



**RÉPUBLIQUE
FRANÇAISE**

*Liberté
Égalité
Fraternité*



anses

TIME FOR PLANT HEALTH TO JOIN ONE HEALTH

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PLANT HEALTH DIRECTOR



Innovations pour la santé des plantes

Summary

1. One Health: from duality to plurality and inclusiveness up to the plants

2. Past and current plant diseases do impact human or animal health

3. A set of common defence features: One Immunity?

4. Contribution of Anses to One Health at the plant level



1. One Health: from duality to plurality and inclusiveness up to the plant

Many pests & pathogens, with various situations

Viroids, viruses, bacteria, fungi & oomycetes, nematodes, insects (pests & vectors), invasive plants
 More than 200 QP in the UE Plant Health Law (UE) 2016/2031

Too fast

D. suzukii, Ash Dieback, Box tree moth (*Cydalima perspectalis*)
 Mineuse sud-américaine de la tomate (*Tuta absoluta*)



Impossible to eradicate

RPW (Red palm weevil, *Rhynchophorus ferrugineus*), *X. fastidiosa* in Corsica

Widely distributed

Sharka (PPV), Flavescence dorée (*Candidatus phytoplasma vitis*)



Very localized

Nematodes *Meloidogyne sp.*, bacterial RSCS *Ralstonia solanacearum*

Intercepted but not established (yet)

B. dorsalis



Close to the border

Japanese beetle (*Popilla japonica*), pine wood nematode (*Bursaphelenchus xylophilus*)



... and various issues

Economic

Crops, fruits, horticulture & et market gardening: *Pyricularia oryzae*, *X. fastidiosa*, PPV ..
Quantitatives & qualitative (HLB, ToBRFV, CBS : *Phyllosticta citricarpa*)



Environnemental/biodiversity

Chalarose du frêne, pyrale du buis



Landscaps & society

X. fastidiosa, CCP, Chancre coloré du platane (*Ceratocystis platani*)

Human health

Ambrosies (*Artemisia artemisiifolia*, *A. trifida*), Datura (*Datura stramonium*)



The roots of One Health

A millennial ascent (2006)

An initiative rather than a new concept:

- Hypocrates (460-370 BC) 'On airs, waters and place'
- Rudolf Virchow (1821-1902)

Education and promotion



Organisation mondiale
de la santé animale
Fondée en tant qu'OIE



World
Organisation
for Animal
Health

The pillars of One Health

Eco-epidemiological risks & hyperspecialization

Pluri/inter/transdisciplinary approaches

Human, animals, environment



> Coordinate approaches:

Human health

Animal health

Environment

+ Sociology – Ecology - Economics

One Health original facts: dual health

Human infectious diseases:

60% animal origin

(Re-)emerging diseases / 1 century :

Zoonoses

Vectorial

Ecological and/or climatic disorders

Bioterrorism:

80% animal origin

Domestic animals, wildlife and humans are exposed to the same threats



One Health original facts: interspecies issues

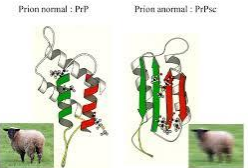
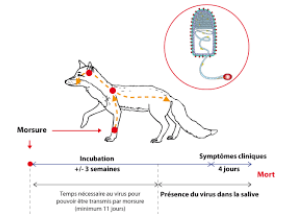
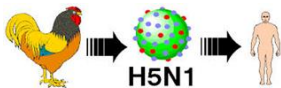
SPECIES BARRIER CROSSING

Contact (rabies)

Contaminated food ingestion (BSE, salmonella poisoning)

Transmission by insects (Nile fever & Rift valley fever)

2003 : avian influenza



One Health original facts: interspecies issues

Species barrier crossing: an issue with plant pathogens?

Crossing the kingdom border: Human diseases caused by plant pathogens

Kim et al., 2020

Environmental Microbiology (2020) 22(7), 2485–2495

Minor importance

BUT

plant pathogenic fungi, bacteria and viruses may have critical impacts on human and animal health and safety

One Health original facts: interspecies issues

Species barrier crossing: an issue with plant pathogens?

