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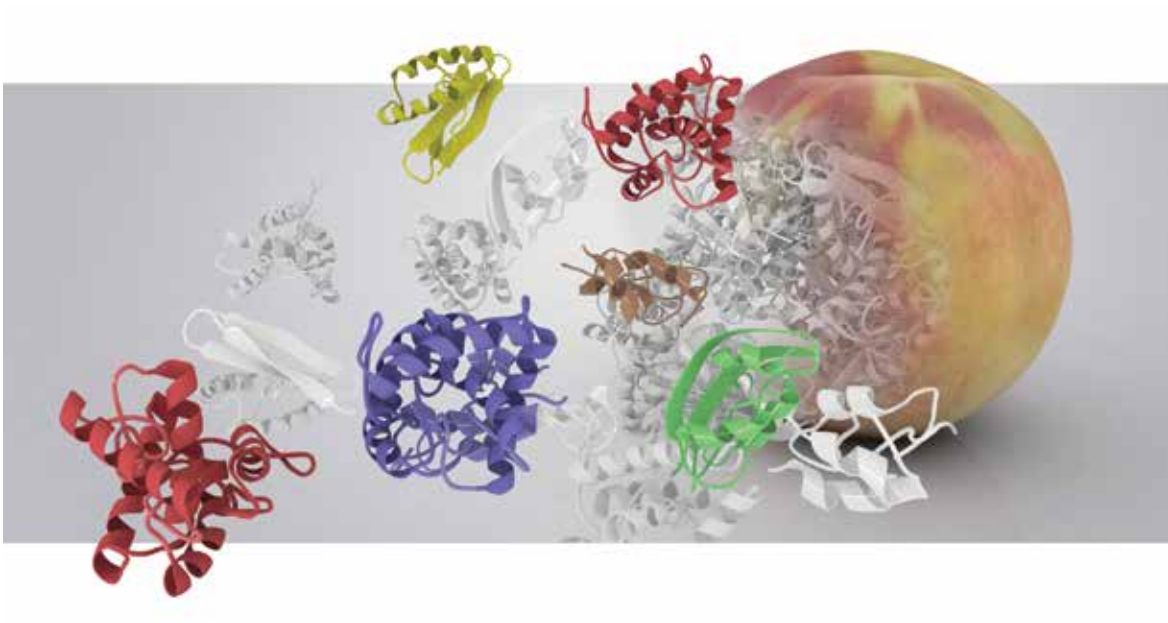
A Clinical Reference Guide to Molecular Allergy

Go Molecular!

2. The Allergen Components

Further information about molecular allergy and the interactive allergy component identification and interpretation tool can be found from **AllergyEducation.co.uk** and **AllergyEducation.ie**



Allergy Education

www.AllergyEducation.co.uk
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ImmunoCAP®
Is it allergy?

Preface

Molecular allergens have been described in scientific literature for well over a decade now, but it has only been in recent years that they have been used more routinely in the allergy clinic.

New technology can be challenging and it often requires a period of adjustment and adaptation. There are many allergen components covering many different sources and their clinical relevance is continually emerging year on year. This can make it difficult to remember their relevance. Many clinicians have commented to me that they could do with a simplified 'all in one guide' so I have tried to simplify molecular allergy based on the components Thermo Fisher Scientific has in its portfolio.

The intention of this reference book is to give a straightforward summary of the main allergen components, what ImmunoCAP products are available, and interpreting test results. I hope you find this guide book useful.

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Molecular Allergy Specialist
Immunodiagnostics
Thermo Fisher Scientific

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Foreword

Component resolved diagnostics is a relatively new concept and has taken allergy into the 21st century allowing better understanding of clinical cross-reactions and beginning to allow us to explain some of the symptoms that we see clinically.

This simple-to-read quick reference guide on component technology allows you to understand what is becoming an essential part of the modern allergy diagnostic armoury. There are helpful introductions explaining the nomenclature and in which groups of patients the allergen has importance. This is followed by a simple guide to interpreting results for all the main allergen groups for which these tests have become available. In some areas their use has already become clear and has affected patient treatment, and with this guide the benefits of these breakthroughs will become more widely available.

Dr. Lee Noimark
Consultant Paediatric Allergist
June 2013

Introduction

As it is adopted into the allergy work-up, molecular allergy is opening new doors that are changing patient management. By using molecular allergens it is possible to understand more about the underlying allergies and add another tool to the diagnostic armoury. Molecular tests are not magic bullets; rather they are an enhancement over conventional extract tests, giving more factual information. The results have to be interpreted like any other specific IgE test and cannot be solely relied upon to determine a diagnosis; results should be used in conjunction with an allergy-focused clinical history.

Molecular allergy testing helps in:

1. Understanding patient risk – adding confidence to your assessment
2. Selecting patients for immunotherapy – useful for venom and aeroallergy patient selection
3. Understanding cross-reactions between species – helping to understand multiple sensitisations e.g. in pollen food syndrome

Many ImmunoCAP allergen components are available in our product range and familiarity with them is essential to understand their clinical implications. To help you implement component testing we have developed a web tool to help you choose which components to select and determine the clinical implications of the results.

This can be also found at:

AllergyEducation.co.uk

The tests themselves are not technically different to other specific IgE tests that are routinely ordered from your lab such as milk, egg, cat or peanut allergens. Extracts like these are made up of lots of different allergen components. Component tests differ as each specific IgE test involves measuring single recombinant or native allergen proteins from a source. For example Pru p 3 is an nsLTP (non-specific lipid transfer protein) from peach.

There is more information on the basics of molecular allergy to be found on our molecular allergy course:

AllergyEducation-MA.com

The purpose of this guide is to offer an ‘all in one’ reference to each allergen source and its components in a single handy booklet. Molecular allergy involves many different allergen proteins and it can be difficult to remember them all and what the results mean. It is also difficult to remember all the relevant allergen codes, allergen nomenclature, what tests are needed to make an assessment and what is actually available in the product range. I hope this booklet addresses these issues to make life a little easier in the clinic.

What's in this guidebook?

Description, Latin name and allergen nomenclature

Each section of the booklet describes a different allergen source and a little background. A comprehensive list of all of our whole allergens, components and clinical interpretation of the main components can be found at:

AllergyEducation.co.uk

For detailed information on the background of each of our whole allergens and components visit:

Phadia.com/Products/Allergy-testing-products/ImmunoCAP-Allergens

Major and minor allergen components

You will often find references and descriptions for major and minor allergens. Major allergen components are allergens that account for over 50% of sensitisation within an allergy. Minor allergens are often less prevalent in triggering allergy (these are often panallergens which are more likely to cross-react with homologous allergens). For instance in Birch allergy the major allergen is Bet v 1 (PR-10 pathogenesis related family number 10), whilst a minor allergen is Bet v 2 (profilin).

ImmunoCAP IgE test products available and new product updates

Thermo Fisher Scientific strives to develop many clinically relevant components each year. Products available at the time of going to press are listed in each section. If you are interested in the latest updates and product releases register by contacting us at:

Allergy-uk.idd@thermofisher.com

Or through:

AllergyEducation.co.uk

Information given in this guide is for single ImmunoCAP components and is also relevant to whole extract allergens (but not ImmunoCAP ISAC, the array chip; this will be included in the third book of this series). The allergen code is also provided which can be useful when ordering from your local testing laboratory. Whole allergens are still a useful guide and offer value by covering missing components from the source. For example, we currently have five allergen components for peanut but over 15 have been described. We provide the most clinically relevant component tests where possible. We recommend when requesting tests you ask for the whole allergen and ask your laboratory to reflex test for relative components if the whole allergen is positive – the best use of time and resources.

