

Suggested mechanism for the formation of acrylamide in foods

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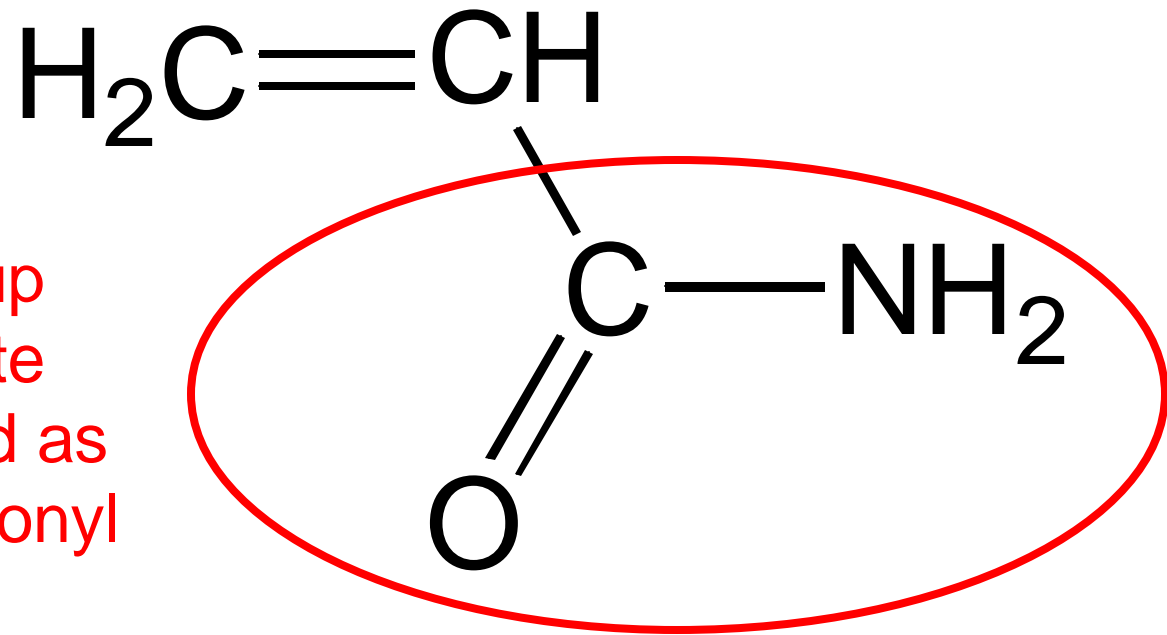
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University of Leeds

ACRYLAMIDE is a reactive molecule which undergoes:

Free radical reactions

Michael addition reactions



The amide group does not activate the double bond as much as a carbonyl or acid group

