THE UNIVERSITY OF MELBOURNE

FOOD20006 Food Microbiology & Safety

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Microbial responses to stress

Ray and Bhunia, 5th ed Ch 10

Intended learning outcomes

Describe how microorganisms adapt to stress in the food environment

Explain how sublethal stress and injury affects detection of microorganisms in food samples

Microbial stress response in the food environment

Food borne microorganisms become stressed when they are exposed to some of the physical and chemical environments during

- Production
- Processing
- Preservation
- Storage
- Transportation
- Consumption of food

Some cells develop resistance to the stress, or suffer reversible injury or lose the ability to be cultured or to multiply.

Responses to stress

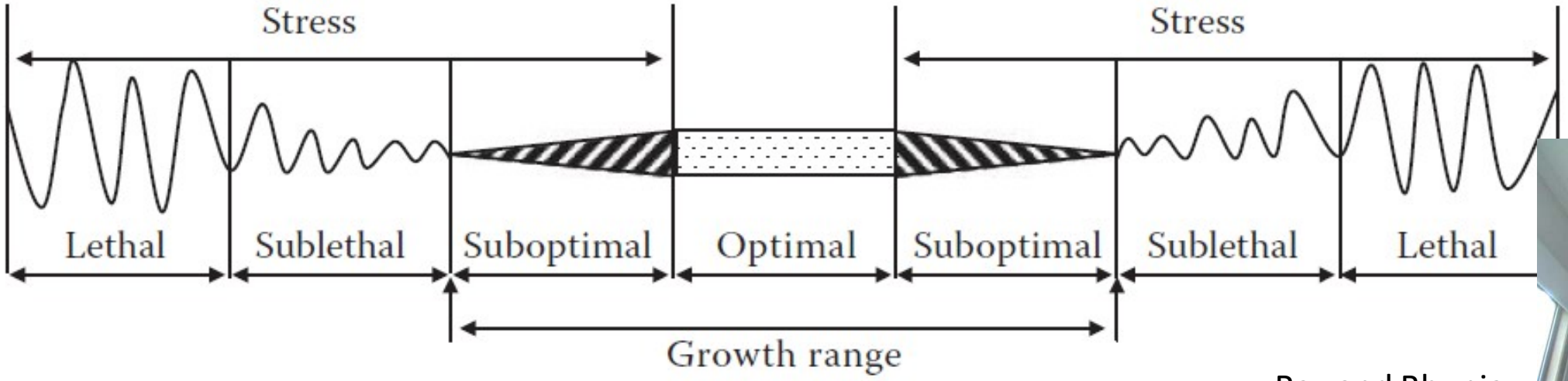
Microorganisms have specific conditions where the growth is optimal however they can multiply slowly under suboptimal conditions

Optimal + sub optimal = growth range

Cells suffer stress when they are outside their optimal conditions

In the sublethal ranges they will be damaged

In the lethal ranges they will be killed



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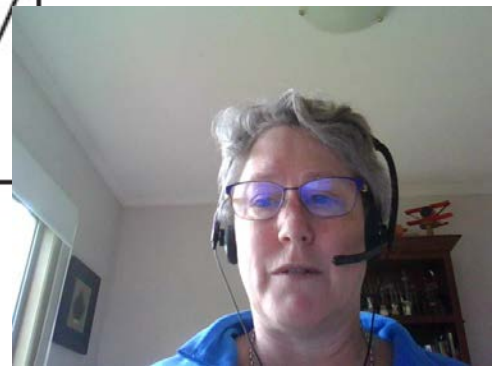


Stress adaptation

Exposure to sub optimal physical or chemical environments triggers stress adaptation or stress response in bacterial cells

Cells that have a brief exposure to suboptimal conditions and adapt are able to withstand harsh conditions

Examples of stress

- Temperature (cold or warm)
- Low Aw
- Low hydrostatic pressure
- UV light
- High salt concentrations
- Antibacterial chemicals (preservatives, disinfectants, antibiotics)

Stress adaptation is not “resistance”

Stress adaptation is a temporary change in the microorganisms in response to brief exposure to suboptimal environments

