Host Resistance:

Two major types:

'Specific recognition'	'Concert' of defense responses
race specific	non-race specific
qualitative	quantitative
major	minor
monogenic	polygenic
differential	general
'**R**-gene'	field resistance
vertical	horizontal

Genetics of resistance continued:

Race-specific resistance:

Resistance characterized by specific recognition (genetic interactions) between host genotypes and pathogen genotypes.

The ranking of cultivars from least to most resistant depends on the pathogen genotype (race) used.

This type of resistance is commonly 'all or nothing' (qualitative)

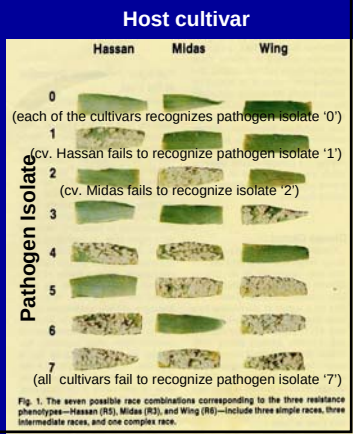


Fig. 1. The seven possible race combinations corresponding to the three resistance phenotypes—Hassan (R5), Midas (R3), and Wing (R6)—include three simple races, three intermediate races, and one complex race.

Genetics of resistance continued:

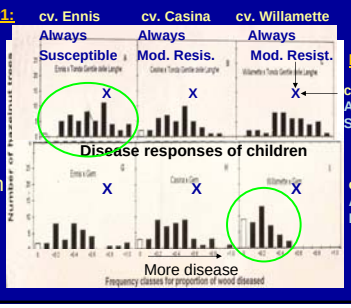
Non race-specific ('horizontal) resistance:

Host cultivars show the same relative level of resistance to all pathogen isolates

When effective, this type of resistance commonly involves multiple genes, each with a small effect (quantitative)

Example:

Disease responses in 2-yr-old seedlings of European hazelnut where the parent cultivars (crossed with each other) varied in level of non-race specific resistance



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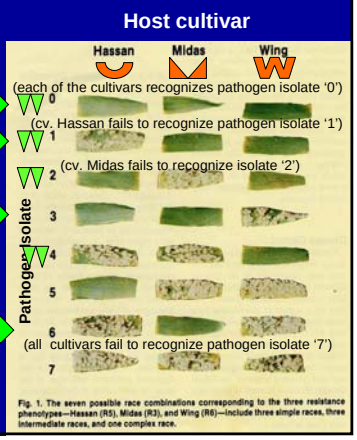
Host gene product
Specific receptor/ recognizer
Pathogen gene product
Negative Effector



Race-specific resistance is based on the

Gene-for-Gene Hypothesis :

The product of a single gene in the host specifically recognizes the product of a gene in the pathogen (i.e., an '*effector*').

During an infection event, an interaction between these products results in incompatibility

(i.e., a hypersensitive response and programmed cell death).

Gene-for-Gene Hypothesis

Host: 'R'–gene'= recognizer
this gene produces a product that 'recognizes'

usually an R-gene is a dominant gene
'dominant' means that receiving a copy of the gene from only one parent is sufficient to trigger the recognition response in the plant

Pathogen: 'AVR' gene'= avirulence gene
this gene produces an elicitor (effector) – it 'elicits the HR'

an AVR-gene is dominant
dominant means that receiving a copy of the gene from only one parent is sufficient to elicit a recognition response in the host

Gene-for-Gene Hypothesis

Host is

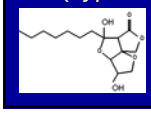
Pathogen	R_z,R_z or R_z,?	?,?
AVR_z,AVR or AVR_z, ?	P H **Resistance**	P ? Disease
?,?	? H Disease	? ? Disease

Specific recognition in upper left box only

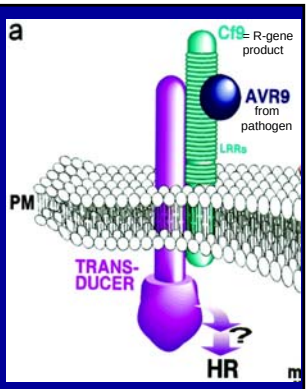
? = recessive allele, this allele is not involved in the interaction. Also sometimes written as 'r' in host, and 'avr' in pathogen

Hypothesized physical model for how R-gene and Avr-gene products interaction on plasma membrane of host cells

Pathogen protein (AVR) interacts with host R-gene protein (Cf9), which triggers the cell death response (hypersensitivity)



Example of AVR gene product from bacterial pathogen

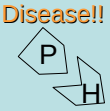
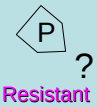


From: MHAJ Joosten and PJGM de Wit Annual Review of Phytopathology Vol. 37:335

What if the pathogen is a necrotrophic fungus that produces a host selective toxin?

Host

Pathogen

Pathogen \ Host	S,S or S,?	?, ?
Tox, Tox or **Tox, ?**	Disease!! 	 ? Resistant
?, ?	?  Resistant	? ? Resistant

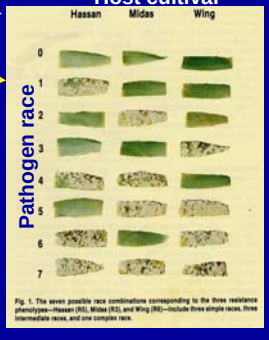
Gene-for-gene II
Tox = gene for toxin
S = gene for receptor
Specific recognition in upper left box only

How many races?

Three cultivars, each with a different R gene yields 8 races (2^3)

Ten cultivars, each with a different R gene could discern a possible 1024 races (2^{10}) !!

The set of cultivars used to characterize races is called a 'differential set'



A common test question:

For each of the boxes, indicate whether or not the races of a rust pathogen will succeed in infecting the host cultivars

Avirulence (A) or lack-of-avirulence (? or 'a') genes possessed

Resistance (R) or lack-of-resistance (? or 'r') genes in each cultivar

Race:	$A_1A_2A_3A_4$	$A_1a_2A_3A_4$	$a_1A_2A_3A_4$	$a_1a_2A_3A_4$	$a_1a_2a_3a_4$
$r_1r_2r_3r_4$					
$R_1r_2r_3r_4$					
$r_1R_2r_3r_4$					
$R_1R_2r_3r_4$					
$R_1R_2r_3R_4$					

'R', 'A' = active product present '?', 'a', 'r' = active product absent

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$r_1r_2r_3r_4$	yes	yes	yes	yes	yes
$R_1r_2r_3r_4$	no	no	yes	yes	yes
$r_1R_2r_3r_4$	no	yes	no	yes	yes
$R_1R_2r_3r_4$	no	no	no	yes	yes
$R_1R_2r_3R_4$	no	no	no	no	yes

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