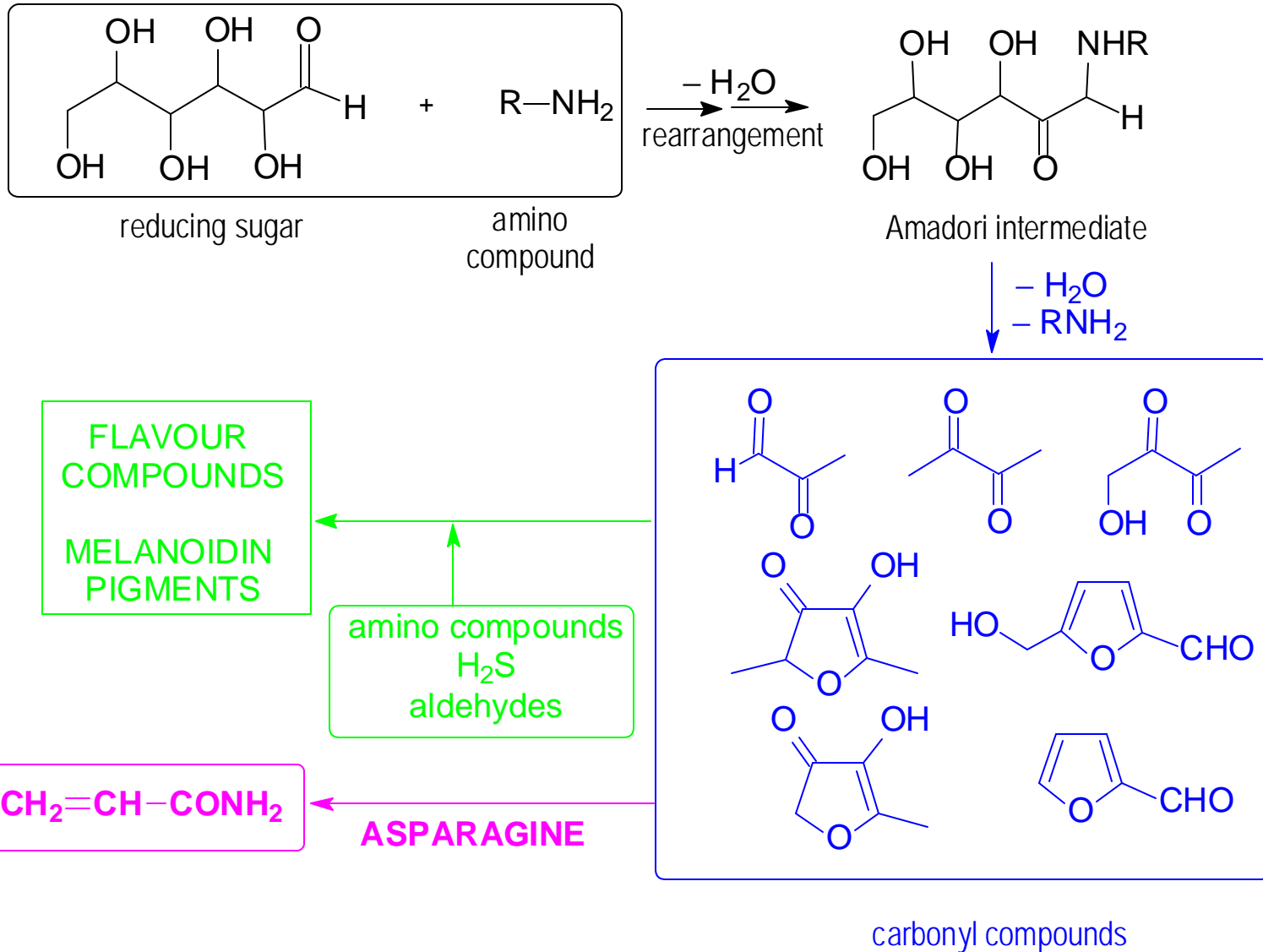
Acrylamide: Product-related issues

- High temperature is important
- Products cooked at high temp with high surface area had highest concentrations of acrylamide (i.e. potato crisps)
- Acrylamide appears to be associated with carbohydrate foods (biscuits, crisps, chips, bread)
- Produced by reactions between natural food components

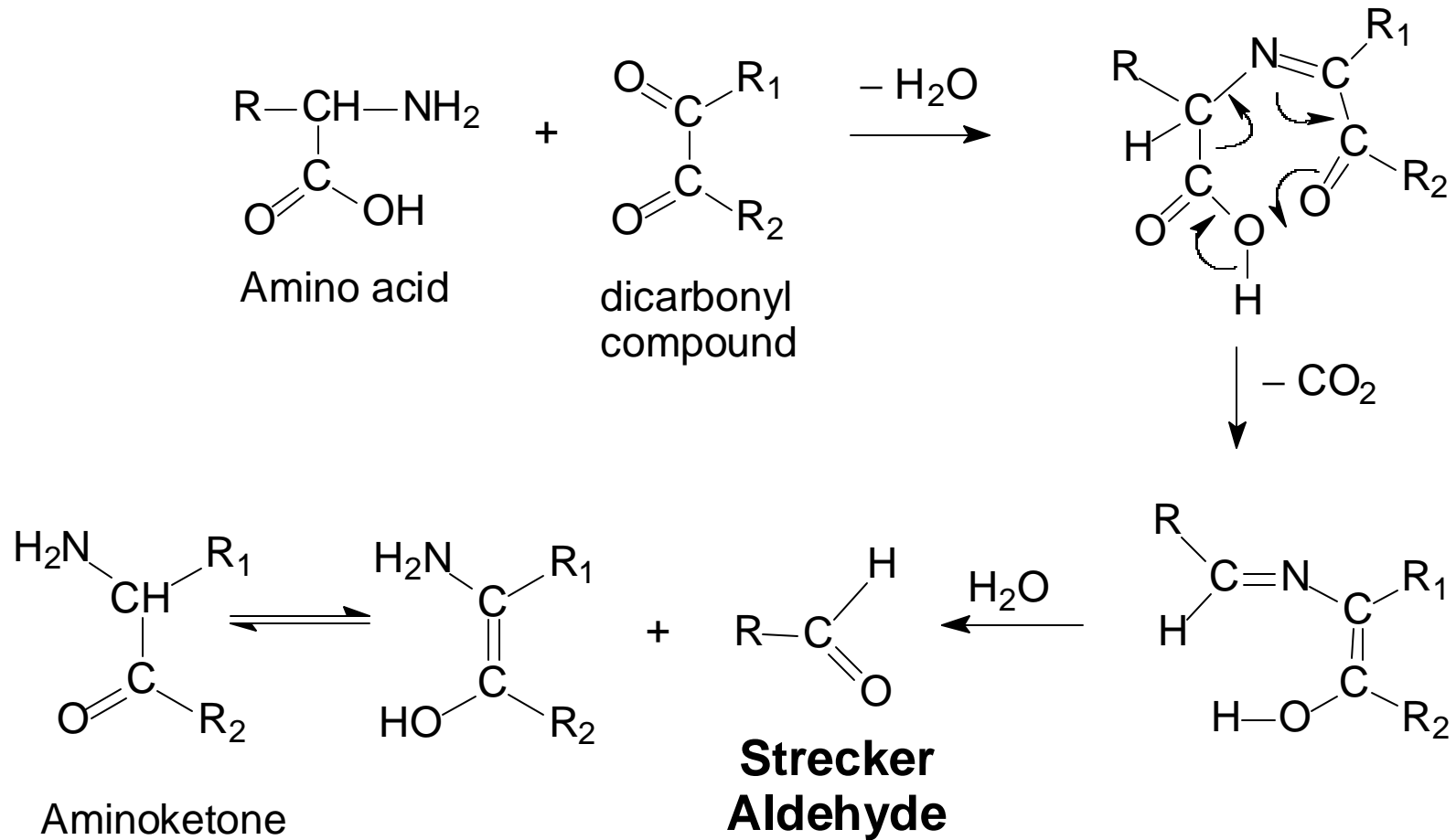
Acrylamide: Possible sources

- From reaction of fat degradation products by reaction with ammonia
- From the Maillard reaction