Interpretation of results

In this guide, interpretation has been simplified as much as possible in terms of the presence of IgE. The presence of allergen-specific IgE is usually a risk of allergy symptoms and a result ≥0.1 kUA/L indicates sensitisation. Traditionally the higher the IgE antibody level the greater the likelihood of being allergic. Some molecular allergens are associated with a much higher risk, whilst some allergens are considered no or very low risk. A high-titre, high-risk allergen such as Ara h 2 or Cor a 9 would often carry a high risk for patients. Always consider test results in association with a clinical history.

Further reading:

Each section has a further reading suggestion which lists a small number of relevant clinical papers.

Allergen components from plant sources

Plant protein families are shared between species; the closer the species are related the more similar the proteins can be. This increases the potential for IgE antibodies directed against pollen allergen epitopes to bind to similar allergen epitopes in food. There are five main types of allergen groups indicated. These are storage proteins, nsLTP, PR-10, profilin proteins and CCDs (cross-reactive carbohydrate determinants):

Protein family	Risk for systemic reactions?	Do I have to consider many different allergen sources?
Storage proteins	**Yes.** Storage proteins are heat and digestion stable which explains their ability to more often cause systemic reaction in addition to oral allergy syndrome (OAS).	**No.** Storage proteins are not cross-reactive, except for very closely related allergen sources (e.g. between legumes such as soy and peanut).
nsLTP	**Yes.** nsLTPs are heat and digestion stable which explains their ability to more often cause systemic reaction in addition to OAS.	**Yes.** Partly cross-reactive (the degree of structural similarity varies between nsLTPs in plant food and pollen).
PR-10	**Low.** Often cause only local symptoms such as OAS due to their sensitivity to heat and digestion, but a few cases with systemic reactions have been reported e.g. for soy Gly m 4 and Celery Api g 1.	**Yes.** Partly cross-reactive (the degree of structural similarity varies between PR-10 in plant food and birch-related pollen).
Profilin	**Low.** Often have little clinical relevance in allergic diseases. However, profilins may cause local reactions in some patients allergic to plant foods including citrus fruits, banana and tomato, and a few cases with systemic reactions have been reported e.g. for melon and lychee.	**Yes.** Highly cross-reactive (high degree of structural similarity between profilins in pollen, plant food and latex).
CCD	**Very low.** Usually not associated with clinical reactions but may induce IgE antibody responses in some patients.	**Yes.** Highly cross-reactive (same CCD structure in pollen, plant food and venoms).

Plant components in common foods and pollens

Component family/ allergen source	Prolifin	PR-10	LTP	Storage proteins				
Birch	Bet v 2	Bet v 1						
Timothy grass	Phl p 12							
Latex	Hev b 8		Hev b 12					
Apple	Mal d 4	Mal d 1	Mal d 3					
Cherry	Pru av 4	Pru av 1	Pru av 3					
Almond	Pru d 4	Pru du 1	Pru du 3	Pru du 2s	Pru du 11S			
Apricot		Pru ar 1	Pru ar 3					
Peach	Pru p 4	Pru p 1	Pru p 3					
Pear	Pyr c 4	Pyr c 1	Pyr c 3					
Raspberry	Rub i 4	Rub i 1	Rub i 3					
Strawberry	Fra a 4	Fra 1	Fra a 3					
Peanut	Ara h 5	Ara h 8	Ara h 9	Ara h 1	Ara h 2	Ara h 3	Ara h 6	Ara h 7
Soy	Gly m 3	Gly m 4		Gly m 5	Gly m 6			
Hazelnut	Cor a 2	Cor a 1	Cor a 8	Cor a 9	Cor a 14			
Brazil Nut				Ber e 1	Ber e 2			
Walnut	Jug r 5		Jug r 3	Jug r 1	Jug r 2	Jug 4		
Pistachio				Pis v 1	Pis v 2	Pis v 3	Pis v 5	
Cashew				Ana o 1	Ana o 2	Ana o 2	Ana o 3	
Sesame	Des i 8			Ses i 1	Ses i 2	Ses i 3	Sesi 6	Ses i 7
Wheat*	Tri a 12		Tri a 14	Tri a 19	Gliadin			
Barley	Hor v 12		Hor v 14	Hor v 21	Hor v 36			
Maize	Zea m 12		Zea m 14	Zea m G1	Zea m G2			
Rice	Ory s 12		Ory s 14	Iry s 19kd	Ory s 36	Ory s GLP52	Ory s GLP63	
Carrot	Dau c 4	Dau c 1	Dau c 3					
Cabbage	Bra o 8		Bra o 3					
Tomato	Lyc 1	Lyc 4	Lyc e 3	Lyc e 7S	Lyc e 11S			
Melon (musk)	Cuc m 2	Cuc m 3						
Celery	Api g 4	Api g 1	Api g 2 and 6					

	Plant food not associated with storage proteins unless found in the seed
	Grasses do not contain PR-10 proteins
	Available plant food ImmunoCAP allergen components
	Protein not fomally identified but likely
	No storage proteins associated with this allergen source

*Wheat – Tri a 19 and gliadin are storage proteins but belong to a different family to, for example, LTPs or 2S albumins – they belong to the cereal prolamin family

Peanut – ***Ara****chis hypogaea* (Ara h)

Peanut allergy is of great interest in the UK and is a problematic allergen source that over the last decade has increased in prevalence. Peanuts are consumed mainly as peanut butter, as snacks, in confectionery and in baked goods. Peanuts also yield cooking oils (both refined and crude, aromatic and non-aromatic).

It is commonly accepted that Ara h 1, Ara h 2 and Ara h 3 are the major peanut allergens.[1-3] These allergens are heat stable and resistant to gastric acid fluid degradation. Ara h 2 is considered to be the most important peanut allergen but IgE also to Ara h 1 and/or Ara h 3 increases risk of severe symptoms.[1-4] The Ara h 2 allergen component provides the most accurate peanut test in terms of diagnosis.[1,5-7] Birch pollen allergy patients sensitised to Bet v 1 (PR-10) or Bet v 2 (profilin) can cross-react with Ara h 8 (PR-10) or Ara h 5 (profilin) in peanut respectively. IgE to timothy grass profilin (Phl p 12) can also cross-react with peanut profilin Ara h 5.

Available ImmunoCAP allergen components

Whole Peanut Extract – f13
rAra h 1 – 7S globulin, storage protein – f422
rAra h 2 – 2S albumin, storage protein – f423
rAra h 3 – 11S globulin, storage protein – f434
rAra h 8 – PR-10 protein – f352
rAra h 9 – nsLTP – f427

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- IgE to any of the storage proteins Ara h 1, Ara h 2 or Ara h 3 indicates a primary peanut allergy. The patient is at high risk of severe, systemic symptoms, especially if Ara h 2 is positive
- If monosensitised to Ara h 8 then the patient is at risk for local reactions, however, the risk of severe, systemic reactions is low. The patient is more likely to experience local symptoms such as OAS. The patient may be sensitised to other PR-10 containing pollens and plant foods due to cross-reactions
- IgE to Ara h 1, Ara h 2, Ara h 3 and Ara h 8 – mixed forms of allergy may occur including local reactions such as OAS and severe, systemic reactions
- IgE to Ara h 9 nsLTP indicates a risk of both systemic and local reactions. The patient may be sensitised to other nsLTPs contained in other plant foods/pollens due to cross-reactions which can cause systemic symptoms in cooked and uncooked foods

Further reading

- Dang TD, *et al.* Increasing the accuracy of peanut allergy diagnosis by using Ara h 2. *J Allergy Clin Immunol* 2012;129(4):1056-1063.
- Nicolaou N, *et al.* Quantification of specific IgE to whole peanut extract and peanut components in predication of peanut allergy. *J Allergy Clin Immunol* 2011;127(3):684-685.
- Eller E and Bindslev-Jensen C. Clinical value of component-resolved diagnostics in peanut-allergic patients. *Allergy* 2013;68(2):190-194.