When cells are returned to optimum conditions and are allowed to multiply then they revert to their original state

This is different than when genetically different variants are selected out of a population

For example, antibiotic resistant organisms may have acquired new genes that make them permanently resistant

Mechanisms for stress adaptation

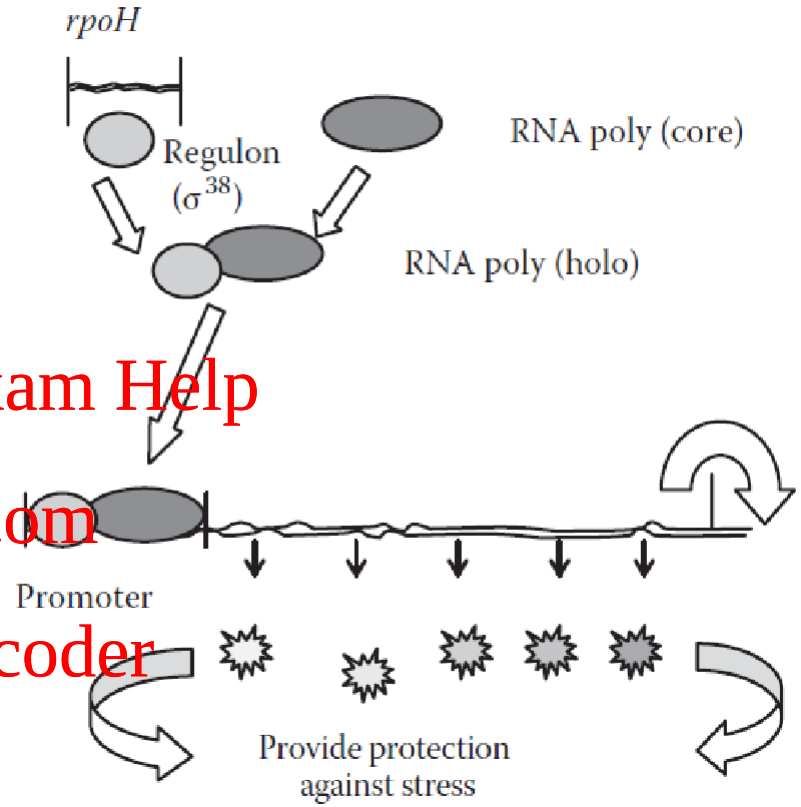
Adaptation to stress involves a change in the expression of specific genes which encode heat shock proteins or stress proteins

When cells detect the stress they synthesise a special component of RNA polymerase