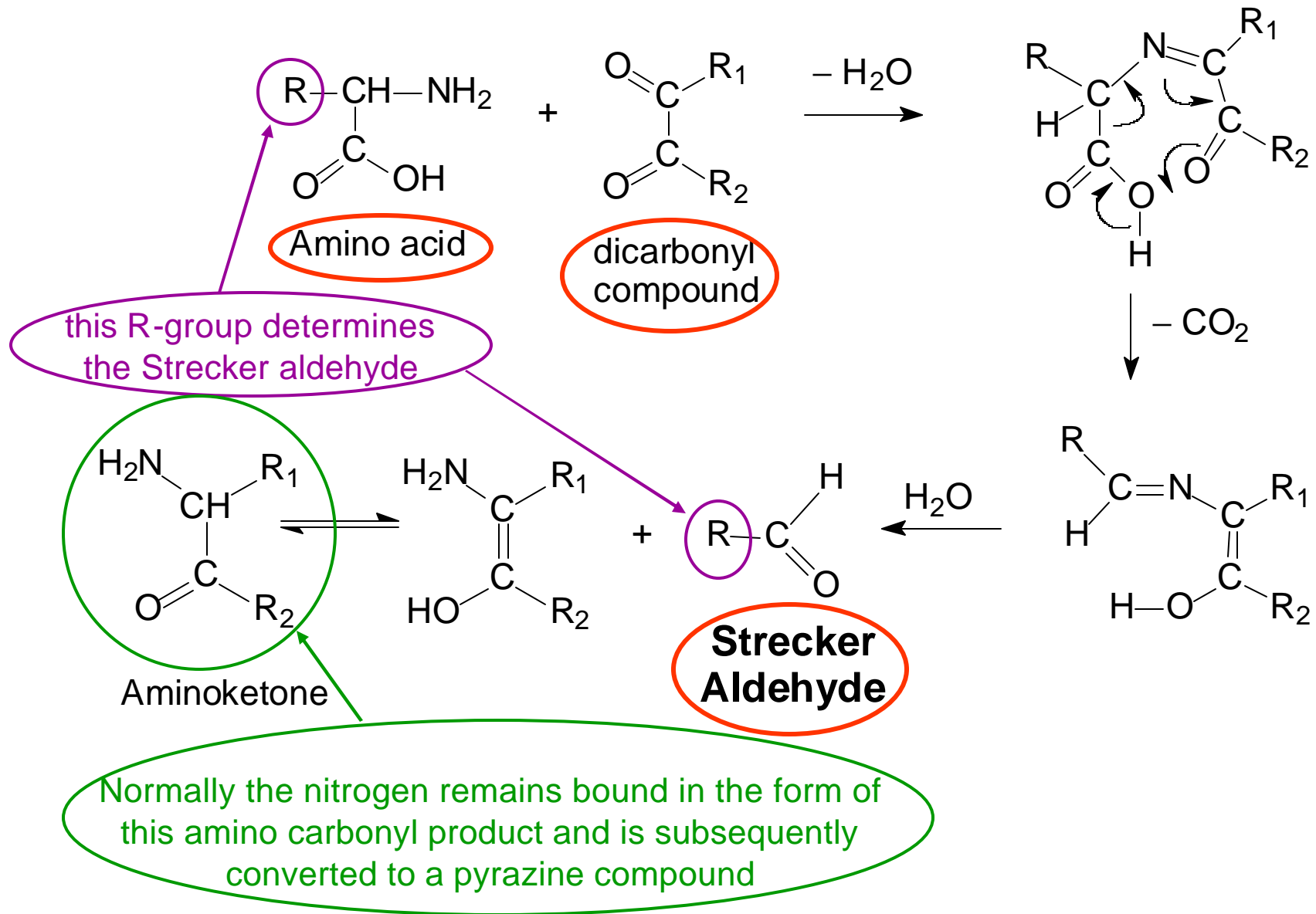
Maillard Reaction



Strecker Degradation of Amino Acids

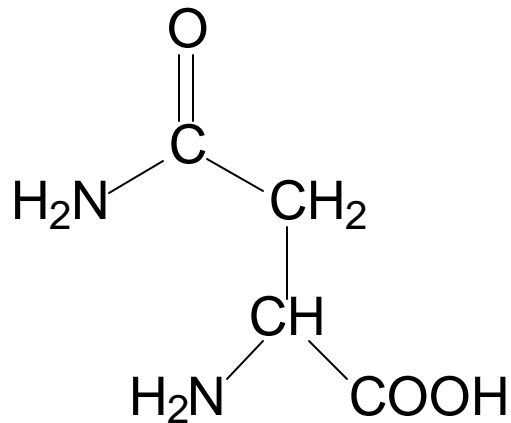


Strecker Degradation of Amino Acids

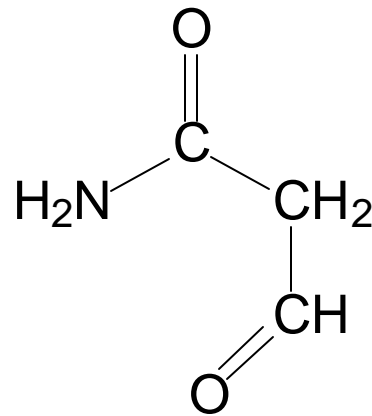


Possible role of Maillard reaction in acrylamide formation

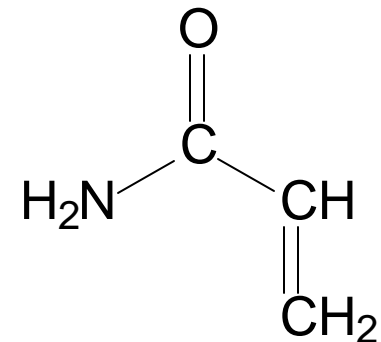
- Asparagine could be an important amino acid
 - Strecker degradation could give an aldehyde with 3 carbon atoms, including an amide group