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Is it allergy?

Soya Bean – ***Gly****cine* ***m****ax* (Gly m)

Soy is widely used worldwide because it is cheap to produce and because of its high biological value and high quality protein content. It is used as soy protein flour, flakes, concentrates and isolates as well as soy oil. It can be a hidden allergen in processed foods such as meat products, sausages, bakery goods, chocolate and breakfast cereals.

The presence of specific IgE to the Gly m 5 and Gly m 6 indicates real soy allergy and risk of severe systemic reactions.[8-9] Gly m 4 (PR-10) is labile to heat, processing and digestion and consumption of processed soy usually causes no or only mild symptoms in Gly m 4 sensitised patients. With unprocessed soy drinks and dietary protein powders (e.g. such as those used in gyms) it is actually possible to ingest a large amount of Gly m 4 at one time, since these products contain high quantities of Gly m 4 that has not been degraded by heat or processing. This can lead to a risk for severe systemic reactions due to high allergen load, especially in pollen-allergic patients during pollen season when there is simultaneous exposure to birch pollen, which contains a cross-reactive PR-10 protein (Bet v 1).[10]

Available ImmunoCAP allergen components

Soya Bean – f14
rGly m 4 – PR-10 protein – f353
nGly m 5 – β-conglycinin, storage protein – f431
nGly m 6 – glycinin, storage protein – f432

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- If IgE to either Gly m 5 or Gly m 6 (or both) is present then the patient is at high risk of severe, systemic reactions
- A high allergen load of Gly m 4 can result in systemic symptoms. Therefore even if Gly m 5 and Gly m 6 are IgE negative it is worth checking how much consumption of soy has occurred (the allergen load) especially if the patient is Gly m 4 positive. For example does the patient regularly drink soya milk?
- Gly m 5 and Gly m 6 are often associated with cross-reactions to other similar proteins in other legumes e.g. lentils, and in tree nuts.

Further reading

- Kosma P, *et al.* Severe reactions after the intake of soy drink in birch pollen allergic children sensitised to Gly m 4 Acta *Paediatr* 2011;100:305-307.
- Holzhauser T, *et al.* Soybean (Glycine max) allergy in Europe: Gly m 5 (beta-conglicinin) and Gly m 6 (glycinin) are potential diagnostic markers for severe allergic reactions to soy. *J Allergy Clin Immunol* 2009;123(2);452-458.
- Garcia BE and Lizaso MT. Cross-reactivity syndromes in food allergy. *J Investig Allergol Clin Immunol* 2011;21(3):162-170.

Hazelnut – ***Cor****ylus* ***a****vellana* (Cor a)

Hazelnut is widely used and can be a "hidden" allergen; for example as an ingredient in confectionery such as chocolate or nougat. Allergic reactions to hazelnuts range from OAS to severe anaphylactic reactions.[11-12]

Cor a 9 and Cor a 14 are both storage proteins which are resistant to digestion and therefore have high allergenic potential to cause systemic symptoms. Presence of specific IgE antibodies to Cor a 8 (nsLTP) is also an indication of severe reactions in patients with a suspected allergy to hazelnut, although nsLTP allergy in northern European countries is less common compared to southern Europe.[13] In geographical areas in which birch is endemic (including the UK), hazelnut allergy has been mainly associated with cross-reactive IgE to Birch Bet v 1 (PR-10) and Bet v 2 (profilin), which usually causes mild symptoms.[14-17]

Available ImmunoCAP allergen components

Whole Hazelnut Extract – f17
rCor a 1 – PR-10 – f428
rCor a 8 – nsLTP – f425
nCor a 9 – 11S globulin, storage protein – f440
rCor a 14 – 2S albumin, storage protein – f439

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- IgE to Cor a 9 and/or Cor a 14 indicates a primary hazelnut allergy, the patient is at high risk of severe, systemic allergy
- If IgE to Cor a 1 is present and the other hazelnut components are negative then risk is low for systemic reactions and local symptoms such as OAS are more likely. The patient may be sensitised to other PR-10-containing pollens and plant foods due to cross-reactions
- If IgE to Cor a 8 (nsLTP) is present then mixed allergy is possible, including systemic and local symptoms such as OAS. The patient may be sensitised to other nsLTPs contained in other plant foods/pollens due to cross-reactions which can cause systemic symptoms in cooked and uncooked foods
- If IgE to all hazelnut components is indicated, then mixed forms of allergy are likely such as OAS alongside systemic symptoms

Further reading

- Flinterman AE, *et al.* Lipid transfer protein-linked hazelnut allergy in children from a non-Mediterranean birch-endemic area. *J Allergy Clin Immunol* 2008;121:423-428.
- Verweis MM, *et al.* Young infants with atopic dermatitis can display sensitization to Cor a 9 an 11S legumin-like seed storage protein from hazelnut (Corylus avellana). *Paediatr Allergy Immunol* 2011;22:196-201.
- De Knop KJ, *et al.* Age related sensitisation profiles for hazelnut (Corylus avellana) in a birch-endemic region. *Paed Allergy Immunol* 2011;22(1 Pt 2):e139-149.
- Masthoff LJ, *et al.* Sensitisation to Cor a 9 and Cor a 14 is highly specific for a hazelnut allergy with objective symptoms in Dutch children and adults. *J Allergy Clin Immunol* 2013;132(2):393-399.

ImmunoCAP® Is it allergy?

Walnut – ***Jug****lans* ***r****egia* (Jug r)

Walnut is closely related to the pecan. Walnuts are often eaten as an ingredient in baked goods for instance meat, poultry, fish and pasta dishes or in salads or ice cream. Walnut oil can be allergenic, although this depends on the extraction method and the purity of the end product.[69]

Jug r 1, a storage protein which is resistant to digestion, has a high allergic potential to cause systemic symptoms. Presence of specific IgE antibodies to Jug r 3, an nsLTP, indicates that local symptoms as well as systemic reactions can occur.[24,70-73]

Available ImmunoCAP allergen components

Whole Walnut Extract – f256
rJug r 1 – 2S albumin, storage protein – f441
rJug r 3 – nsLTP – f442

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- IgE to Jug r 1 indicates a primary walnut allergy; the patient is at high risk of severe, systemic reactions
- If IgE to Jug r 3 (nsLTP) is indicated then mixed allergy is possible, involving systemic and local symptoms such as OAS. The patient may be sensitised to other nsLTPs contained in other plant foods/pollens due to cross-reactions which can cause systemic symptoms in cooked and uncooked foods
- Walnut and pecan are closely genetically related and show extensive cross-reactions even between storage proteins[24,79]

Further reading

- Pastorello E, *et al.* Lipid transfer protein and vicilin are important walnut allergens in patients not allergic to pollen. *J Allergy Clin Immunol* 2004;114(4):908-914.
- Maloney J, *et al.* The use of serum-specific IgE measurements for the diagnosis of peanut, tree nut and seed allergy. *J Allergy Clin Immunol* 2008;122(1):145-151.
- Sastre J. Molecular diagnosis in allergy. *Clin Exp Allergy* 2010 Oct;40(10):1442-1460.
- Rosenfeld L, *et al.* Walnut allergy in peanut-allergic patients: Significance of sequential epitopes of walnut homologues to linear epitopes of Ara h 1, 2 and 3 in relation to clinical reactivity. *Int Arch Allergy Immunology* 2012;157:238-245.

