

**What  
MAP  
Can & Can't  
Do For You !**

*Jim Gorny, Ph.D.*



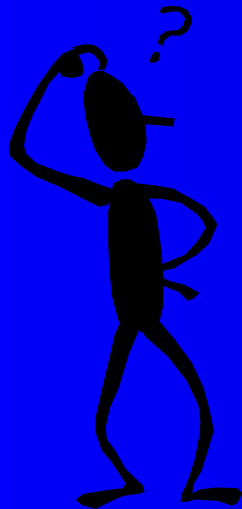
**POSTHARVEST TECHNOLOGY**  
**Research & Information Center**

# The Fresh-cut Produce Evolution



# What Bag Do I Use for (blank) ?

- Empirical Approach
- System Approach



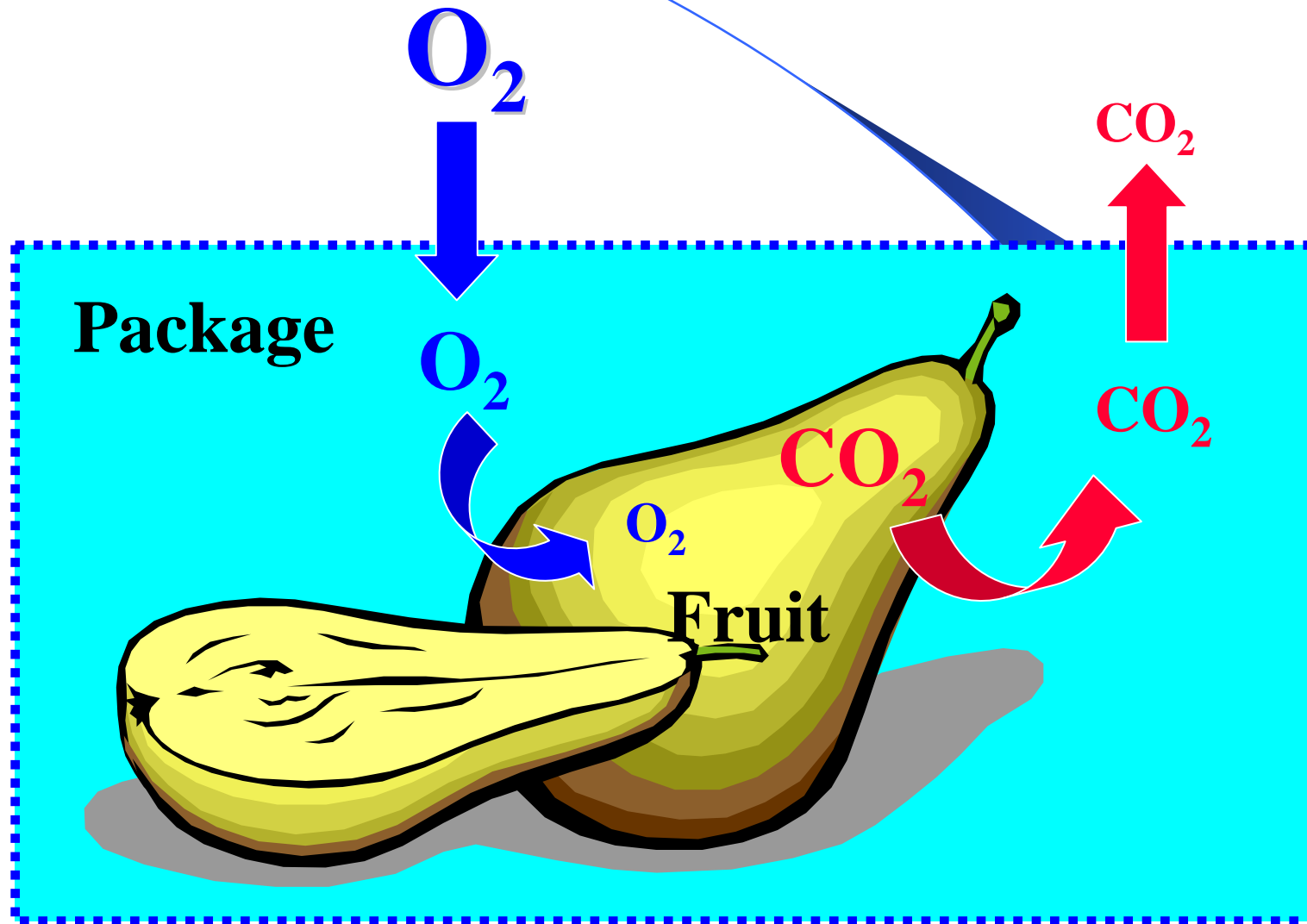
# **Why Use MAP ?**

- I. Increased Shelf-life**
- II. Appearance Quality**
- III. Sensory Quality**
- IV. Increased Marketability**
- V. Will MAP Deliver These Benefits ?**

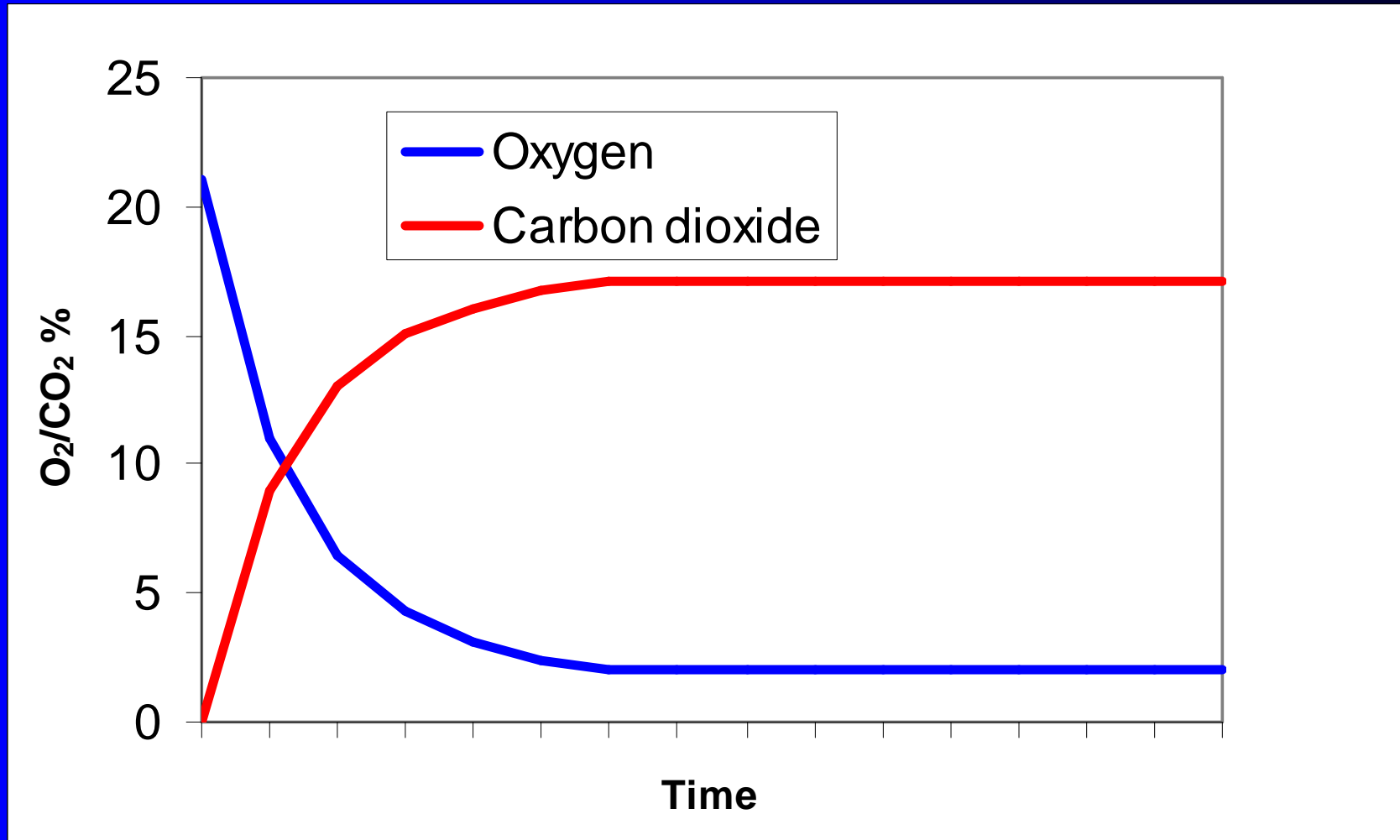
# How Does MAP Work ?

