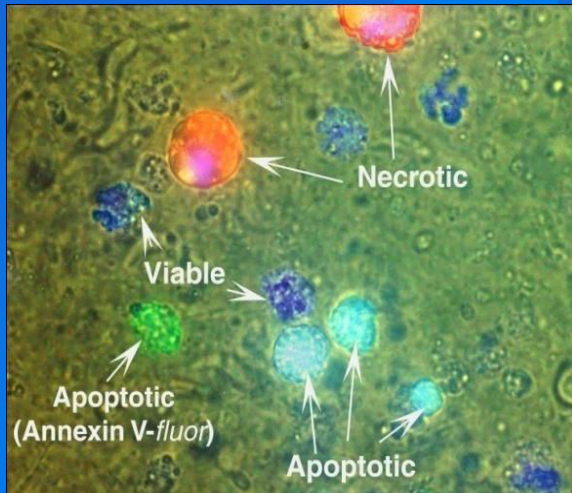
“Trogoncytosis”: The signaling molecules released by one cell act on neighboring target cells (plasma membrane-like transmitters).

- e.g. CDKs – cell dependent kinases

Methods



Methods





Methods

Fluorescent conjugates

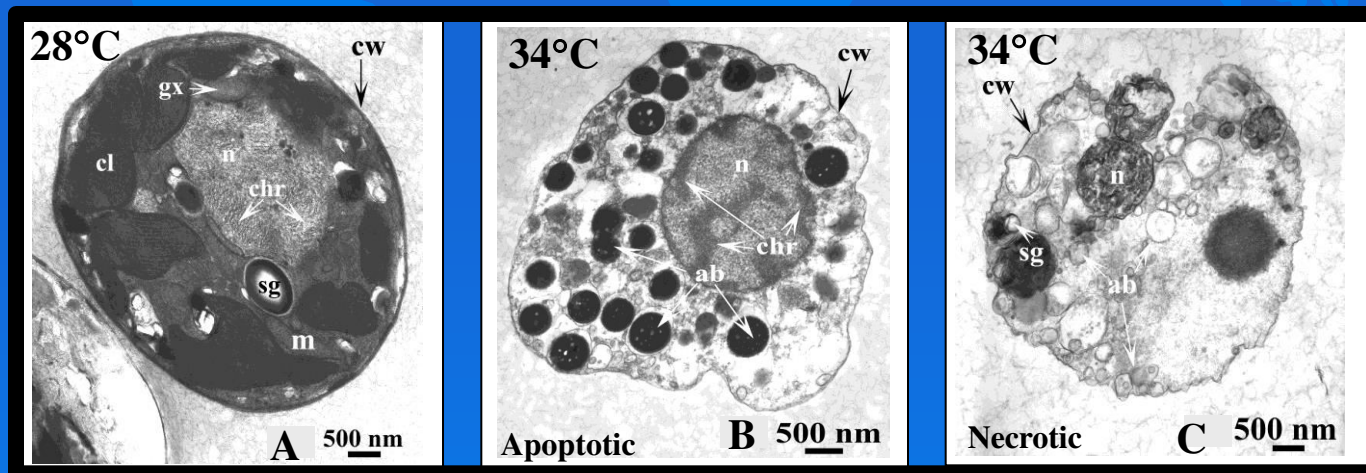
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Results