Cashew – ***Ana****cardium* ***o****ccidentale* (Ana o)

The cashew nut comes from the cashew nut tree, a member of the Anacardiaceae family, and is closely related to pistachio. Cashew nut is commonly used as a thickening agent in soups, meats and stews and particularly features in Indian cuisine.

Three storage proteins have been identified so far: Ana o 1, Ana o 2 and Ana o 3 (no nsLTP identified yet). Ana o 3 is a 2S albumin storage protein (the same family as Ara h 2 from peanut) which is resistant to digestion and has a high allergic potential to cause systemic symptoms.[74,77– 78] Significant cross-reactivity has been reported between pistachio nut and cashew nut.[74-76] Cross-reactivity between cashew nut and walnut is possible, as a result of Ana o 2, the legumin protein which is a major allergen in cashew nut and is also present in walnut.[74] The cross-reactivity is also suggested by *in vitro* studies.

Available ImmunoCAP allergen components

Whole Cashew Extract – f202
rAna o 3 – 2S albumin, storage protein – f443

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- IgE to Ana o 3 indicates a primary cashew allergy; The patient is at high risk of severe, systemic, reactions
- Cashew and pistachio are closely genetically related and show extensive cross reactivity even between storage proteins[74-76]

Further reading

- Hasegawa M, *et al.* Clinical features of four cases with cashew nut allergy and cross-reactivity between cashew nut and pistachio. *Allergol Int* 2011;60(4):425-432.
- Robotham JM, *et al.* Ana o 3, an important cashew nut (Anacardium occidentale L.) allergen of the 2S albumin family. *J Allergy Clin Immunol* 2005;115(6):1284-1290.
- Roux K, *et al.* Tree nut allergens. *Int Arch Allergy Immunology* 2003;131:234-244.
- Fernandez C, *et al.* Allergy to pistachio: cross reactivity between pistachio nut and other Anacardiaceae. *Clin Exp Allergy* 1995; 25(12):1254-1259.

Stone Fruits – Peach and Rosaceae Family

Due to high structural homology, general stone fruit allergy can be resolved using peach allergen components. In fact Pru p 3 can be a useful general marker for nsLTP allergy in fruit and vegetables due to its cross-reactive nature and high nsLTP levels concentrated in the skin. nsLTPs are highly conserved and widely distributed throughout the plant kingdom.[18-22] They have been identified as allergens in the Rosaceae subfamilies of the Prunoideae (peach, apricot, plum) and of the Pomoideae (apple).

Sensitisation to Pru p 3 is associated with systemic symptoms as well as oral allergy.[24] Pru p 1 cross-reacts extensively with Bet v 1 homologues from Prunus species (e.g. cherry, apricot, plum) and other Rosaceae fruits such as apple and also, and to a lower degree, PR-10 proteins from foods like carrot, celery, soy and peanut.

Available ImmunoCAP allergen components

Stone Fruit Whole Extract – e.g. Almond (f20), Apple (f49), Apricot (f237), Peach (f95), Pear (f94),
Plum (f255), Raspberry (f343), Strawberry (o212)
rPru p 1 PR-10 – f419
rPru p 3 nsLTP – f420
rPru p 4 Profilin – f421

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- IgE to Pru p 3 (nsLTP): mixed allergy is possible including systemic and local symptoms such as OAS. The patient may be sensitised to other nsLTPs contained in other plant foods/pollens due to cross-reactions which can cause systemic symptoms in cooked and uncooked foods
- If IgE to Pru p 1 and the other peach components are negative then risk is low for systemic reactions and local symptoms such as OAS are more likely. The patient may be sensitised to other PR-10-containing pollens and plant foods due to cross-reactions
- IgE to profilin Pru p 4: low risk, highly cross-reactive. Therefore a high IgE antibody titre result could explain broad sensitisations to other plant proteins that contain profilin, including latex, banana, tomato, potato, avocado, timothy grass, peanut etc

Further reading

- Asero R. Lipid transfer protein cross-reactivity assessed *in vivo* and *in vitro* in the office: pros and cons. *J Investig Allergol Clin Immunol* 2011;21(2):129-136.
- Pascal M, *et al.* Lipid transfer protein syndrome: clinical pattern, cofactor effect and profile of molecular sensitization to plant-foods and pollens. *Clin Exp Allergy* 2012;42(10):1529-1539.
- Rueda M, *et al.* Lipid transfer protein syndrome: clinical pattern, co-factor effect and profile of molecular sensitization to plant-foods and pollens. *Clin Exp Allergy* 2012;42:1529-1539.
- Garcia BE and Lizaso MT. Cross-reactivity Syndromes in Food Allergy. *J Investig Allergol Clin Immunol* 2011;21(3):162-170.

Wheat – ***Tri****ticum* ***a****estivum* (Tri a)

Wheat is a grass and therefore wheat flour contains many allergen components which are cross-reactive (e.g. profilin) although some are considered as true wheat food allergens. Most wheat allergic patients have IgE antibodies to multiple components both to grass cross-reactive ones and to true food allergens. Gliadins are non-water soluble proteins but are readily dissolved by stomach acid and are considered as true food allergens. Many patients with immediate food wheat allergy are sensitized to the gliadin and/or the nsLTP group of wheat allergens.

IgE antibodies to gliadin (containing α, γ, β and ω gliadins), Tri a 19 (ω-5 gliadin) or Tri a 14 (nsLTP), are associated with allergic reactions to ingested wheat. The wheat proteins, α,γ, β and ω gliadins (especially ω-5 gliadin) have also been reported as major allergens in Wheat – Dependent Exercise-Induced Anaphylaxis (WDEIA).[25-31] Moreover, ω-5 gliadin has been shown to be a specific risk marker in children with immediate allergy to ingested wheat.[32]

Available ImmunoCAP allergen components

Wheat whole extract – f4
α, γ, β and ω gliadins – f98
rTri a 19 ω -5 gliadin – f416
rTri a 14 – nsLTP – f433

Clinical utility

Increasing specificity in wheat food allergy diagnostics, understanding patient risk, an indicator for immediate wheat allergy, detection of wheat-dependent exercise-induced anaphylaxis (WDEIA)

Interpreting the results

- IgE sensitisation to α, γ, β and ω gliadins can indicate immediate wheat food allergy with the patient at high risk of severe, systemic, reactions
- IgE sensitisation to ω-5 gliadin (omega-5) gives even higher specificity than gliadin f98 and is associated with immediate wheat allergy and WDEIA
- ω-5 gliadin has a natural limited presence on the f4 Wheat ImmunoCAP and some wheat allergic patients, especially WDEIA patients, are negative to the f4-test but positive to ω-5 gliadin
- If IgE to Tri a 14 (nsLTP) is present then mixed allergy is possible including systemic and local symptoms such as OAS. The patient may be sensitised to other nsLTPs contained in other plant foods/pollens due to cross-reactions which can cause systemic symptoms in cooked and uncooked foods

Further reading

- Dengsuwan T, *et al.* Wheat ω-5 gliadin is a major allergen in children with immediate allergy to ingested wheat. *J Clin Immunol* 2001:108(4);634-638.
- Ito K, *et al.* IgE antibodies to ω-5 gliadin is associated with immediate symptoms on oral wheat challenge in Japanese children *Allergy* 2008;63:1536-1542.
- Hofmann SC, *et al.* IgE detection to α/β/γ gliadin and its clinical relevance in wheat-dependant exercise-induced anaphylaxis. *Allergy* 2012;67:1457-1460.