asparagine

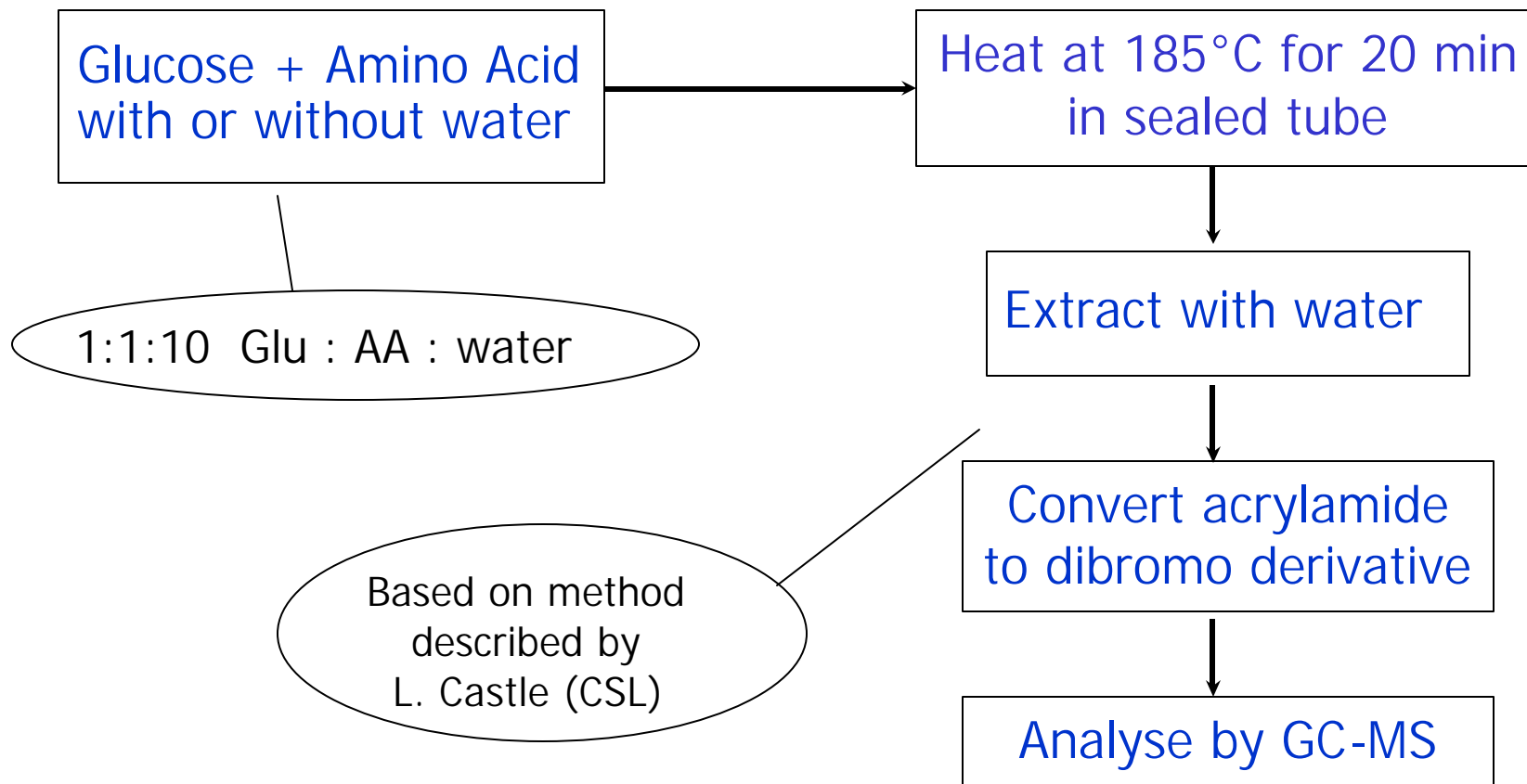


Strecker aldehyde



acrylamide

Investigation of Acrylamide Formation in Model Systems



Acrylamide produced in reactions between glucose and amino acids

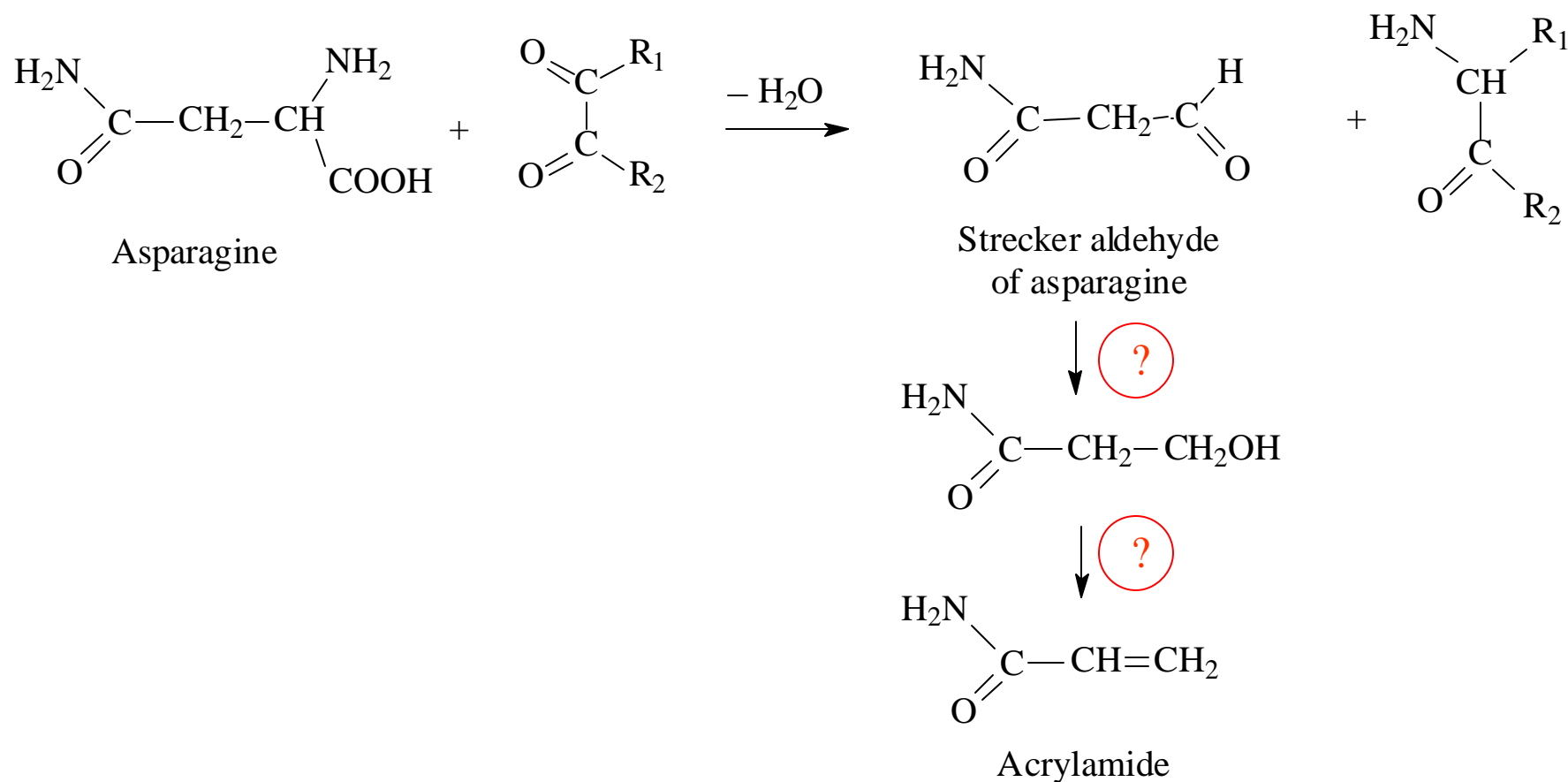
Amino acid	acrylamide (mg/mol)	
	with water	dry
Asparagine	221	25
Methionine	nd	5
Glycine	nd	nd
Cysteine	nd	nd
Glutamine	tr	tr
Aspartic acid	tr	nd
Asparagine heated alone	nd	nd

Mottram, Wedzicha & Dodson. Nature **419**, 448-449 (3 Oct 2002)

