Module 10 Lecture 01

# Biotechnology and food safety

# Biotechnology

- ***Old definition***

  **Use of living organisms and their products in production and processing**

- ***New Definition***

  **Use of the techniques of genetic engineering genetic modification, gene splicing, gene technology**

# Examples of genetic modification in food production

- brewing yeast - digests complex carbohydrates
- tomato - delayed softening on plant, enhanced flavour
- soya - improved herbicide tolerance
- rice - Reduced allergen levels
- milk - cows milk with the characteristics of human milk
- maize - pest resistance

# Examples of genetic modification to improve nutrition

- increased yield (e.g. drought resistance)
- improved safety (e.g. reduced natural toxins and allergens, reduced agrochemical use)
- improved quality (e.g. improved ripening, modified starch characteristics)
- improved nutritional value (e.g. improved protein quality, decreased anti-nutritional factors)

# Advantages of genetic modification

- speed - compared to conventional breeding
- specificity - no need to eliminate undesirable traits by back crossing
- genes can come from any source - not bound by sexual compatibility

# Food safety

**“reasonable certainty that no harm will result from intended uses under the anticipated conditions of consumption”**

*(OECD 1993)*

# Food safety

**“Whenever changes are made in the process by which a food is made or a new process is introduced, the implications for the safety of the product should be examined. The scope of the evaluation will depend on the nature of the perceived concerns”**

*(WHO, 1991)*

# Evolution of food sources

- hunter/gatherer - eating what was available
- farmer - selecting best crops / animals and breeding from them
- breeder - applying scientific principles to enhance desirable characteristics
- biotechnologist - application of genetic engineering

# Safety of traditional foods

- no formal evaluation process
- knowledge of previous history of use
- limited initial introduction
- gradual enlargement of use allows adverse effects to be detected

# Safety of foods obtained by biotechnology

- "the use of these techniques does not result in food which is inherently less safe than that produced by conventional ones" *(WHO, 1991)*
- "this (biotechnology) does not inherently lead to foods that are less safe than those developed by conventional techniques" *(OECD, 1993)*
- "food safety considerations … are basically of the same nature as those … from conventional breeding" *(FAO, 1996)*

# Potential hazards in foods obtained by biotechnology

- ***products of the introduced genes***
- ***products of unintended effects***
  - **insertional effects of the genetic modification procedure**
  - **metabolic effects of the novel gene product**

# Potential hazards from new foods

- toxicity
- nutritional adequacy
- allergenicity
- gene transfer
- pathogenicity

# Safety evaluation of food additives

- *In vitro* studies
  - genetic toxicity
  - metabolic effects
- *In vivo* studies
  - acute toxicity
  - chronic toxicity and carcinogenicity
  - reproduction and teratogenicity

# Limitations of the food additive approach for whole foods

- validity of animal model
- application of 100-fold safety factor
- complexity of test material

# Determination of safety of foods obtained by biotechnology

"the most practical approach to the determination of safety is to consider whether they (foods obtained by biotechnology) are substantially equivalent to analogous conventional food products"

*(OECD, 1993)*

# Substantial equivalence

- ***focused comparison***
  - **phenotypic and genotypic characteristics of organism (e.g. agronomic characteristics)**
  - **chemical composition of unprocessed and processed products (e.g. key nutrients and toxicants)**
  - **biological effects (e.g. mutagenicity test or feeding study**
  - **food uses (e.g. potential intakes)**

# Substantial equivalence

- ***GMO or food from GMO is shown to be substantially equivalent to traditional counterpart***
  - **few GMO's or foods from GMO's are in this category unless highly processed (e.g. soy oil)**
  - **no further food safety concerns need to be addressed**

# Substantial equivalence

- ***GMO or food from GMO is shown to be substantially equivalent to its traditional counterpart except for certain well defined differences***
  - **most unprocessed GMO's and foods from GMO's are in this category (e.g. genetically modified tomato)**
  - **a safety evaluation should be carried out focusing on the defined differences**

# Substantial equivalence

- ***Substantial equivalence cannot be shown between the GMO or food derived therefrom and a traditional counterpart***
  - **it is unlikely that many food from GMO's will be in this category**
  - **an extensive safety evaluation should be carried out:**
    **the protocol should be determined based on the properties of the food**

# Marker genes

- needed to aid selection of genetically modified plants
- raise no unique food safety concerns
- apply same safety evaluation strategies as for other novel genes
- focus evaluation on the properties of the gene product