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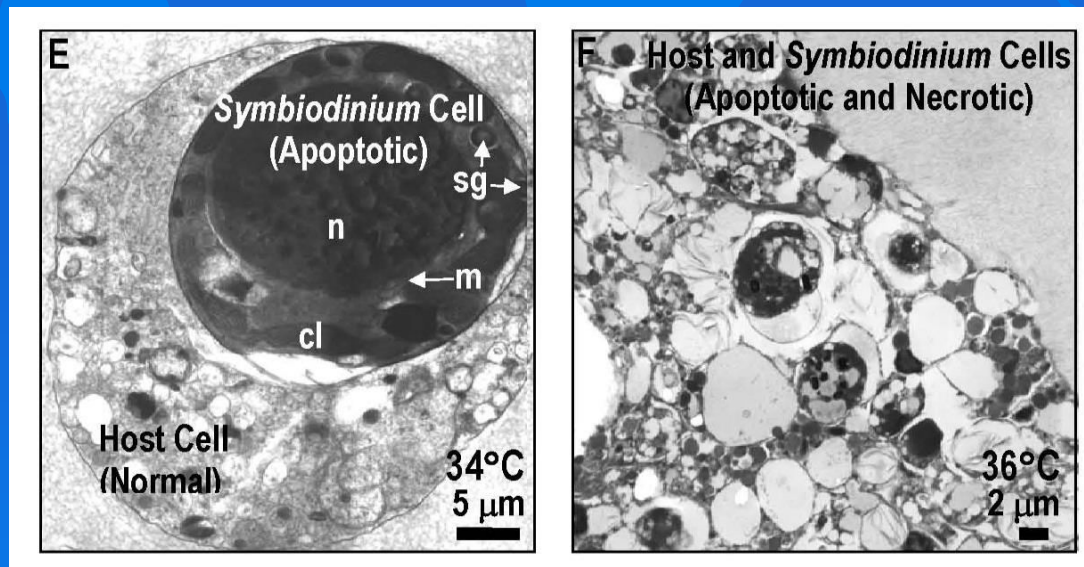


Results

Fluorescent conjugates

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Apoptosis of host *Acropora hyacinthus*

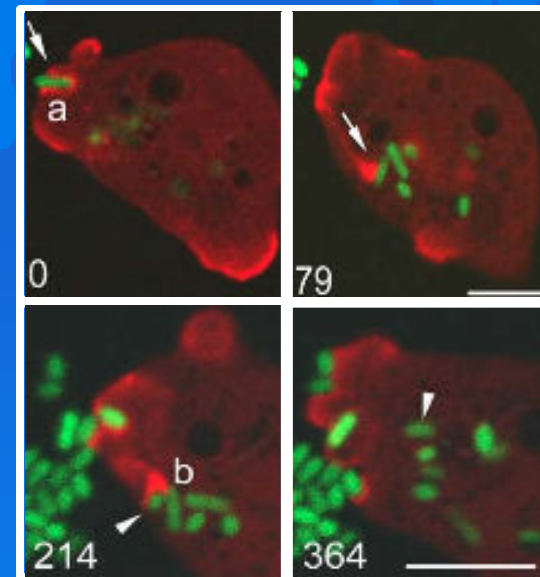
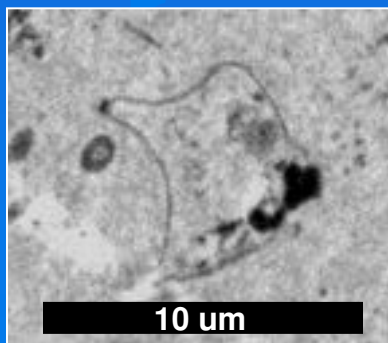
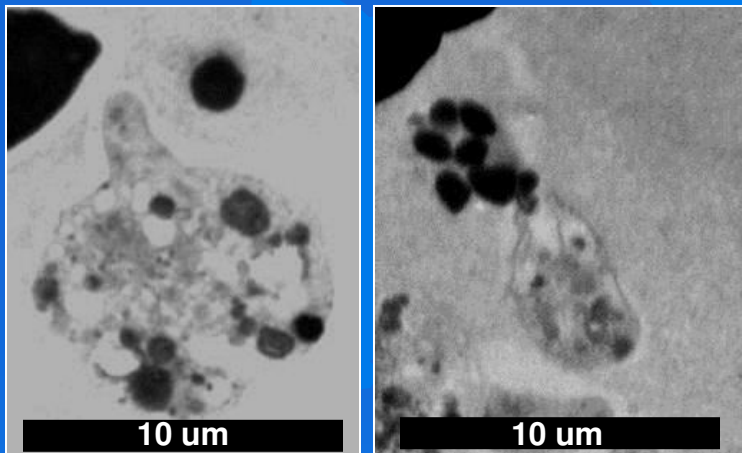