The RNA polymerase then transcribes the genes which encode stress proteins

The stress proteins protect cells from the stress

When the stimulus (stress) goes away then the gene expression ceases



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Low pH foods

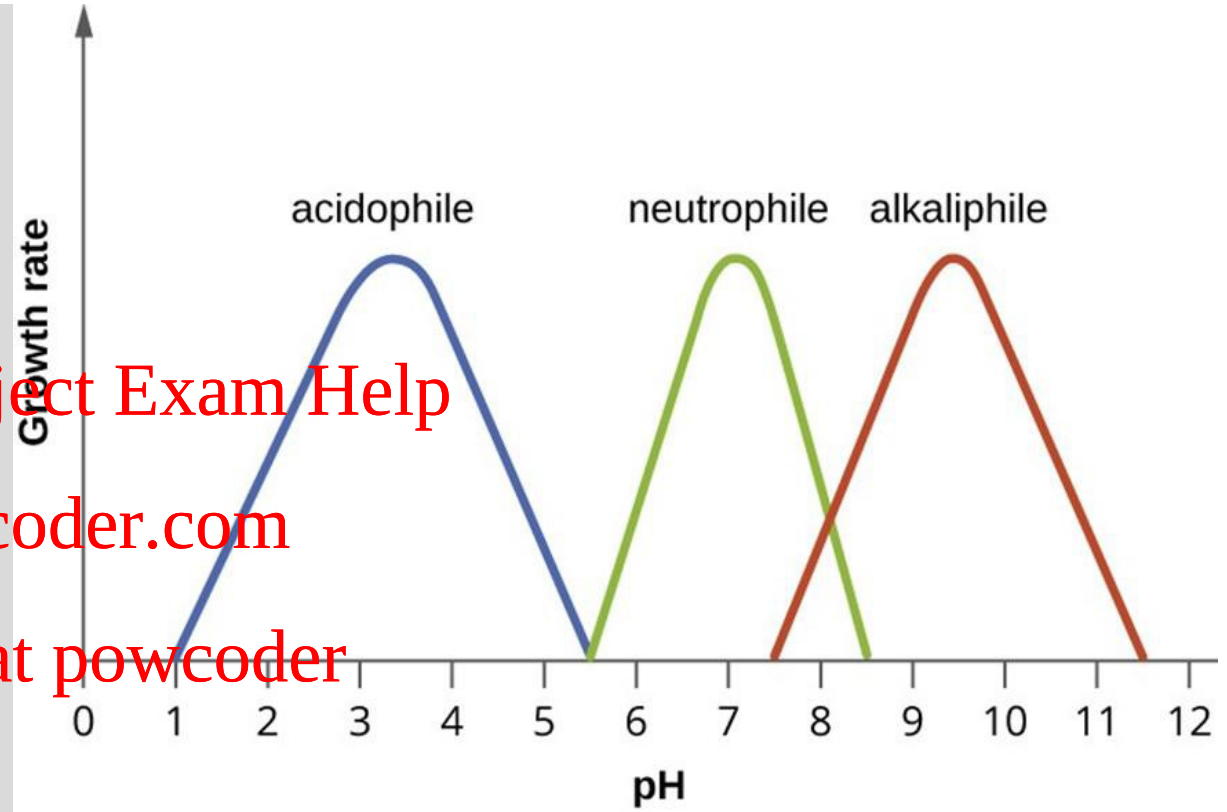
Many foodborne pathogens and spoilage bacteria are sensitive to low pH and die in high acid foods (pH≤4.5)

Cells most enteric pathogens die in the low pH of the stomach (pH2)

A few cells survive the stomach, into the GI tract and establish infections

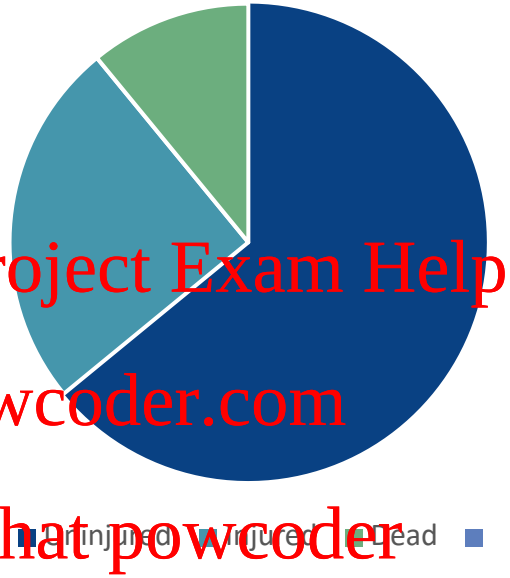
If a pathogen in a food is stress adapted then it is better able to survive in the stomach and cause infection

Food safety = eliminate or reduce the presence of stress adapted pathogens in ready to eat food



Three populations of stressed cells

1. Uninjured normal cells
2. Reversibly injured cells (injured)
3. Irreversibly injured cells (dead)



The relative percentages depend on the

- implicit nature of the organisms
- the nature and duration of the stress and
- the methods of detection

Injured cells differ from normal cells

Increased sensitivity to many compounds

- Surface active compounds (bile salts, deoxy cholate or SDS)
- NaCl
- Some chemicals
- Enzymes (lysozyme or RNase)
- Antibiotics
- Dyes (crystal violet or brilliant green)
- Low pH
- undissociated acids