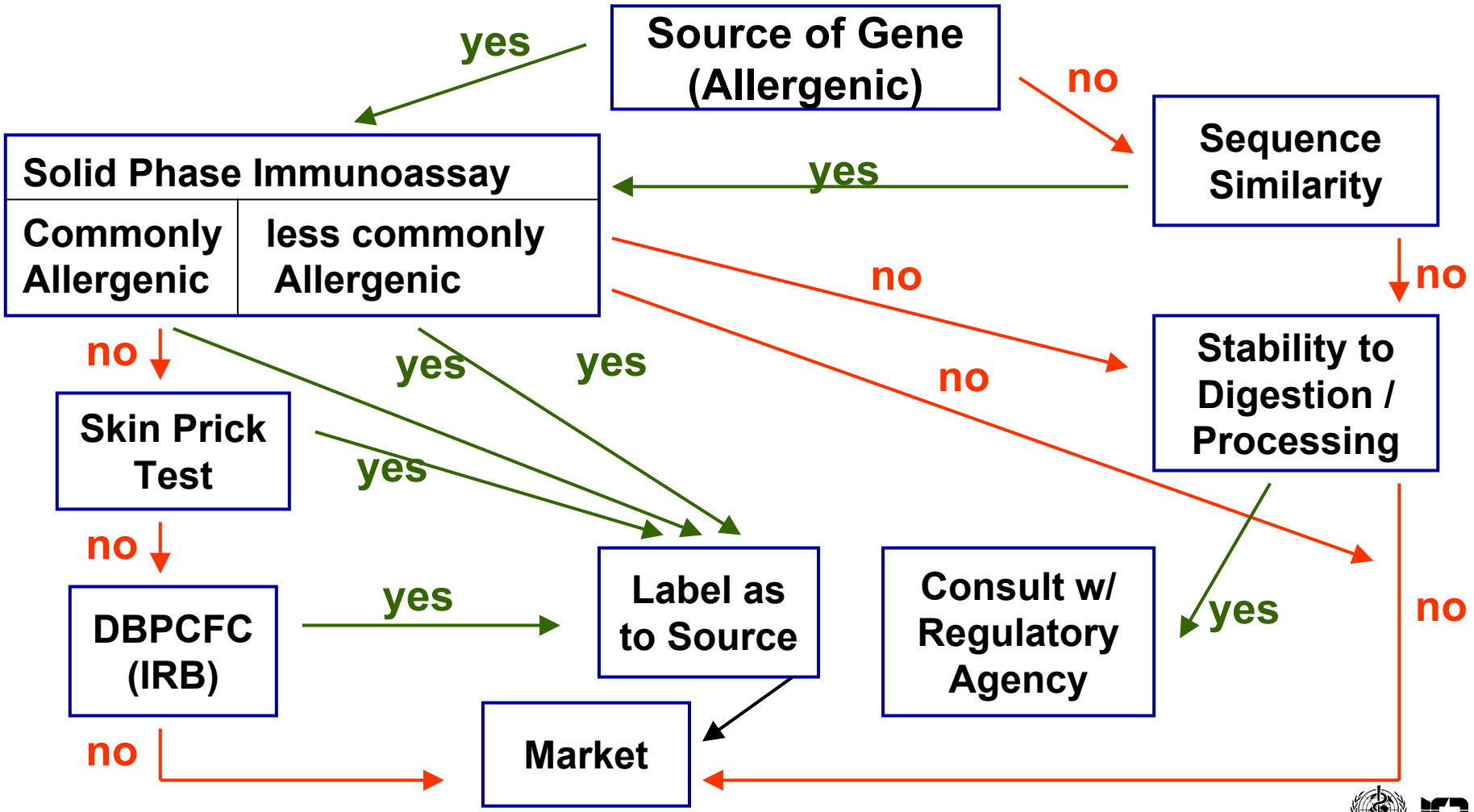
# Allergenicity

- currently there are no tests for determining the allergenicity of an unknown protein
- known food allergens can be detected
  - using sera from sensitive individuals
  - using skin prick test
- allergenicity can be predicted to some extent
  - physico-chemical characteristics

# Properties of known food allergens

- heat stability
- pH stability
- stability to gastrointestinal proteases
- high concentration in plasma
- molecular weight 10 - 60kDa

# Assessment of the allergenic potential of G.M. crops



# Gene transfer from GMO's to gut microorganisms

- in nature, gene transfer is observed only between closely related species
- for functionality in a transformant, the gene must be under the control of an active promoter
- for colonisation, a transformant must have a competitive advantage over the natural flora

# Summary

- Humans have used genetic modification through breeding for centuries to improve the food supply
- There are no new food safety risks from food products obtained using biotechnology compared to products produced by traditional techniques
- Comparative approaches establish the safety of food products obtained using biotechnology relative to existing products
- Safety evaluation should be on a case by case basis focusing on new component(s) in the biotechnology product