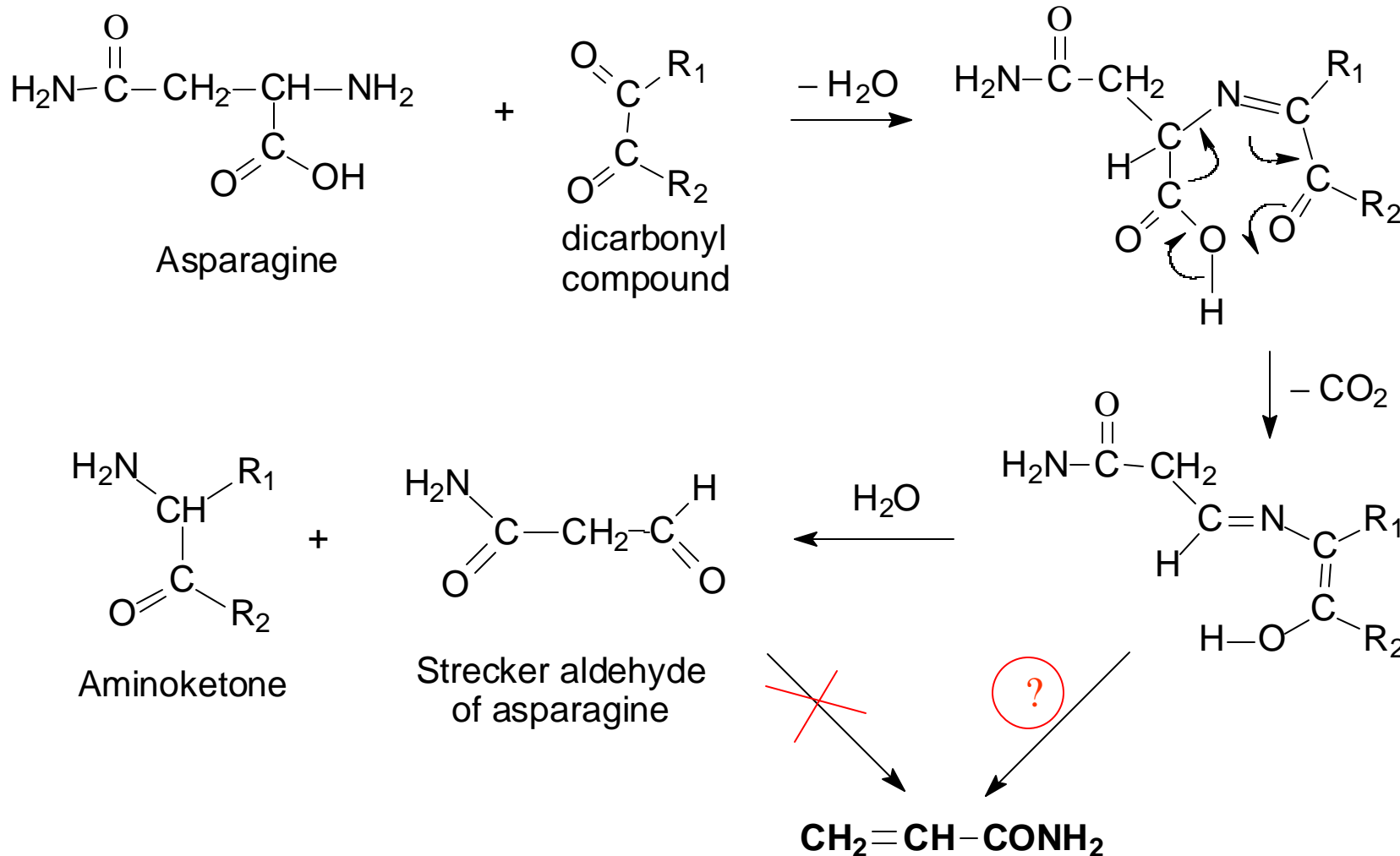
Asparagine in Plant Foods

	Free amino acid	
	mg/100g	% total
Potato (for crisps)	940	40%
Wheat flour	167	14%
Rye (high protein)	173	18%