- **Reduced Product Respiration**
- **Slows Ripening & Aging**
  - **Pigment Degradation**
  - **Softening or Toughening**
  - **Carbohydrate Conservation**
- **Slows Browning Reactions**
- **Altered Microbe Population Dynamics**

# MAP Fundamentals



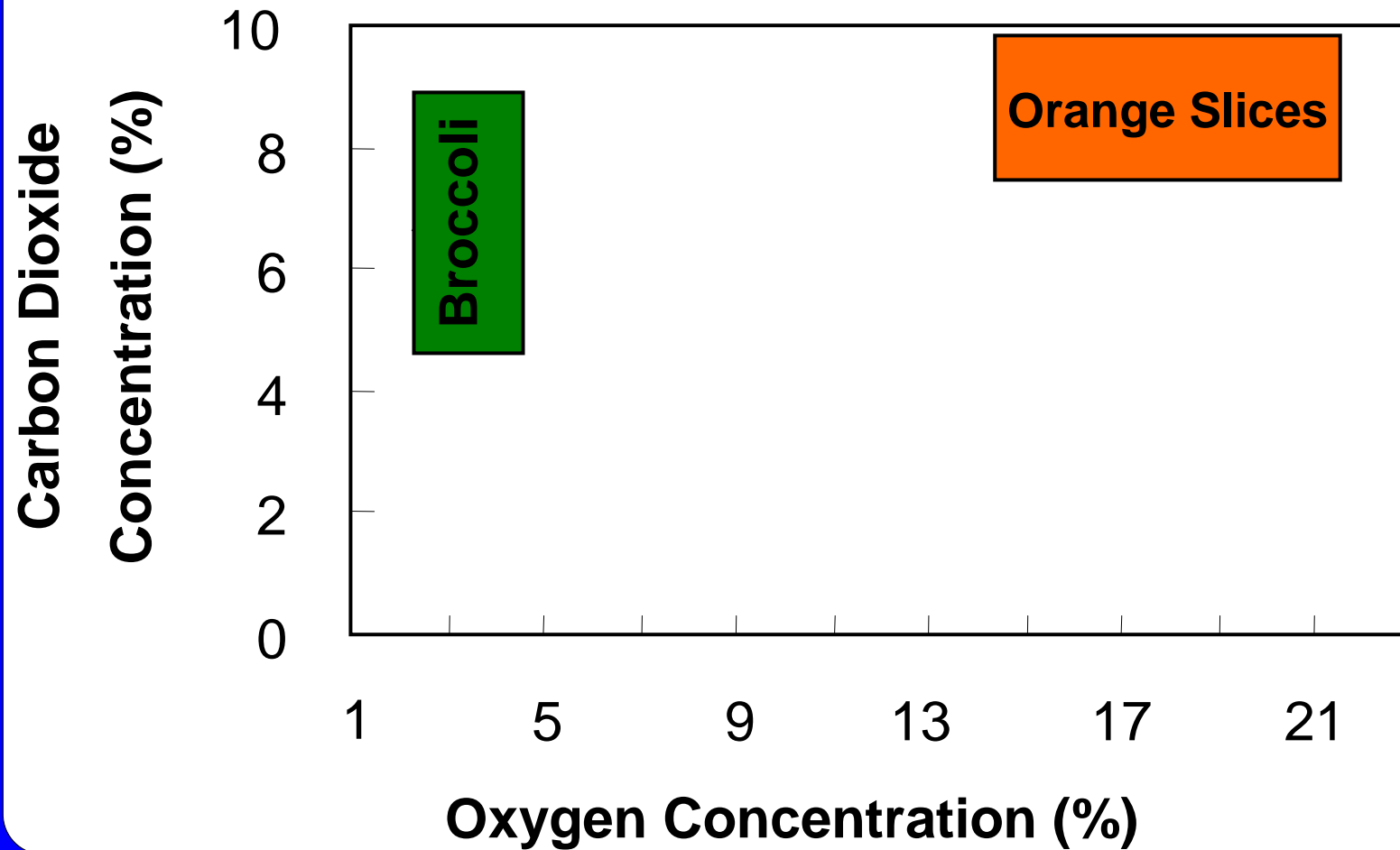
## Produce MAP Dynamics



# What Atmosphere Will Deliver Benefits ?

- Oxygen
- Carbon Dioxide
- Relative Humidity

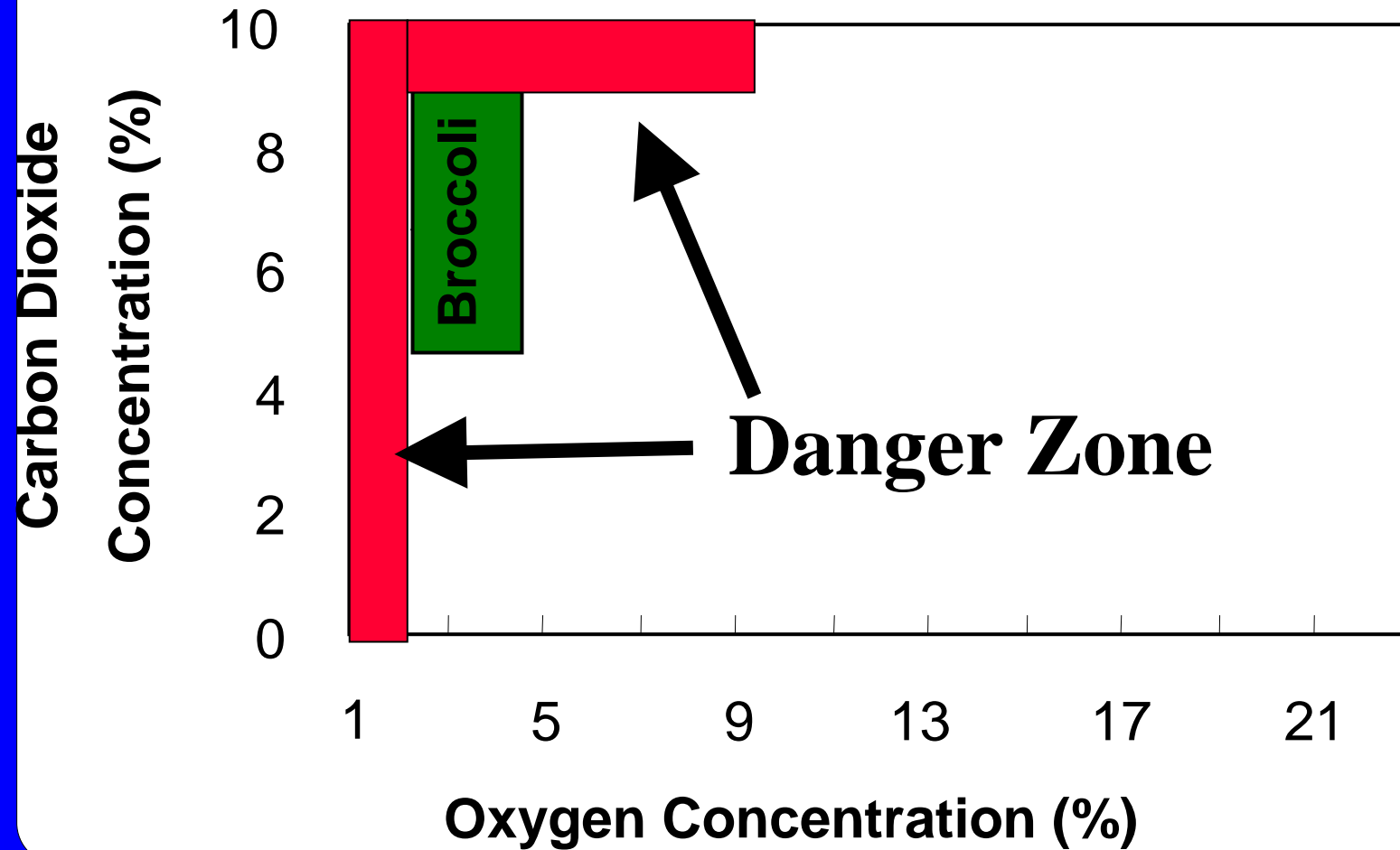
# MAP Windows of Opportunity



# What Atmosphere(s) Will Induce Damage ?

- Fermentation
- Off Flavors & Odors
- Carbonation
- Accelerated Deterioration → Decay
- Water Condensation

# MAP Danger Zones



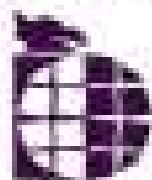
## Broccoli, Florets

Optimum Temp: 32-41°F

	<u>Reduced O<sub>2</sub></u>	<u>Increased CO<sub>2</sub></u>
Benefit Level:	2-3%	6-7%
Benefits:	Asc. Acid Retention Chlorophyll Retention	Reduced Soft Rot
Potential for Benefit:	Good	Good
Injurious Level:	<1%	>9%
Injury Symptoms:		Severe Off Odor
Potential for Injury:	Great	Great