ImmunoCAP® Is it allergy?

Latex – ***Hev****ea* ***b****rasiliensis* (Hev b)

Latex allergy can trigger contact urticaria but also severe and even life-threatening allergic reactions. Does the patient have a genuine latex allergy? The association of latex allergy and allergy to plant-derived foods is called latex-fruit syndrome. An increasing number of plant sources such as avocado, banana, chestnut, kiwi, peach, tomato, potato and bell pepper have been associated with this syndrome.

IgE antibodies to Hev b 1 and Hev b 3 are considered markers for latex allergy especially in children who have had multiple operations, such as those with spina bifida (SB).[33] IgE to Hev b 5 and Hev b 6 is mainly associated with occupational exposure to latex e.g. in healthcare workers and food handling personnel using latex gloves.[34-36] Patients with latex-pollen syndrome are often sensitised to MUXF3 (CCD) and/or Hev b 8 (profilin).[37]

Available ImmunoCAP allergen components

Latex Whole Extract – K82
rHev b 1 – K215
rHev b 3 – K217
rHev b 5 – K218
rHev b 6.01 – K219
rHev b 6.02 – K220
rHev b 8 – Profilin – K221
MUXF3 – CCD – o214

Clinical utility

Understanding risk and cross-reactions

Interpreting the results

- IgE to Hev b 1, Hev b 3, Hev b 5 or Hev b 6 indicates a risk for genuine latex allergy
- Sensitisation to Hev b 8 and/or MUXF3 and no sensitisation to Hev b 1, Hev b 3, Hev 5 and Hev b 6 indicates a low risk of latex allergy
- IgE to Hev b 8 only, may indicate latex-pollen syndrome due to cross-reactions with other plants that contain profilin proteins. This does not normally indicate true latex allergy
- IgE to latex Hev b 5 and Hev b 6 is also associated with latex-fruit syndrome (e.g. avocado, kiwi, chestnut or banana

Further reading

- Ebo DG, *et al.* Component-resolved diagnosis from latex allergy by micro-array. *Clin Exp Allergy* 2010;40(2):348-358.
- Garnier L, *et al.* Molecular allergens in the diagnosis of latex allergy. *Eur Ann Allergy Clin Immunol* 2012;44(2):73-79.
- Ott H, *et al.* Microarrays of recombinant Hevea brasiliensis proteins: A novel tool for the component-resolved diagnosis of natural rubber latex allergy. *J Investig Allergol Clin Immunol* 2010;20(2):129-138.
- Schuler S, *et al.* Microarray-based component-resolved diagnosis of latex allergy: isolated IgE-mediated sensitization to latex profilin Hev b 8 may act as confounder. *Clin Transl Allergy* 2013;3(1):11.

Hen's egg – *Gallus domesticus* (Gal d)

The total number of egg proteins is not known, but more than 40 have been suggested for egg white alone,[39] and up to 24 different antigenic protein fractions have been isolated. Ovomucoid (Gal d 1), ovalbumin (Gal d 2), ovotransferrin/conalbumin (Gal d 3) and lysozyme (Gal d 4) have been identified as the most important allergens in egg white.[38] Ovomucoid has been demonstrated to be a major allergen, making up 10% of the egg white protein. Gal d 1 has several important characteristics which make its allergic potential high, such as stability to heat and digestion by proteases. Patients with elevated IgE to ovomucoid are at risk to both raw and cooked egg products.[40-42] Specific IgE to Gal d 1 is also a risk factor for persistent hen's egg allergy.[43-45]

Available ImmunoCAP allergen components

Egg White Extract – f1
nGal d 1 – ovomucoid – f233
nGal d 2 – ovalbumin – f232
nGal d 3 – conalbumin – f323
nGal d 4 – lysozyme – k208

Clinical utility

Egg allergy persistence, understanding patient risk

Interpreting the results

- IgE sensitisation to Gal d 1 indicates high risk of a persistent egg allergy
- IgE sensitisation to Gal d 1 indicates the patient is at high risk to raw and cooked egg
- IgE sensitisation to Gal d 2, Gal d 3 and Gal d 4 (Gal d 1 negative or low levels) – indicates a risk to raw egg and tolerance to extensively heated egg

Further reading

- Ando H, *et al.* Utility of ovomucoid-specific IgE concentrations in predicting symptomatic egg allergy. *J Allergy Clin Immunol* 2008; 122:583-588.
- Alessandari C, *et al.* Ovomucoid (Gal d 1) specific IgE detected by microarray system predict tolerability to boiled hen's egg and an increased risk to progress to multiple environmental sensitisation. *Clin Exp Allergy* 2012;42(3):441-450.
- Benhanou AH, *et al.* State of the art and new horizons in the diagnosis and management of egg allergy. *Allergy* 2010;65:283-289.

Cow's milk – ***Bos d****omesticus* (Bos d)

A wide variety of milk protein allergens have been observed giving IgE responses. The major allergens in cow's milk are casein, α-lactalbumin and β-lactoglobulin, although allergens that are present in low quantities, such as Bovine Serum Albumin (BSA) and lactoferrin, are also important since 35-50% of patients are sensitised to these allergens.[50]

Available ImmunoCAP allergen components

Milk allergen – f2
nBos d 4 – α-lactalbumin – f76
nBos d 5 – ββ-lactoglobulin – f77
nBos d 6 – BSA – e204
nBos d 8 – Casein – f78
nBos d – Lactoferrin – f334

Clinical utility

Milk allergy risk assessment, IgE to casein is an indicator for reactions to cooked milk products and for milk allergy persistence

Interpreting the results

- IgE to Bos d 8 (casein) indicates high risk of milk allergy persistence
- IgE to Bos d 8 (casein) indicates high risk to uncooked and cooked milk products
- IgE negative or low levels of IgE to Bos d 8 and higher levels to either Bos d 4, Bos d 5, Bos d 6 or Lactoferrin indicates a risk for uncooked milk, but a tolerance to cooked milk products is likely

Further reading

- Fiocchi A, *et al.* Molecular diagnosis of cow's milk allergy. *Curr Opin Allergy Clin Immunol* 2011;11:216-221.
- Nowak-Wegrzyn A, *et al.* Tolerance to extensively heated milk in children with cow's milk allergy. *J Allergy Clin Immunol* 2008;122:342-347.
- Ito K, *et al.* The usefulness of casein-specific IgE and IgG4 antibodies in cow's milk allergic children. *Clin Mol Allergy* 2012;10(1):1.

Tropomyosin

House dust mite – *Der**matophagoides pteronyssinus*** (Der p)
Shimp – *Pen**aeus ****a****ztecus*** (Pen a)

Tropomyosin proteins are highly cross-reactive actin-binding proteins located in muscle fibres amongst many invertebrate species such as shrimps (Pen a 1), dust mite (Der p 10), cockroach (Bla g 7) and crustacean foods such as crab, lobster and snails.[58] Therefore tropomyosin is an allergen that can be inhaled and ingested.