Possible mechanism for formation of acrylamide from asparagine



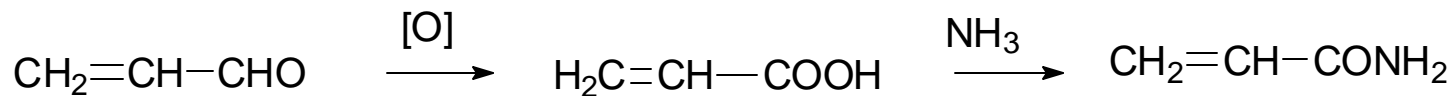
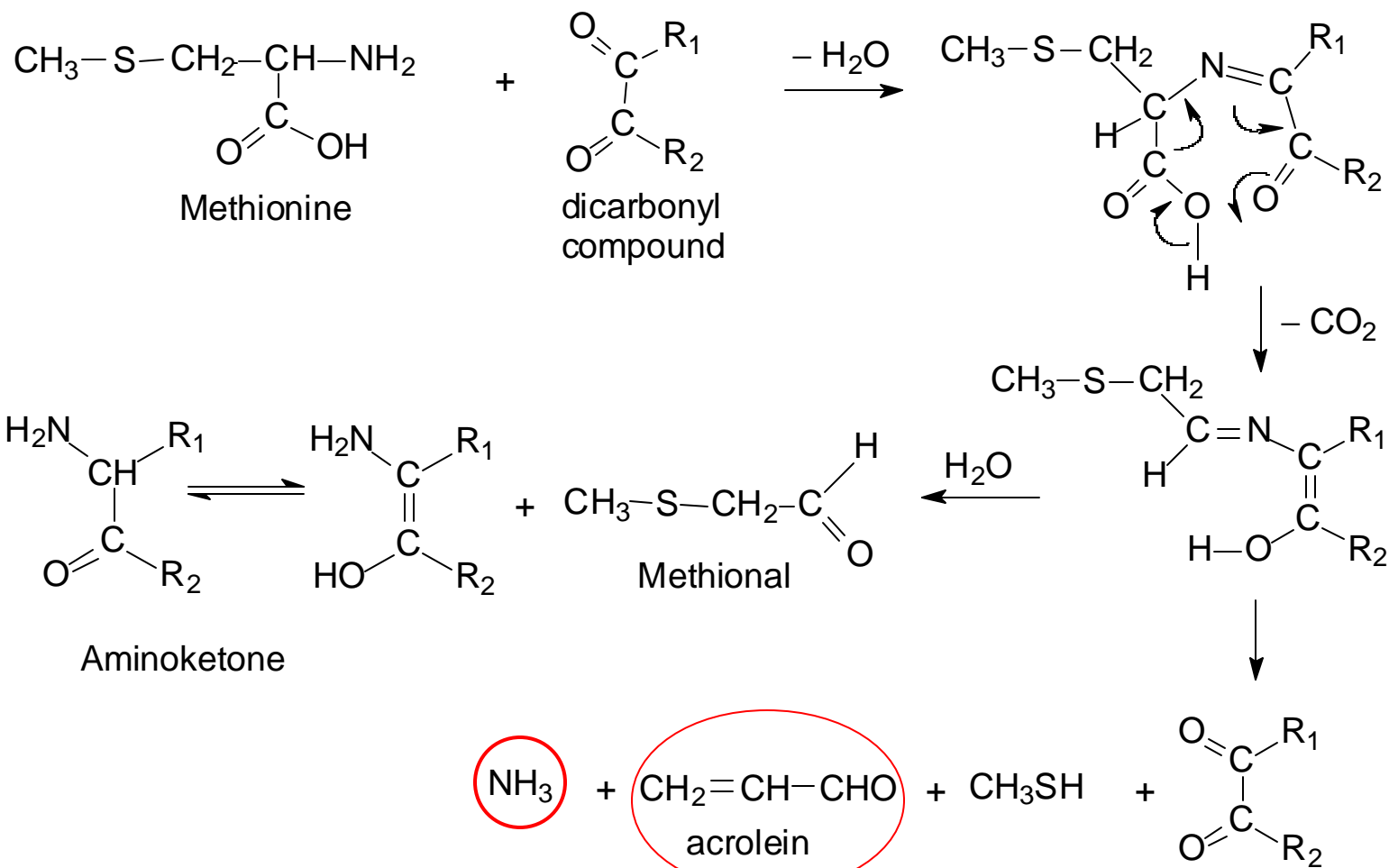
Possible mechanism for formation of acrylamide from asparagine