# Packaging Design for Fresh-cut Produce

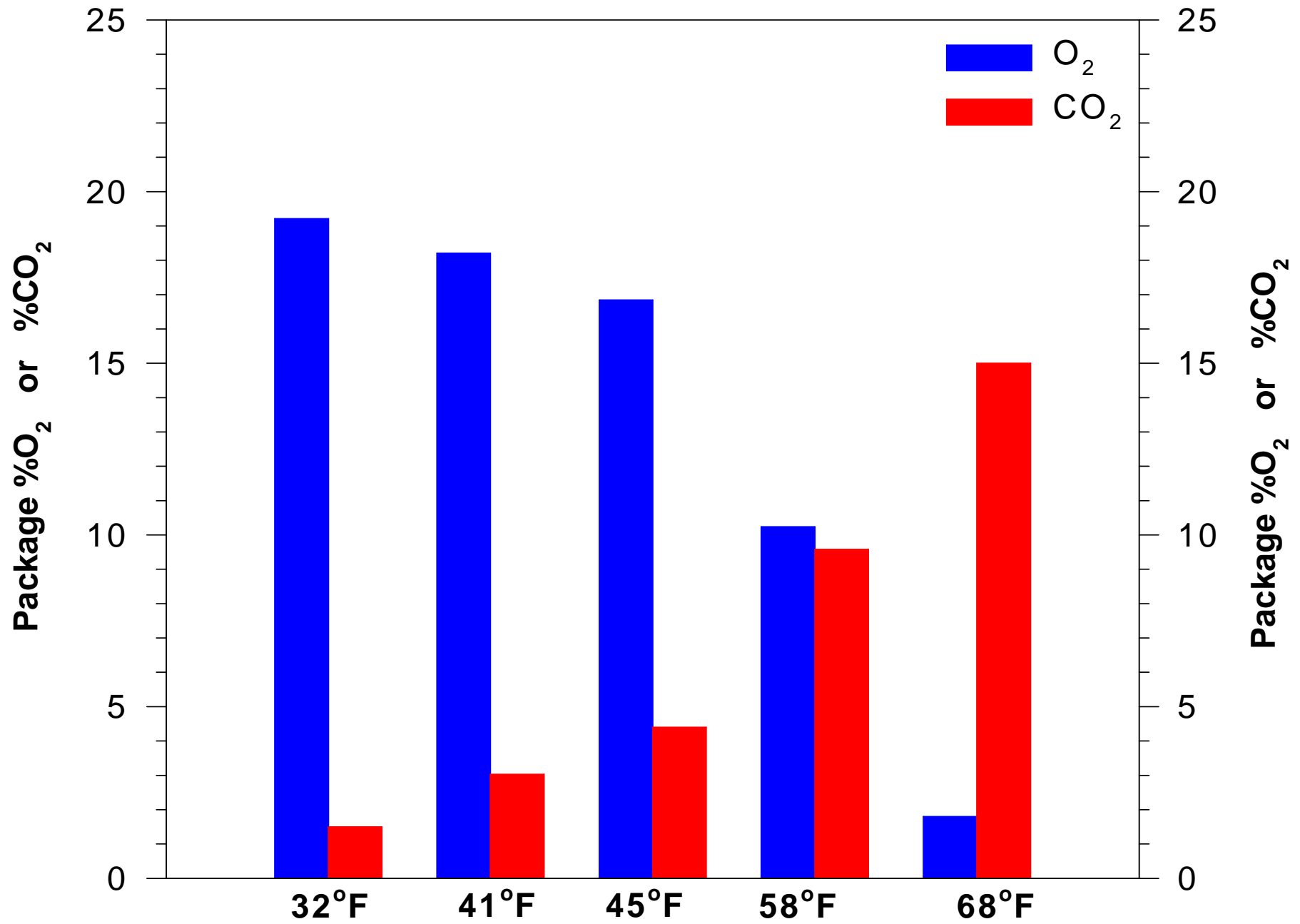


International Fresh-cut  
Produce Association

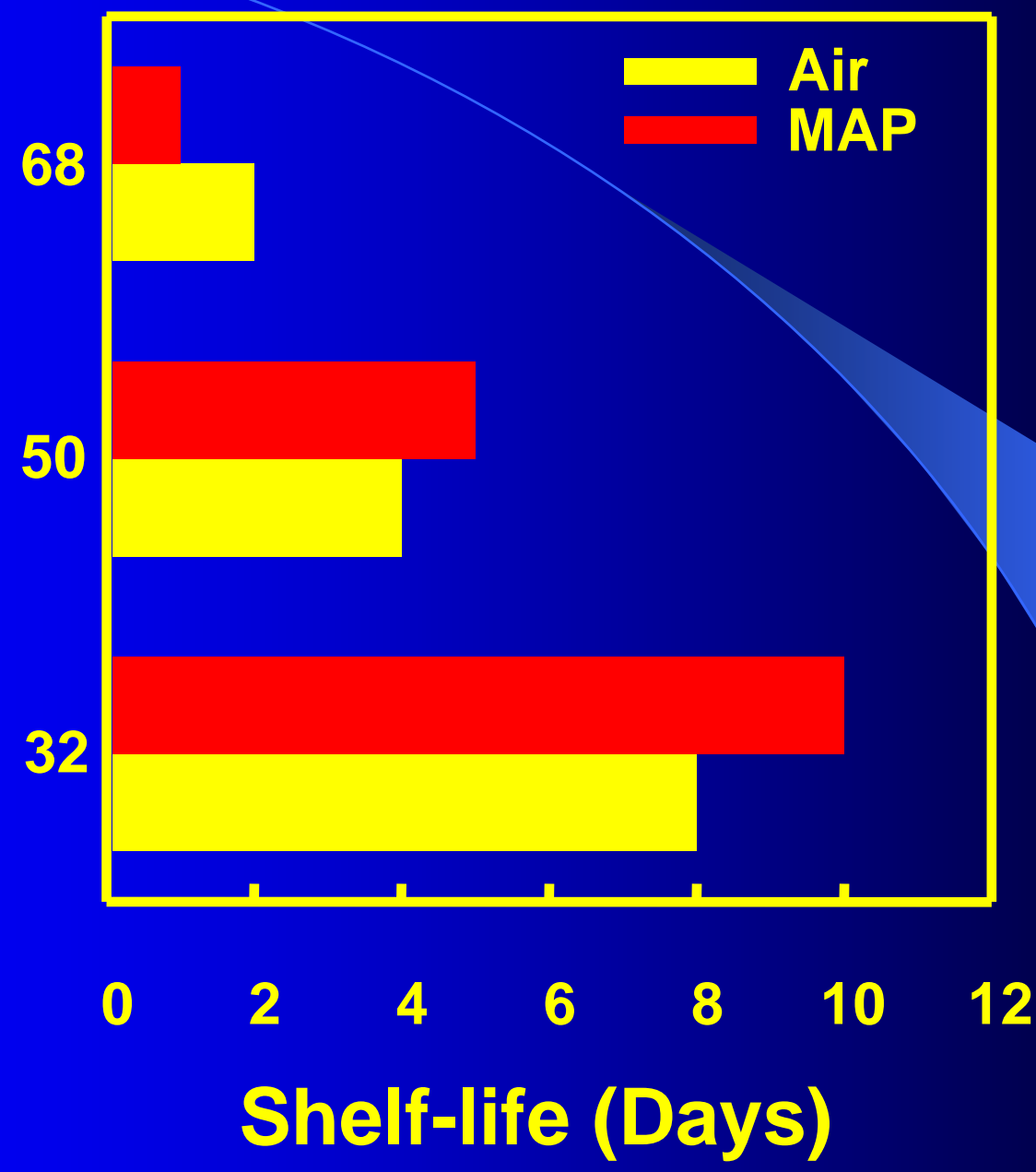
# **What Temperatures Will The Product be Exposed To ?**

- **Product Respiration Rate**
- **Equilibrium Atmosphere**

# Package Equilibrium Atmosphere



Temperature (°F)



# Microbes & MAP

- **Non Spoilage Microflora**
- **Spoilage Microflora**  
*Psuedomonads, Mold, Lactic Acid Bacteria*
- **Human Pathogens**  