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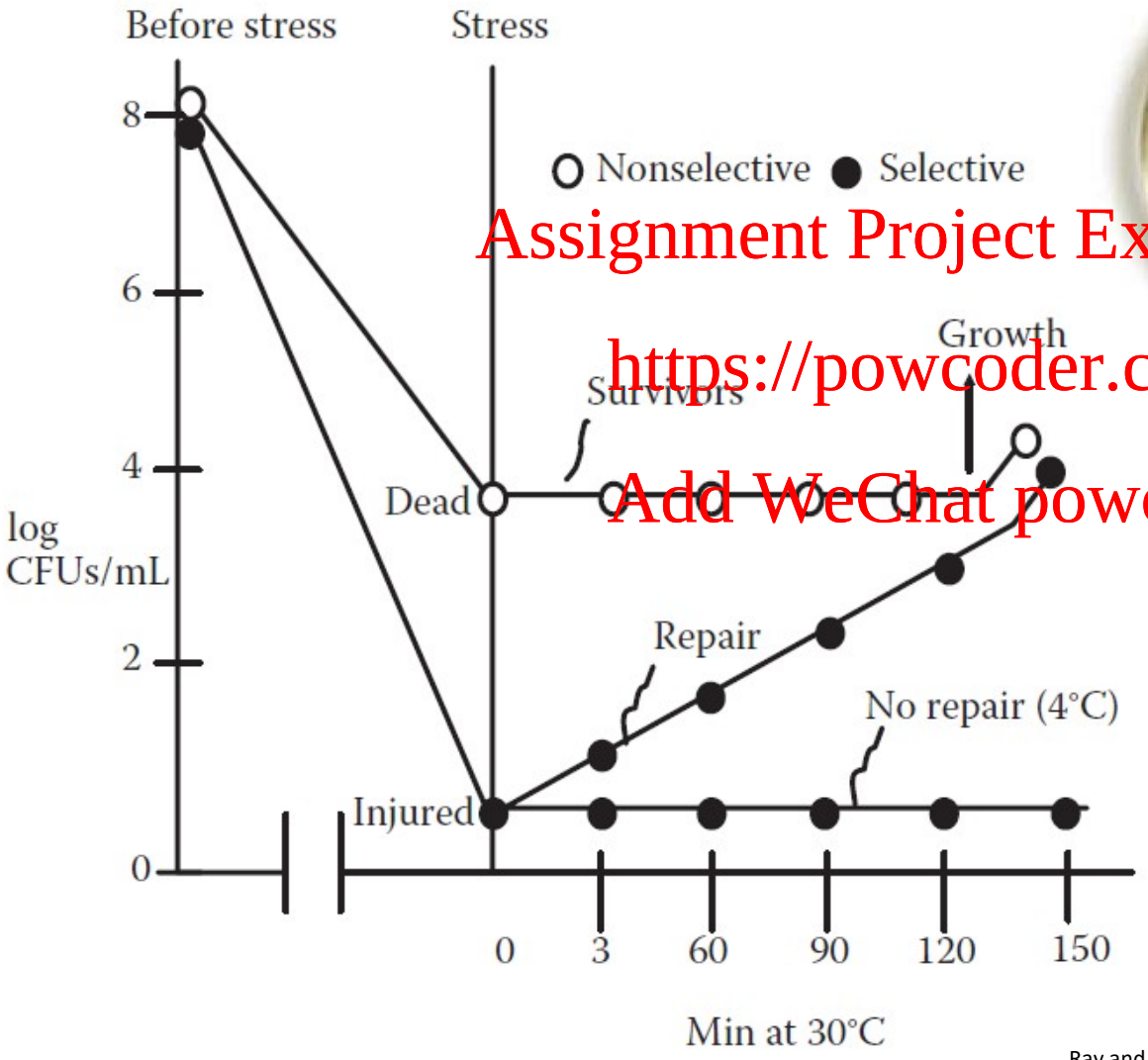
Injured cells do not multiply unless the injury has been repaired