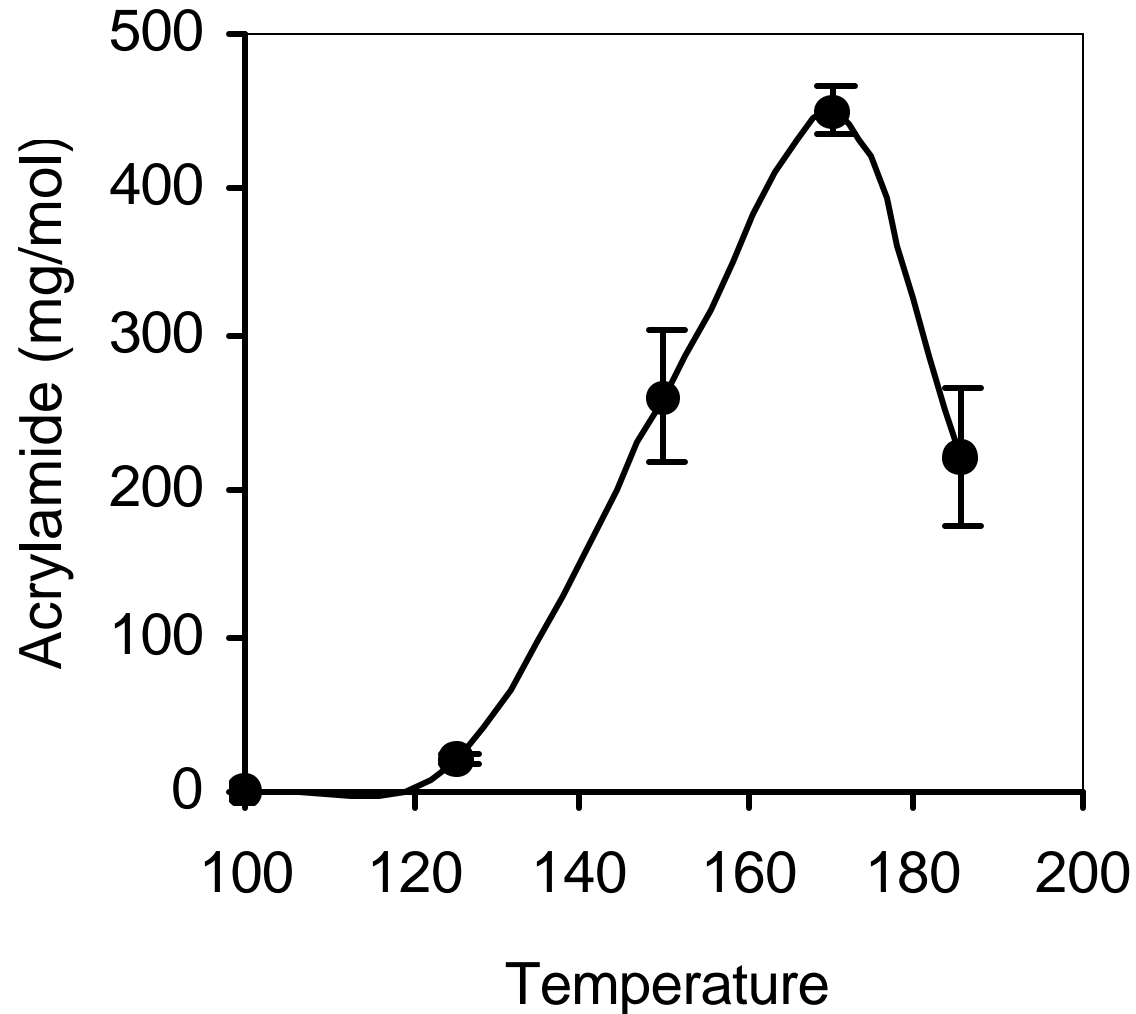
Acrylamide formed from heating amino acids and butanedione