*E coli, Salmonella, C. Bot, Listeria*

# MAP Effects on Spoilage Microflora

- ***Pseudomonads***: Reduced Growth
- **Mold**:  $\geq 10\% \text{CO}_2$  Reduced Growth
- **Lactic Acid Bacteria**: Enhanced by
  - Low  $\text{O}_2 \leq 1\%$
  - High  $\text{CO}_2 \geq 40\%$(Carlin et al, 1990)

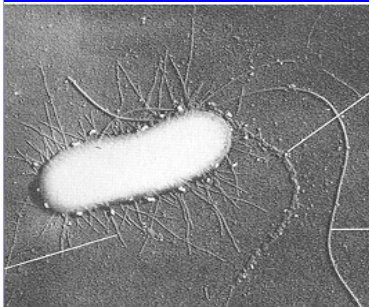
# MAP Effects on Human Pathogens

## *Listeria monocytogenes:*

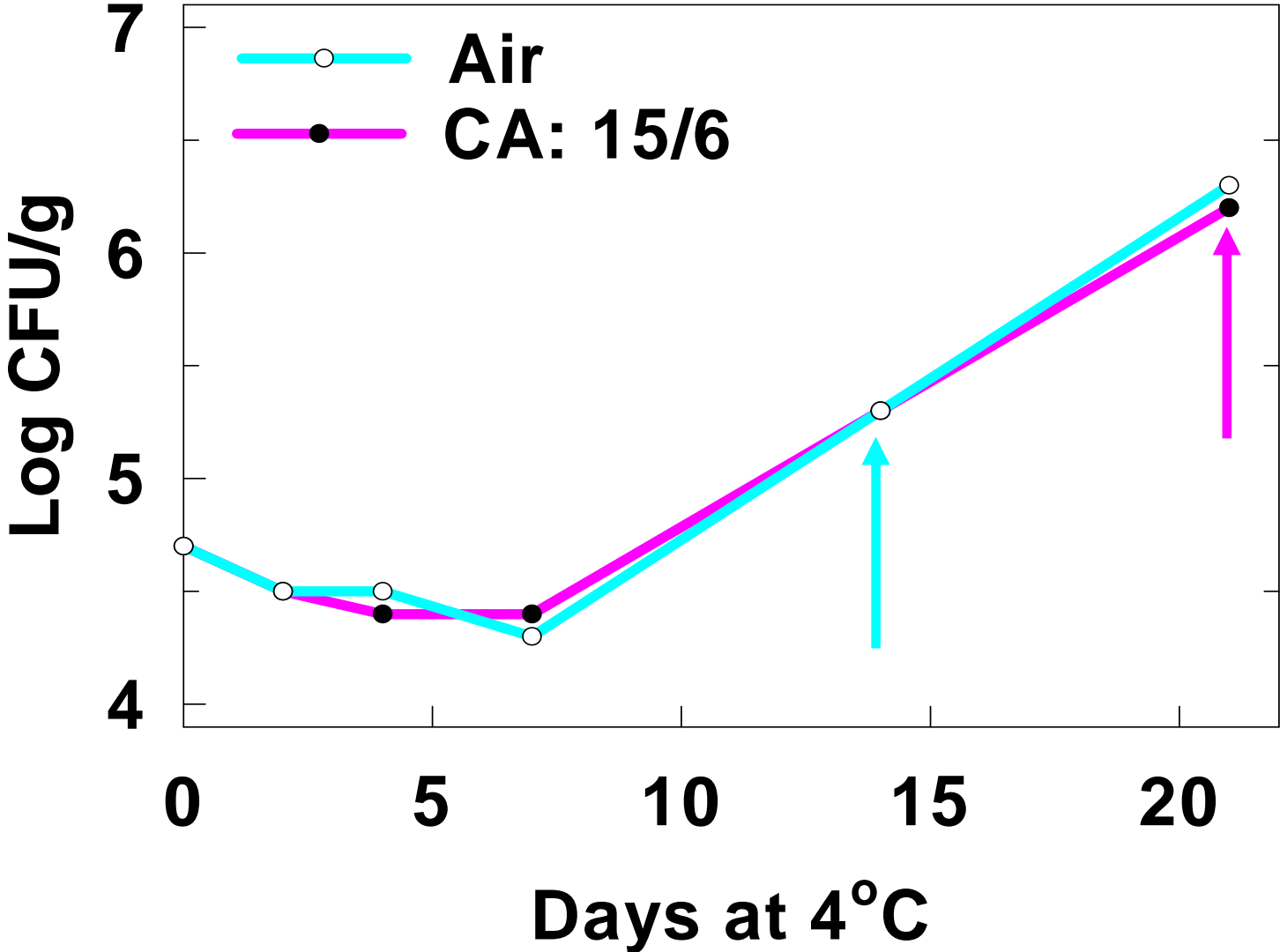
No Effect on Survival or Growth  
Shredded Lettuce (3/97)  
(Beuchat & Brackett, 1990)