Pen m 1 is heat stable in raw and cooked shrimp.[57] About 10% of dust mite-allergic patients have IgE to tropomyosin. Some studies suggest that exposure to dust mite tropomyosin may sensitise against shrimp tropomyosin.[60] Patients with IgE to Der p 10 may potentially have a higher risk of allergic reactions to shellfish (crustaceans and mollusc), insects and parasites.[59]

Available ImmunoCAP allergen components

rDer p 10 – Tropomyosin, House dust mite (Dermatophagoides pteronyssinus) – d205
rPen a 1 – Tropmyosin, Shrimp (Penaeus aztecus) – f351

Clinical utility

Risk markers, cross-reactive determinations. Specific IgE results to either Pen a 1 or Der p 10 would explain multiple positive results to different shellfish whole extracts

Interpreting the results

- As tropomyosins are highly cross-reactive (and highly homologous) it is possible to use one type of tropomyosin IgE test to measure IgE sensitisation. The results would at least explain sensitisation patterns to numerous invertebrate species including those between mite and shrimp
- IgE to Pen a 1 indicates an allergy risk to different tropomyosins and to crustacean foods in general – cross-reactions through tropomyosin can cause systemic symptoms
- Some patients sensitised to Der p 10 may react to crustacean tropomyosin such as Pen a 1 in shrimp. These patients are at higher risk of crustacean allergy

Further reading

- Sastre J. Molecular diagnosis in allergy. *Clin Exp Allergy* 2010;1442-1460.
- Gamez C, *et al.* Tropomyosin IgE positive results are a good predictor of shrimp allergy. *Allergy* 2011;66;1375-1383.
- Garcia BE and Lizaso MT. Cross-reactivity syndromes in food allergy J *Investig Allergol Clin Immunol* 2011;21(3):162-170.
- Leung NYH, *et al.* Current immunological and molecular biological perspectives on seafood allergy: A comprehensive review. *Clin Rev Allerg Immunol* 2012; Epub ahead of print.

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Fish Allergens – Parvalbumins

Cod – *Gad*us *m*orhua – (Gad m)
Carp – *Cyp*rinus *c*arpio – (Cyp c)

Pavalbumins are small acidic calcium-binding buffer proteins found in muscle fibres and are the major allergens in fish and amphibians. Parvalbumins are highly cross-reactive. The degree of cross-reactivity is dependent on the degree of protein homology. Parvalbumins proteins have high allergenic potential and are resistant to change even after cooking.

Cyp c 1 (carp, oily fish) and Gad c 1 (cod, white fish) are both major fish allergen proteins and both respective markers for fish IgE sensitisation. Parvalbumins are expressed in lower levels in certain fish species such as tuna, swordfish and some mackerel. This perhaps explains why some fish-allergic patients can tolerate these species.

Recombinant carp parvalbumin was found to contain 70% of the IgE epitopes present in natural extract of cod, tuna and salmon.[60-61] This suggested that the substance would make a valid tool in the diagnosis of patients with fish allergy.[61] Purified carp parvalbumin has been shown to react with IgE antibodies of more than 95% of individuals allergic to fish, and to contain around 83% of the IgE epitopes present in other fish species.[63]

Available ImmunoCAP allergen components

rGad c 1 – Cod – f426
rCyp c 1 – Carp – f355

Clinical utility

Understanding risk and cross-reactive determinations

Interpreting the results

- IgE to Cyp c 1 indicates high risk allergy to carp and closely related fish (oily fish) due to cross-reactions
- IgE to Gad c 1 indicates a high risk allergy to cod and closely related fish (white fish) due to cross-reactions
- Using Cyp c 1 and Gad c 1 gives a broad spectrum parvalbumins analysis of white fish and oily fish
- A negative result to both would lead to further investigations

Further reading

- Sastre J. Molecular diagnosis in allergy. *Clin Exp Allergy* 2010;1442-1460.
- Garcia BE and Lizaso MT. Cross-reactivity syndromes in food allergy. *J Investig Allergol Clin Immunol* 2011;21(3):162-170.
- Sharp MF and Lopata AL. Fish allergy in review. *Clin Rev Allerg Immunol* 2013: Epub ahead of print.

Using ImmunoCAP components for aeroallergen immunotherapy; patient selection in birch and grass patients

Timothy Grass – *Phl*eum *p*ratense – (Phl p)
Birch – *Bet*ula *v*errucosa – (Bet v)

Using ImmunoCAP allergen components it is possible to identify patients who are the most likely to respond to aeroallergen immunotherapy. Immunotherapy vaccines are manufactured to include most major allergens from the sensitisation source.[64-65]

For example, birch immunotherapy vaccines contain mainly the birch major allergen Bet v 1 (PR-10). This applies to both subcutaneous immunotherapy (SCIT) and sublingual immunotherapy (SLIT). The exact quantities of allergen present varies from manufacturer to manufacturer.[64-65]

In some cases a patient may not be positive for the major allergen from the allergen source and is less likely to respond satisfactorily to aeroallergen immunotherapy.[66] In the case of birch allergy the minor allergens include Bet v 2 (profilin) and Bet v 4 (polcalcin). These are minor pan-allergens and highly cross-reactive and if the patient is sensitised only to these, further investigations may be needed to identify the true allergen source.

The above statements can also be applied to patients selected for grass immunotherapy; in the same way patients can be identified and grouped into how they are likely to respond to immunotherapy. The process for selecting patients for timothy grass and birch allergy immunotherapy is illustrated in the below table:

Available ImmunoCAP allergen components

Timothy Grass	
rPhl p 1	g205
rPhl p 2	g206
nPhl p 4	g208
rPhl p 5b	g215
rPhl p 6	g209
rPhl p 7	g210
rPhl p 11	g211
rPhl p 12 (profilin)	g212
rPhl p 1 + rPhl p 5b	g213
rPhl p 7 + rPhl p 12	g214

Birch	
rBet v 1	t215
rBet v 2	t216
rBet v 4	t220
rBet v 6	t225
rBet v 2 + Bet v 4	t221

Timothy grass and birch aeroallergy – the minor and major allergens

Clinical decision	ImmunoCAP major allergens	ImmunoCAP minor allergens	Interpretational overview
Patient selected for Timothy Grass Immunotherapy	rPhl p 1 + rPhl p 5b (g231*)	rPhl p 7 + rPhl p 12 (g214*)	**IgE to major allergens and no IgE to minor allergens –** good candidate for specific immunotherapy.
Patient selected for Birch Immunotherapy	rBet v 1 (t215)	rBet v 2 + rBet v 4 (t221*)	**IgE to minor allergens and no IgE to major allergens –** patient may not respond to specific immunotherapy.

*Indicates dual allergen component

Further reading

- Focke M, *et al.* Heterogeneity of commercial timothy grass pollen extracts. *Clin Exp Allergy* 2008;38(8):1400-1408.
- Focke M, *et al.* Molecular composition and biological activity of commercial birch pollen allergen extracts. *Eur J Clin Invest* 2009;39(5):429-436.
- Schmid-Grendelmeier P. Recombinant allergens – routine diagnostics or still only science? *Der Hautarzt* 2010;61(11):946-953.
- Letrán A, *et al.* Measurement of IgE to pollen allergen components is helpful in selecting patients for immunotherapy. *Ann Allergy Asthma Immunol* 2013;111(4):295–297.
- Passalacqua G, *et al.* The additional values of microarray allergen assay in the management of polysensitised patients with respiratory allergy. *Allergy* 2013;68(8):1029-1033.
- Sastre J. Molecular diagnosis and immunotherapy. *Curr Opin Allergy Clin Immunol* 2013;13(6):646–50.