Amino acid	Amount acrylamide (mg/mol)			
	Glucose		Butanedione	
	with water	dry	with water	dry
Asparagine	221	25	63	40
Methionine	nd	5	tr	6
Glycine	nd	nd	nd	tr
Cysteine	nd	nd	tr	nd
Glutamine	tr	tr	tr	1
Aspartic acid	tr	nd	tr	2

Strecker Degradation of Methionine



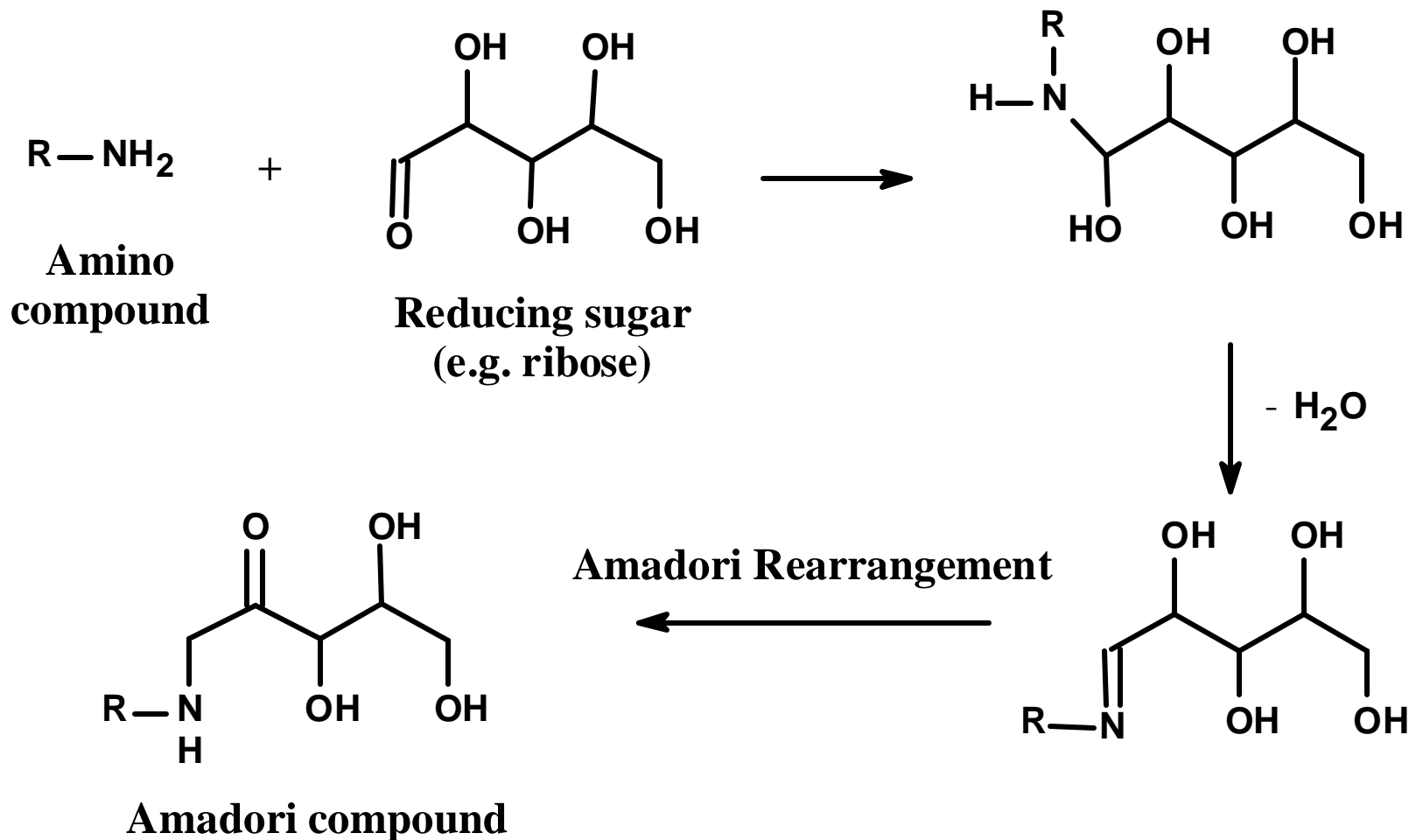
Effect of temperature on Acrylamide formation in ASN + Glucose model systems



CONCLUSIONS

- Asparagine will react with reducing sugars to give acrylamide
- Most other amino acids do not give acrylamide
- Strecker degradation involving dicarbonyl compounds appears to be important
- Temperatures in excess of 125°C required for formation of acrylamide in ASN + GLU model system
- Asparagine is major free amino acid in potatoes and some cereals

Initial Stages of the Maillard Reaction



J.E. Hodge 1953

Formation of carbonyls from the Amadori compound