## *E coli O157:H7:*

No effect on survival or growth  
Shredded Lettuce & Cucumber  
(Abdul-Raouf et al, 1993)



# Growth of *L monocytogenes* in Asparagus Held in MAP and Ambient Air



(Berrang et. al, 1989)

# MAP Effects on Human Pathogens

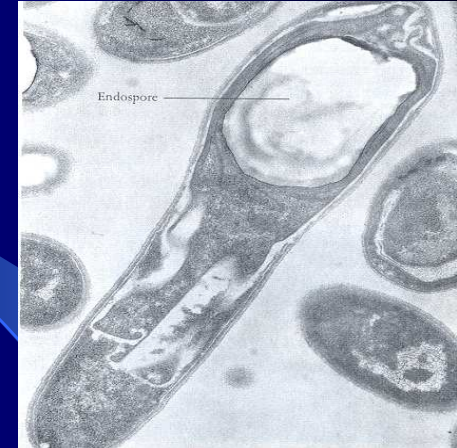
## *Clostridium botulinum*:

**Product pH Dependent**

**Refrigeration**

**Overt Spoilage Often Occurs BEFORE  
Toxin Production (Austen et al, 1998)**

**Competitive Resident Microflora**



# What Bag Do I Use for (blank) ?

- **Defined Target Atmosphere**
- **Defined Temperature = Respiration**
- **Define Product Weight**
- **Define Package Size**
- **Define Film Thickness**

## What OTR Film Do I Use for (blank) ?

$$\text{OTR} = RR_{\text{O}_2} \cdot t \cdot W/A \cdot (\text{O}_{2\text{atm}} - \text{O}_{2\text{pkg}})$$

Where:

**OTR = Film O<sub>2</sub> Permeability (OTR)**

**RR = Respiration Rate (O<sub>2</sub> Consumption)**

**t = Film Thickness**

**W = Product Weight**

**A = Film Surface Area**

**O<sub>2pkg</sub> = Desired O<sub>2</sub> Concentration In the Pkg**

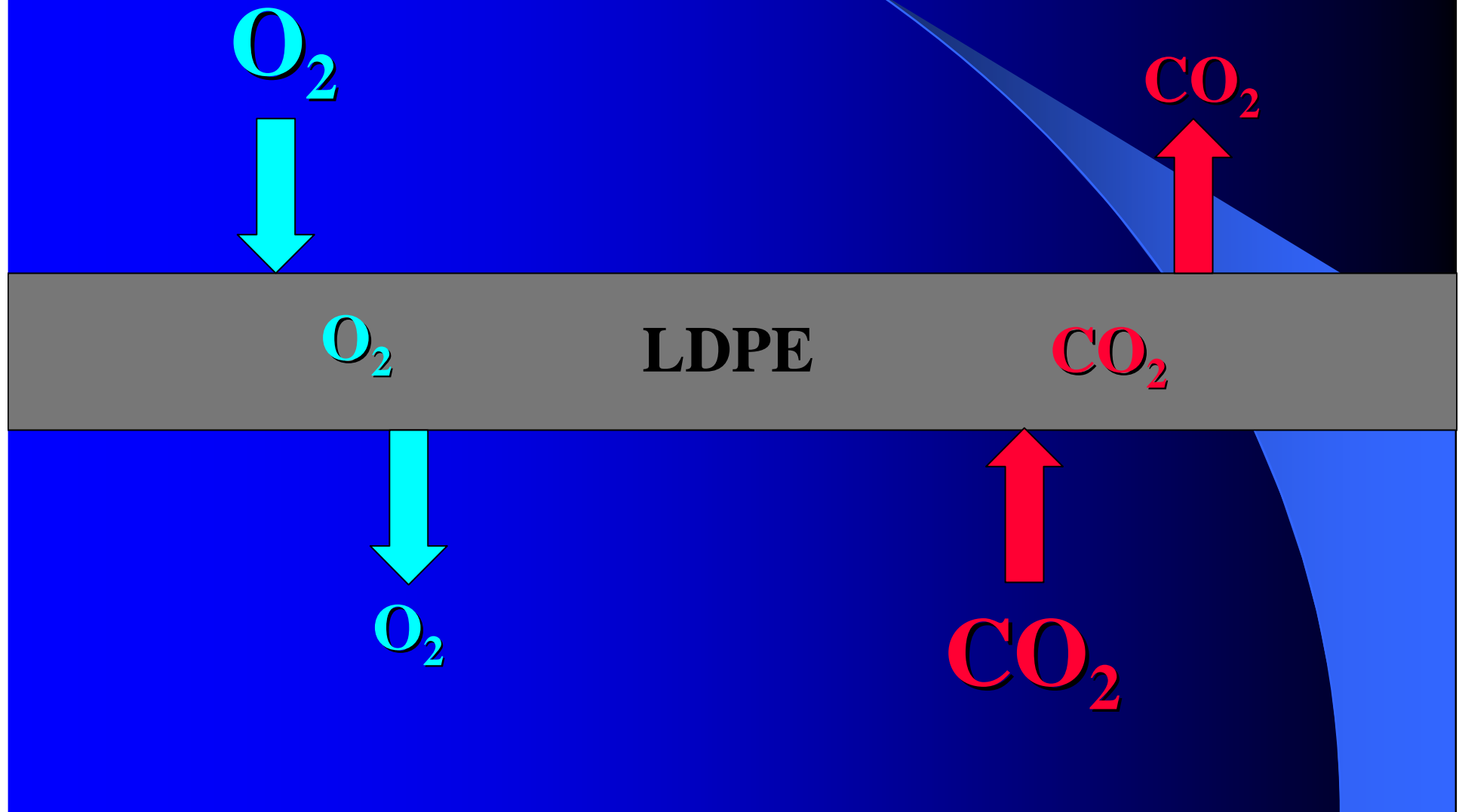
# What Materials Do I Use ?

- **Oxygen Transmission Rate (OTR) - Breathability**
- **Determination of Appropriate  $\text{CO}_2/\text{O}_2$  Permeability ratio ( $\beta$ )**

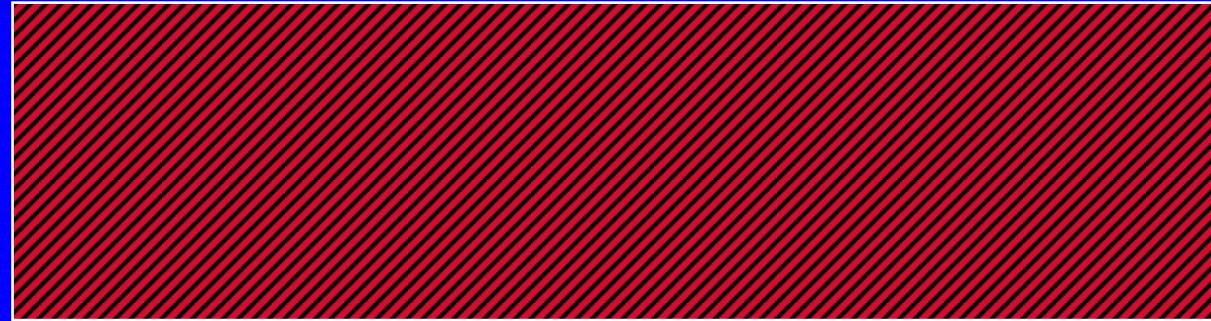
# Common MAP Systems

- **Mono or Multiple Layer Films**
- **Patches or Membranes**
- **Micro or Macro Perforation**