Using ImmunoCAP components for venom immunotherapy (VIT)

Common wasp – *Ves*pula *v*ulgaris – (Ves v)
Honey bee – *Api*s *m*ellifera – (Api m)

Identifying the correct allergen source is highly important for optimising VIT, and ImmunoCAP components can assist diagnosis when patients appear to be IgE test positive to both honey bee and common wasp. Double reactivity to both bee and wasp is not clinically common. In many cases double IgE test positivity can be caused by cross-reactions to CCDs.[67-68] Proteins with CCD can be found in many other allergen sources such as plant foods (e.g. peanut) pollens or mites. Recombinant venom components do not carry CCD and therefore provide specificity to the venom diagnostics.

The below decision tree table gives an outline for selecting patients for the correct immunotherapy.

Patients with suspected venom allergy should also be tested for ImmunoCAP tryptase. The patients with high basal levels of tryptase should be investigated for mastocytosis since these patients have higher risk for severe reactions during venom immunotherapy. It is recommended that special attention should be paid to patients who have a basal tryptase measurement of over 10 µg/L.

Available ImmunoCAP allergen components

Honey Bee – rApi m 1 Phospholipase A2, Honey bee – i208
Common Wasp – rVes v 1 Phospholipase A1 – i211
Common Wasp – rVes v 5 – i209
European paper wasp – rPol d 5 – i210

Clinical decision	ImmunoCAP components	Interpretational overview
Venom immunotherapy (patient has double positivity to wasp venom and bee venom)	Ves v 1 + Ves v 5 + Api m 1 + CCD MUXF 3	IgE to Ves v 1, Ves v 5 and no IgE to Api m 1. CCD positive – good candidate for wasp immunotherapy. IgE to Api m 1 and no IgE to Ves v 1 or Ves v 5. CCD positive – good candidate for honey bee immunotherapy. IgE to Ves v 1, Ves v 5 and Api m 1, CCD negative – candidate may need dual immunotherapy to bee and wasp. IgE to CCD and no IgE to Ves v 1, Ves v 5 and Api m 1. Further investigations may be necessary to identify underlying source.

Further reading

- Mittermann I, *et al.* Recombinant allergen-based IgE testing to distinguish bee and wasp allergy. *J Allergy Clin Immunol* 2010;125(6):1300-1307.
- Muller U, *et al.* IgE to recombinant allergens Api m1, Ves v 1 and Ves v 5 distinguish double sensitisation from cross reaction in venom allergy. *Allergy* 2012;67:1069-1073.
- Ebo DG, *et al.* Component-resolved diagnosis of wasp (yellow jacket) venom allergy. *Clin Exp Allergy* 2013;43(2):255-261.

ImmunoCAP®
Is it allergy?

Allergen components

The term allergen component is used for products based on molecular allergens purified from either their natural source (native) or biotechnologically produced as recombinant proteins.

By using tests for single allergenic components as a complement to more traditional IgE antibody tests, further clinically relevant information can be gained.

ImmunoCAP Allergen components are useful tools when investigating and explaining allergic reactions in detail and to determine if they are caused by cross-reacting IgE antibodies to different allergens.

Product		Code	Size	Art. No.	Barcode
Grass pollens					
nCyn d 1 Bermuda grass	*Cynodon dactylon*	g216	10	14-4972-01	CFA
rPhl p 1 Timothy	*Phleum pratense*	g205	10	14-5234-01	BSU
rPhl p 2 Timothy	*Phleum pratense*	g206	10	14-5235-01	C0K
nPhl p 4 Timothy	*Phleum pratense*	g208	10	14-5288-01	C0L
rPhl p 6 Timothy	*Phleum pratense*	g209	10	14-5289-01	BSV
rPhl p 7 Timothy	*Phleum pratense*	g210	10	14-5290-01	BSW
rPhl p 11 Timothy	*Phleum pratense*	g211	10	14-5291-01	BSX
rPhl p 12 Profilin, Timothy	*Phleum pratense*	g212	10	14-5292-01	BSY
rPhl p 1, rPhl p 5b Timothy	*Phleum pratense*	g213	10	14-5312-01	BU1
rPhl p 7, rPhl p 12 Timothy	*Phleum pratense*	g214	10	14-5313-01	BU2
rPhl p 5b Timothy	*Phleum pratense*	g215	10	14-5338-01	BV3
Weed pollens					
nAmb a 1 Ragweed	*Ambrosia elatior*	w230	10	14-4969-01	CF8
nArt v 1 Mugwort	*Artemisia vulgaris*	w231	10	14-4970-01	CF9
nArt v 3 LTP, Mugwort	*Artemisia vulgaris*	w233	10	14-4983-01	CJ2
rPar j 2 LTP, Wall pellitory	*Parietaria judaica*	w211	10	14-5311-01	C2M
nSal k 1 Saltwort	*Salsola kali*	w232	10	14-4978-01	CFE
rPla l 1 Plantain	*Plantago lanceolata*	w234	10	14-5751-01	D1H

Product		Code	Size	Art. No.	Barcode
Tree pollens					
rBet v 1 PR-10, Birch	*Betula verrucosa*	t215	10	14-5225-01	BPV
rBet v 2 Profilin, Birch	*Betula verrucosa*	t216	10	14-5226-01	BR1
rBet v 4 Birch	*Betula verrucosa*	t220	10	14-5287-01	BT7
rBet v 6 Birch	*Betula verrucosa*	t225	10	14-5345-01	CF1
rBet v 2, rBet v 4 Birch	*Betula verrucosa*	t221	10	14-5310-01	BU0
nCup a 1 Cypress	*Cupressus arizonica*	t226	10	14-4977-01	CFD
rOle e 1 Olive	*Olea europaea*	t224	10	14-5705-01	CTC
nOle e 7 LTP, Olive	*Olea europaea*	t227	10	14-4993-01	CKT
rOle e 9 Olive	*Olea europaea*	t240	10	14-4999-01	CTZ
rPla a 1 London plane	*Platanus acerifolia*	t241	10	14-5957-01	D2H
Microorganisms					
rAlt a 1	*Alternaria alternata*	m229	10	14-5346-01	CE0
rAsp f 1	*Aspergillus fumigatus*	m218	10	14-5293-01	BPL
rAsp f 2	*Aspergillus fumigatus*	m219	10	14-5294-01	BPM
rAsp f 3	*Aspergillus fumigatus*	m220	10	14-5295-01	BT4
rAsp f 4	*Aspergillus fumigatus*	m221	10	14-5296-01	BPH
rAsp f 6	*Aspergillus fumigatus*	m222	10	14-5297-01	BPP
Epidermals and animal proteins					
nBos d 6 BSA, Cow	*Bos spp.*	e204	10	14-5009-01	BRV
rCan f 1 Dog	*Canis familiaris*	e101	10	14-4955-01	CBN
rCan f 2 Dog	*Canis familiaris*	e102	10	14-4956-01	CBP
nCan f 3 serum albumin Dog	*Canis famliaris*	e221	10	14-5241-01	C14
rCan f 5 Dog	*Canis familiaris*	e226	10	14-4998-01	CMZ
rFel d 1 Cat	*Felis domesticus*	e94	10	14-4905-01	BY0
rFel d 4 Cat	*Felis domesticus*	e228	10	14-5702-01	CT9
rEqu c 1 Horse	*Equus caballus*	e227	10	14-5700-01	CN7
nFel d 2 serum albumin Cat	*Felis domesticus*	e220	10	14-5240-01	BRX
nSus s Pig albumin, Swine	*Sus scrofa*	e222	10	14-5242-01	C36
Mites					
nDer p 1 House dust mite	*Dermatophagoides pteronyssinus*	d202	10	14-4966-01	CFG
rDer p 2 House dust mite	*Dermatophagoides pteronyssinus*	d203	10	14-4967-01	CG2