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Repair of reversible injury

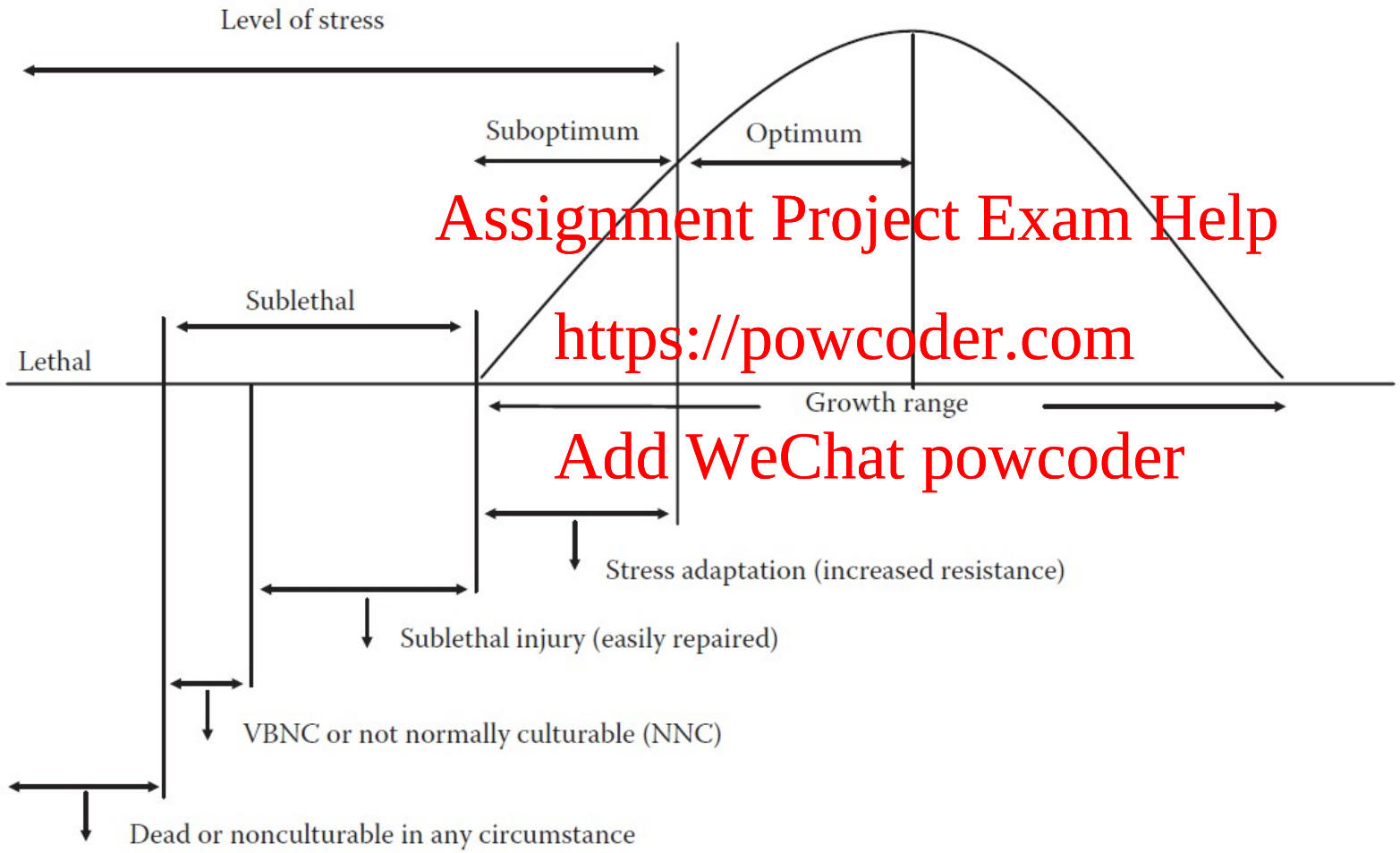
Injured cells are able to repair the injury and become similar to normal cells if they are given the right conditions

Suspending a subject easily stressed population repair medium and giving them time to recover will increase the number of colony-forming units

Injured survivors a be able to form colonies on nonselective media but are unable to tolerate selective agents

If they repair then they regain resistance and conform colonies on selective media

Recovery from stress differs according to the level of stress



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