# Monolayer or Laminate Films



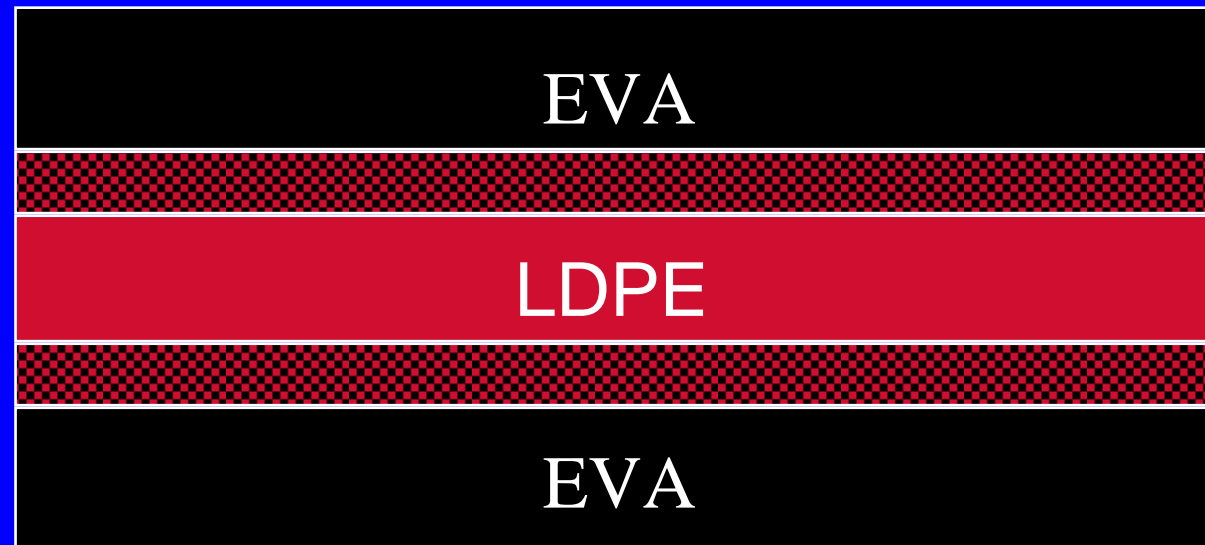
# LDPE-EVA Blend



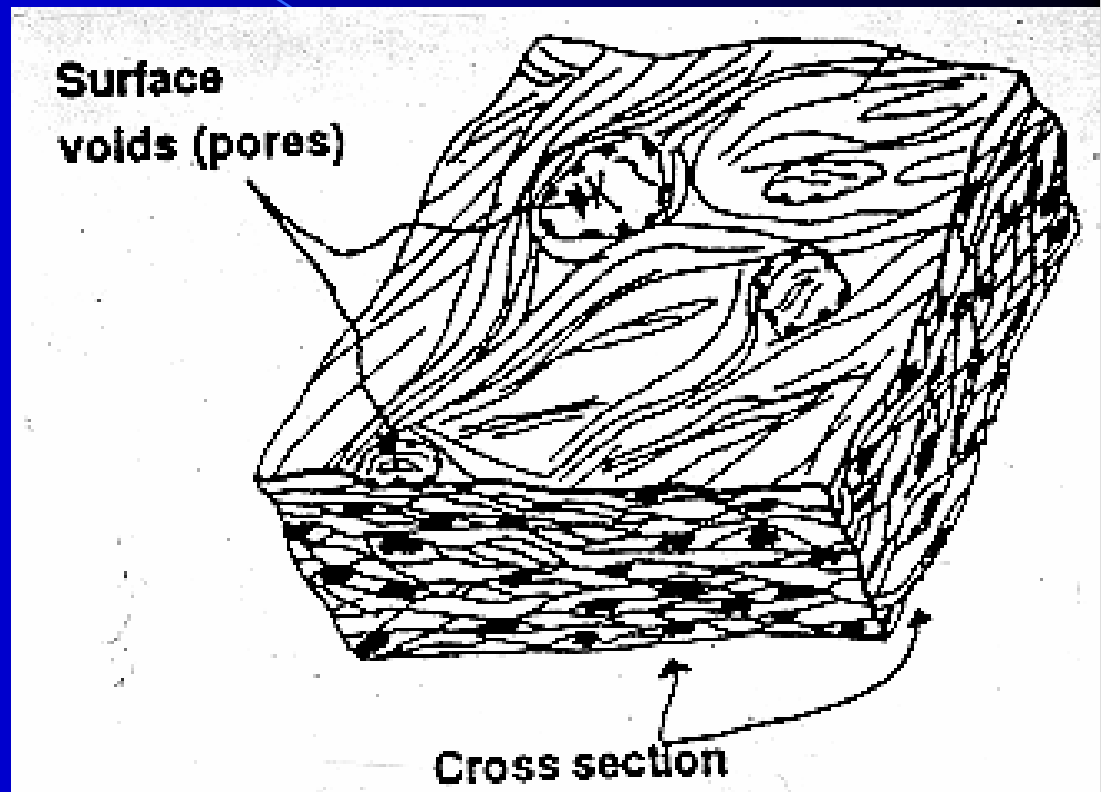
# LDPE-EVA Lamination



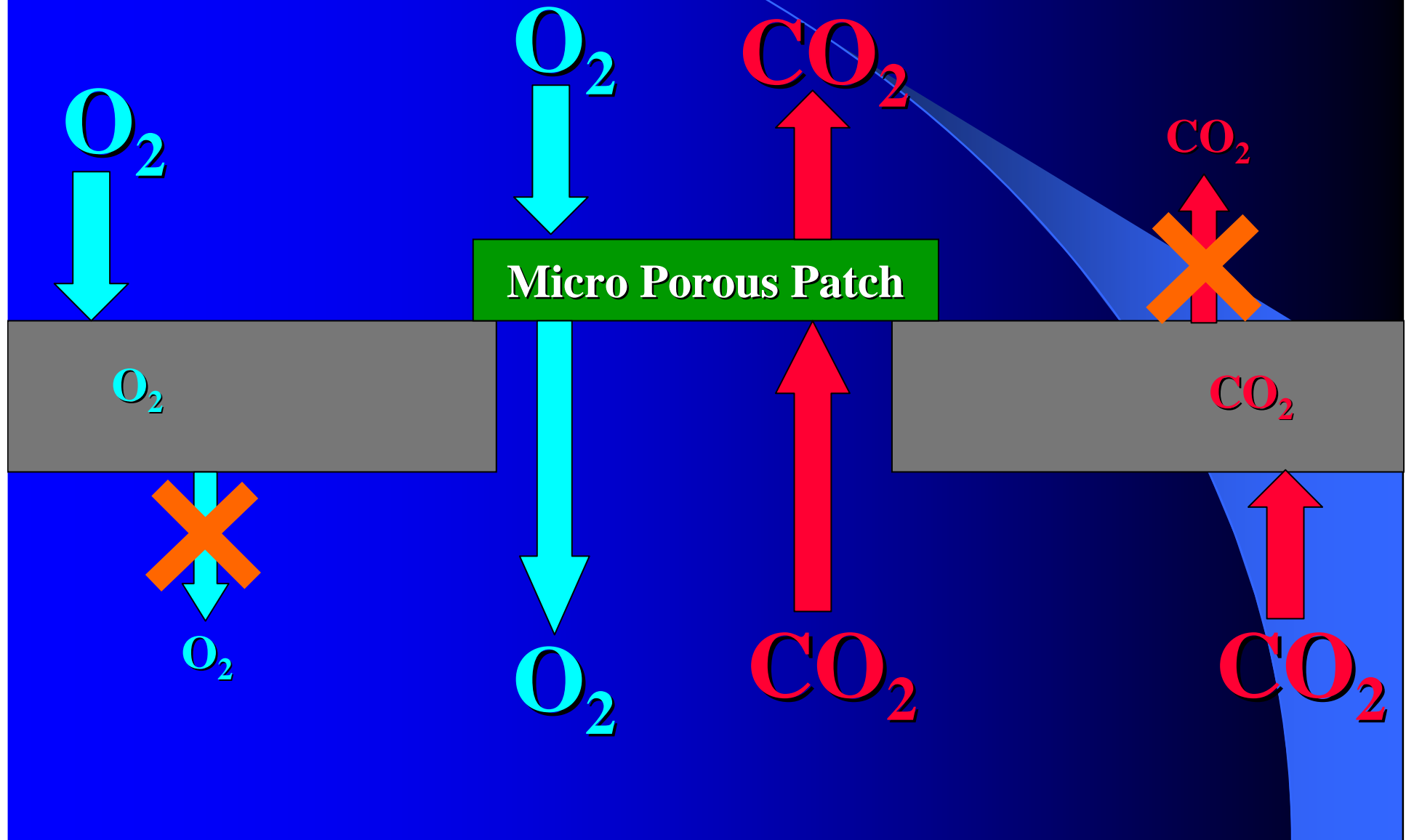