Product		Code	Size	Art. No.	Barcode
Venoms					
rApi m 1 Phospholipase A2, Honey bee	*Apis mellifera*	i208	10	14-4987-01	CJ7
rVes v 1 Phospholipase A1, Common wasp	*Vespula vulgaris*	i211	10	14-4995-01	CMR
rVes v 5 Common wasp	*Vespula vulgaris*	i209	10	14-4992-01	CJ8
rPol d 5 Paper wasp	*Polistes dominulus*	i210	10	14-4994-01	CJ09
Occupational					
rHev b 1 Latex	*Hevea brasiliensis*	k215	10	14-5324-01	C20
rHev b 3 Latex	*Hevea brasiliensis*	k217	10	14-5326-01	C2A
rHev b 5 Latex	*Hevea brasiliensis*	k218	10	14-5327-01	C1Z
rHev b 6.01 Latex	*Hevea brasiliensis*	k219	10	14-5328-01	C28
rHev b 6.02 Latex	*Hevea brasiliensis*	k220	10	14-5329-01	C22
rHev b 8 Profilin, Latex	*Hevea brasiliensis*	k221	10	14-5330-01	C1V
rHev b 9 Latex	*Hevea brasiliensis*	k222	10	14-5331-01	C2C
rHev b 11 Latex	*Hevea brasiliensis*	k224	10	14-5333-01	C29
Occupational / Enzymes					
Alkalase	*Bacillus spp.*	k205	10	14-5126-01	C1F
nAna c 2 Bromelain, Pineapple	*Ananas comosus*	k202	10	14-5127-01	BT1
nAsp o 21 alpha-amylase	*Aspergillus oryzae*	k87	10	14-5370-01	595
nCar p 1 Papain, Papaya	*Carica papaya*	k210	10	14-5130-01	BT0
nGal d 4 Lysozyme, Egg	*Gallus spp.*	k208	10	14-5128-01	C0T
Maxatase	*Bacillus licheniformis*	k204	10	14-5128-01	C2F
Savinase	*Bacillus spp.*	k206	10	14-5132-01	C2R
nSus s Pepsin, Swine	*Sus scrofa*	k213	10	14-5258-01	C3B

Product		Code	Size	Art. No.	Barcode
Foods					
rAct d 8 PR-10, Kiwi	*Actinidia deliciosa*	f430	10	14-4984-01	CG7
rAna o 3 Cashew nut	*Anacardium occidentale*	f443	10	14-5760-01	D0W
rApi g 1.01 PR-10, Celery	*Apium graveolens*	f417	10	14-4957-01	CBR
rAra h 1 Peanut	*Arachis hypogaea*	f422	10	14-4963-01	CDF
rAra h 2 Peanut	*Arachis hypogaea*	f423	10	14-4964-01	CDG
rAra h 3 Peanut	*Arachis hypogaea*	f424	10	14-4965-01	CDH
rAra h 8 PR-10, Peanut	*Arachis hypogaea*	f352	10	14-5341-01	CEZ
rAra h 9 LTP, Peanut	*Arachis hypogaea*	f427	10	14-4980-01	CFC
rBer e 1 Brazil nut	*Bertholletia excelsa*	f354	10	14-5343-01	CDS
nBos d 4 alpha-lactalbumin, Milk	*Bos spp.*	f76	10	14-4522-01	CTP
nBos d 5 beta-lactoglobulin, Milk	*Bos spp.*	f77	10	14-4523-01	CTR
nBos d 8 Casein, Milk	*Bos spp.*	f78	10	14-4524-01	CTS
nBos d Lactoferrin, Milk	*Bos spp.*	f334	10	14-5253-01	C16
rCor a 1 PR-10, Hazel nut	*Corylus avellana*	f428	10	14-4981-01	CFB
rCor a 8 LTP, Hazel nut	*Corylus avellana*	f425	10	14-4968-01	CDP
nCor a 9, Hazel nut	*Corylus avellana*	f440	10	14-5758-01	D0M
rCor a 14, Hazel nut	*Corylus avellana*	f439	10	14-5754-01	CZP
rCyp c 1 Carp	*Cyprinus carpio*	f355	10	14-5344-01	CF0
rGad c 1 Cod	*Gadus morhua*	f426	10	14-4971-01	CEY
nGal d 1 Ovomucoid, Egg	*Gallus spp.*	f233	10	14-4805-01	904
nGal d 2 Ovalbumin, Egg	*Gallus spp.*	f232	10	14-4804-01	903
nGal d 3 Conalbumin, Egg	*Gallus spp.*	f323	10	14-5222-01	C18
rGly m 4 PR-10, Soy	*Glycine max*	f353	10	14-5340-01	CDR
nGly m 5 beta-conglycinin, Soy	*Glycine max*	f431	10	14-4990-1	CLV
nGly m 6 Glycinin	*Glycine max*	f432	10	14-4991-01	CLU
rJug r 1 Walnut	*Juglans regia*	f441	10	14-5762-01	D0T
rJug r 3 LTP, Walnut	*Juglans regia*	f442	10	14-5954-01	D11
rMal d 1 PR-10, Apple	*Malus domestica*	f434	10	14-5703-01	CWR
rMal d 3 LTP, Apple	*Malus domestica*	f435	10	14-5704-01	CWS
rPen a 1 Tropomyosin, Shrimp	*Penaeus aztecus*	f351	10	14-5335-01	C11
rPru p 1 PR-10, Peach	*Prunus persica*	f419	10	14-4960-01	CBV
rPru p 3 LTP, Peach	*Prunus persica*	f420	10	14-4961-01	CBW
rPru p 4 Profilin, Peach	*Prunus persica*	d421	10	14-4962-01	CBX
rTri a 14 LTP, Wheat	*Triticum aestivum*	f433	10	14-5701-01	CN6
rTri a 19 Omega-5 Gliadin, Wheat	*Triticum spp.*	f416	10	14-4954-01	C8H
Gliadin		f98	10	14-5752-01	CXG
Miscellaneous					
MUXF3 CCD, Bromelain		214	10	14-5339-01	CJU

Educational resources

- Website: **AllergyEducation.co.uk** – Thermo Fisher Scientific educational website explaining the basics of Molecular Allergy and an interactive tool to help with identification of relevant components and interpretation
- Website: **AllergyEducation-MA.com** – Thermo Fisher Scientific educational training course exploring the basics of Molecular Allergy
- Canonica GW, *et al.* A WAO – ARIA – GA2LEN consensus document on molecular-based allergy diagnostics. *World Allergy Organ J* 2013;6(1):17.
- Thermo Fisher Scientific – Cross reactivity in plant food allergy – A focused book on cross-sensitisation
- Thermo Fisher Scientific – Native and cross-reactive allergen components – A more detailed book giving an overview of allergen components
- Thermo Fisher Scientific – Individual literature packs on various components are available. Educational PowerPoint slide sets are also available. Please contact Thermo Fisher Scientific if you would like a set:

– Egg	– Milk	– Birch
– Grass	– Hazelnut	– Peanut
– Wheat	– Soybean	– Venoms
– Apple	– Walnut	– Cashew

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Notes

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