Results

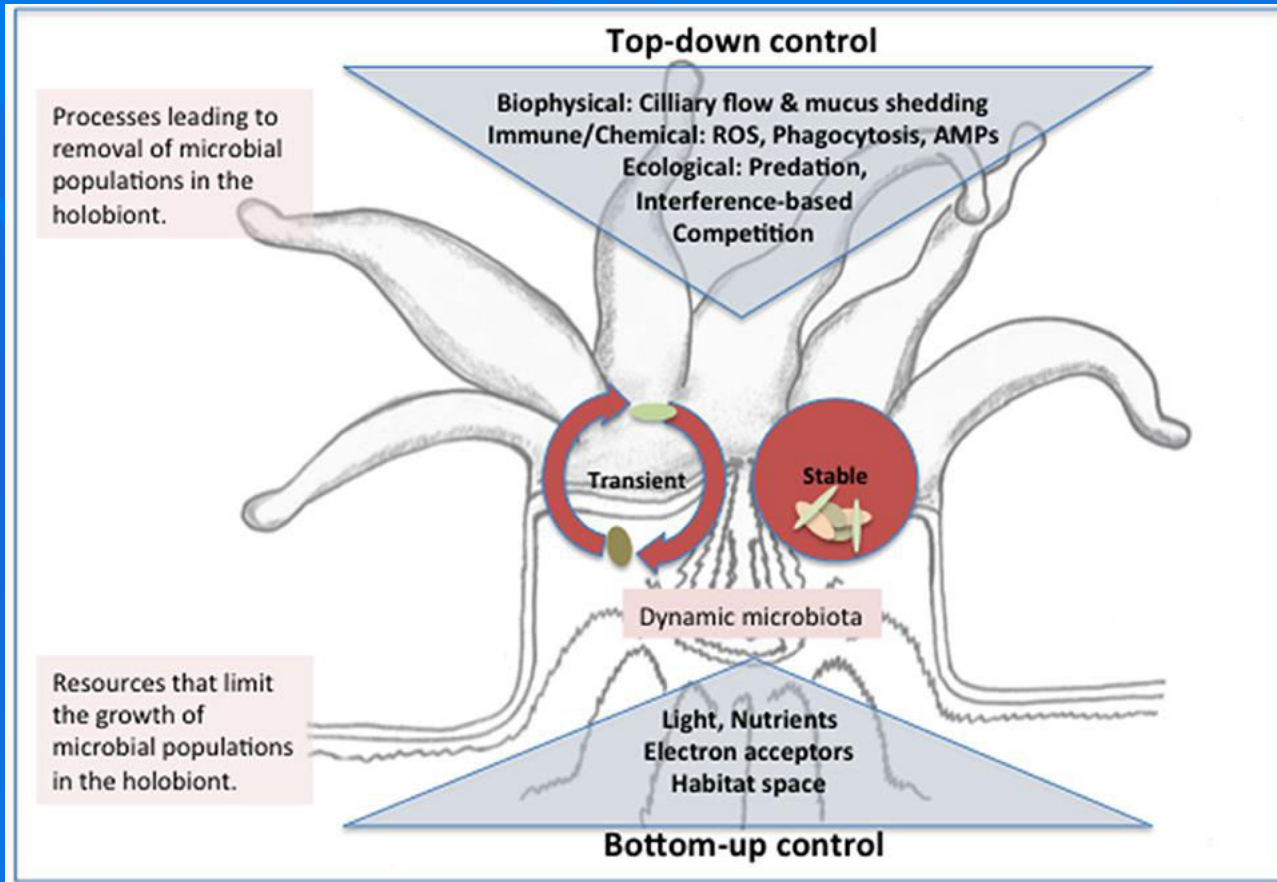
Fluorescent conjugates

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2. Phagocytosis fluorometric assays;



Clarke and Maddera, 2006;
bar = 5 µm

Self vs not-self



Front. Cell. Infect. Microbiol., 07 January 2015 | <http://dx.doi.org/10.3389/fcimb.2014.00176>