# LDPE-EVA Coextrusion



# Micro Porous Patches



# Micro Porous Patches

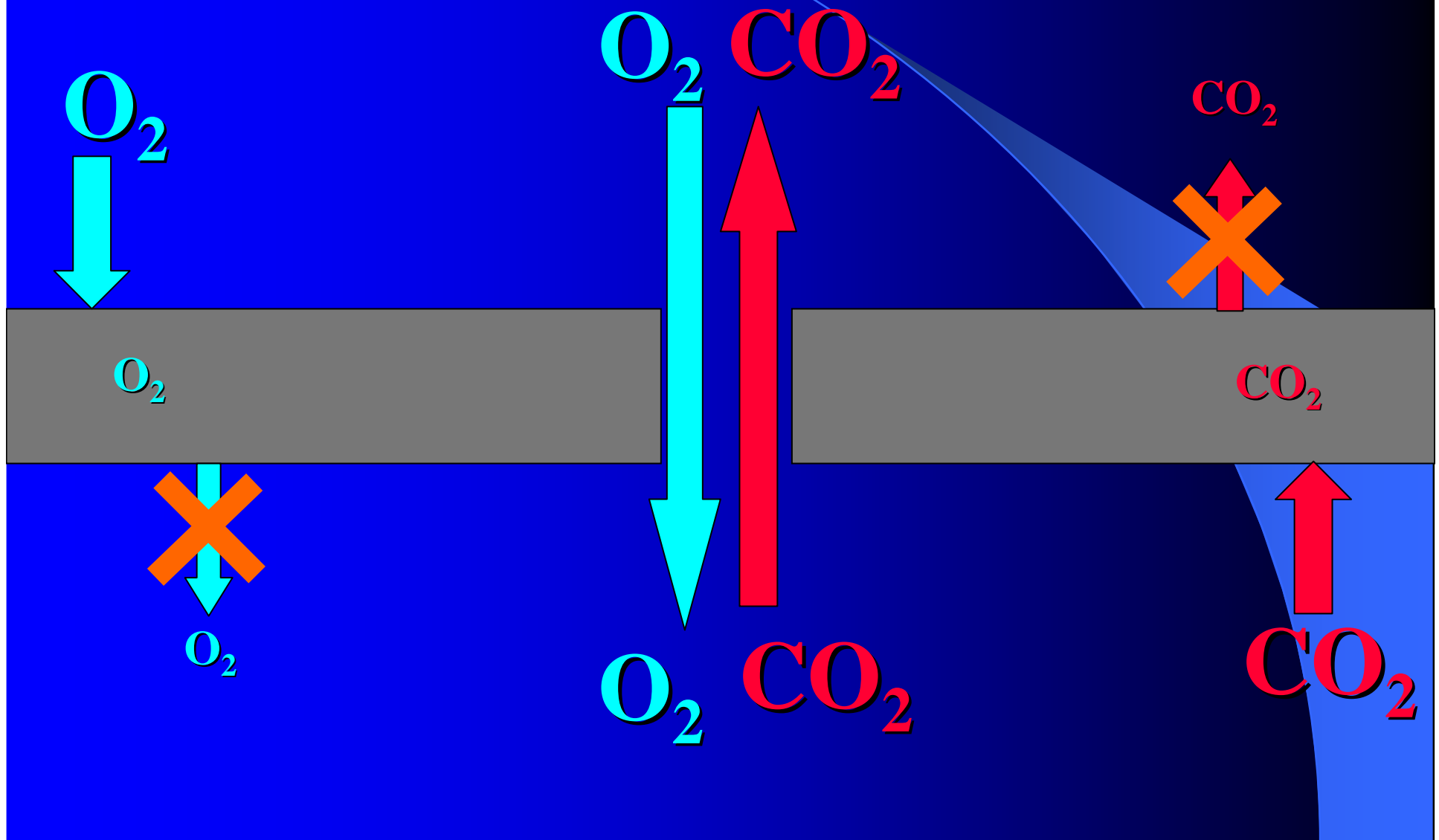


# Microperforation



(Side View)

# Macro or Micro Perforation

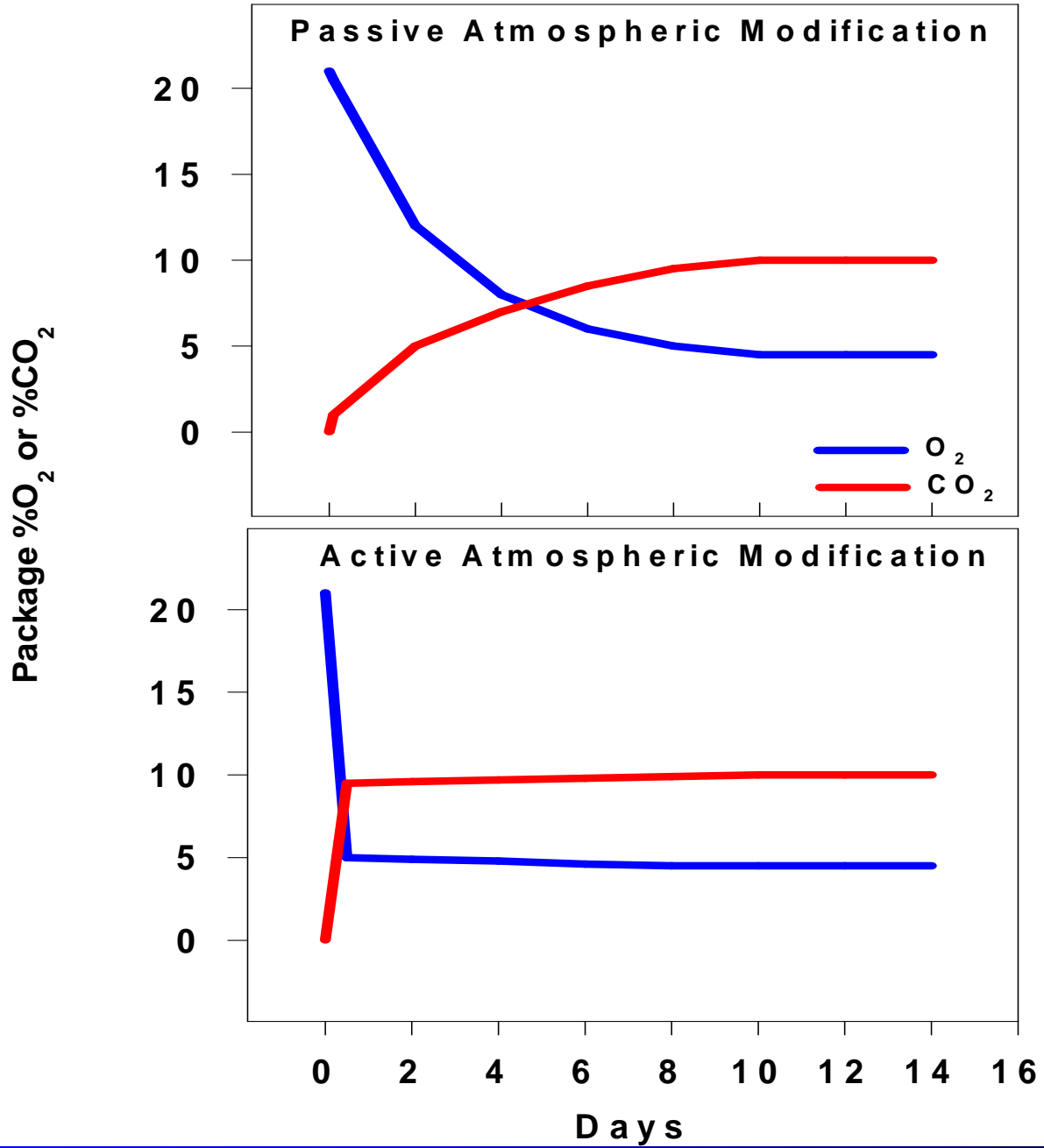


# Other MAP Considerations

- **Clarity**
- **Stiffness**
- **Sealability**
- **Machinability**
- **Printability**

# Gas Flushing & Vacuum Packaging

- **Rapidly Delivers A Desired Atmosphere**
- **Does NOT Alter Equilibrium Atmosphere**



# MAP

## Can

- Increase Shelf-life
- Slow Microbial Growth
- Maintain Nutritional Quality
- Slows Browning

## Cannot

- Sub for Temp. Control
- Stop Microbial Growth
- Improve Quality

# Fresh-cut Fruit Products: New MAP Challenges



# Value-Added & Fresh-cut Produce

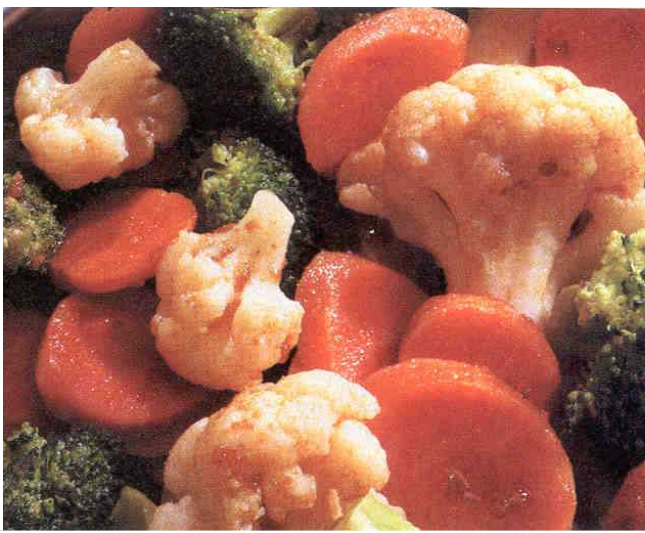
---

- ❖ Salad Kits
- ❖ Home Meal Replacement
- ❖ Foodservice



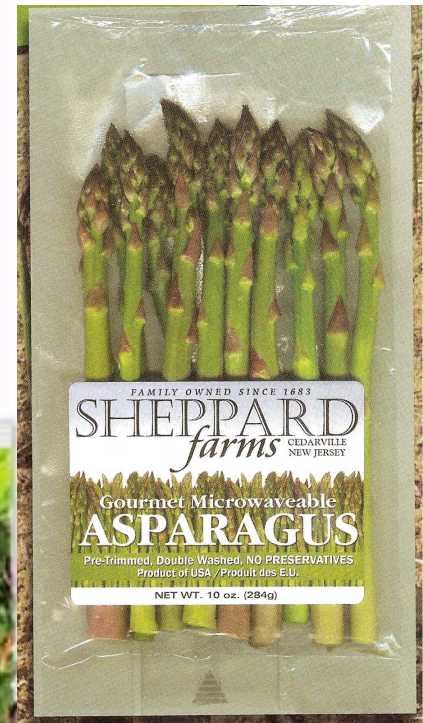


# Microwavable Convenience & Ready Meals





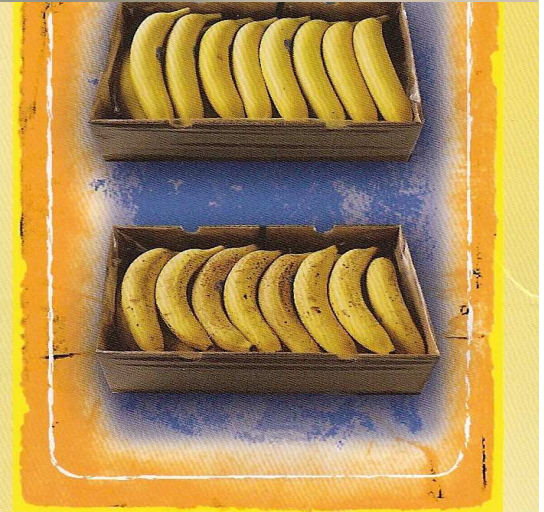
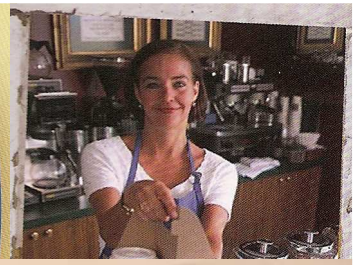
**Cryovac®**  
**Simple**  
**Steps™**  
 U.S. Pat Pending  
 10/051,584  
 U.S. Patent  
 10/486,534



**“Dream Steam”**  
**Creative New Food & Wipf**  
**AG (Switzerland)**



**“Esterpeel Q Bag”**  
**FFP (UK)**



To ensure the most accurate comparison, boxes were opened on 1st day of arrival at store. Opened banana boxes merchandised at 74 degrees.

To ensure the most accurate comparison, boxes were stored at 60 degrees.



Bistro To Go™





## Methods: Bin MAP

**Allows for Surge Capacity  
Weather/Market Conditions**

**Shipment of 100% Useable  
Product**

**Enabling Technology for  
Cleaned and Cored**

- **Iceberg Lettuce**
- **Romaine Lettuce**
- **Cabbage**
- **Whole Peeled Onions**



## Methods: Fresh-cut Tomato Packaging



**Maxwell  
Chase  
Tomato Tray**

**Jim Gorny, Ph.D.  
Executive Director**



**POSTHARVEST TECHNOLOGY**  
Research & Information Center

**University of California  
Department of Plant Sciences MS2  
3045 Wickson Hall  
1 Shields Ave  
Davis, CA 95616**

**Tel: 530.754.9270**

**Email: [jrgorny@ucdavis.edu](mailto:jrgorny@ucdavis.edu)**

**<http://postharvest.ucdavis.edu/>**