FUNGI: *Alternaria*, *Bipolaris*, *Fusarium*, *Colletotrichum*, *Cladosporium* spp.

OOMYCETES: *Pythium* sp.

BACTERIA: *Agrobacterium*, *Rhizobium*, *Erwinia*, *Burkholderia*, *Pantoea* spp.

VIRUSES: PMMoV, TMV

SYMPTOMS: From fever to septicemia (blood, ophthalmic, pulmonary diseases)

Case study: disruption of type III effector-mediated phagocytosis in a human cell line upon infection with *Pseudomonas syringae* pv. *tomato*



One Health original facts: interspecies issues

Species barrier crossing: an issue with plant pathogens?

+ BIOCONTROL AGENTS:

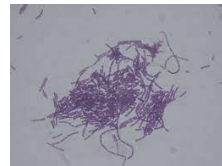
Comparative phenotypic, genotypic and genomic analyses of Bacillus thuringiensis associated with foodborne outbreaks in France

Bonis et al., 2021

PLoS One, doi: 10.1371/journal.pone.0246885.eCollection 2021.

Hypothesis of an **agricultural origin** for the Bt contamination

Call for further investigations on Bt pesticides



One Health original facts: interspecies issues

Species barrier crossing: a food contamination issue only?

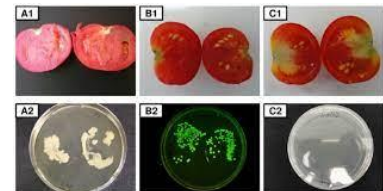
2015-2020: Centers for Disease Control and Prevention (CDC) in the USA

Annual outbreaks with lettuce and other vegetables + germinated sprouts contaminated with either *E. coli* or *Salmonella sp.*

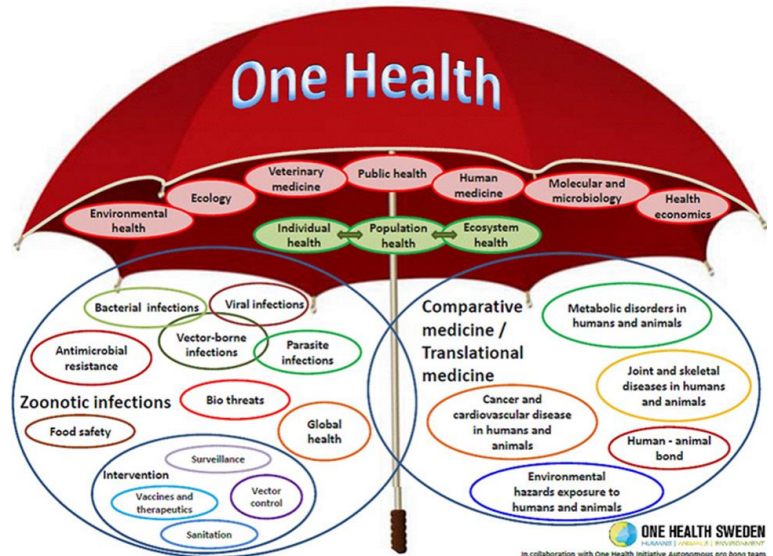


Contamination of tomato by *Salmonella spp.* (Zarkani et al. 2019 ; Ferelli et al. 2020).

- *in planta* colonization
- Abscisic acid biosynthesis > stomata opening



One Health: where are plants?



Environment ?

Food security and/or safety?

One Health: the oncoming arise of plants



The implementation of One Health requires a paradigm shift in how we manage the health of people, animals, plants and the ecosystems which support them.



2. Past and current plant diseases do impact human or animal health

Since a long time ago ...



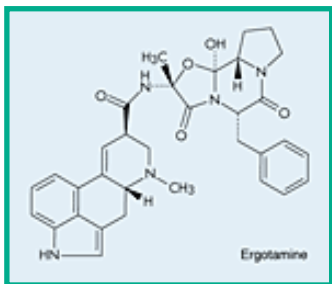
Ergotism : both a medieval threat to crops and a human epidemics

Claviceps purpurea

Ergotamine

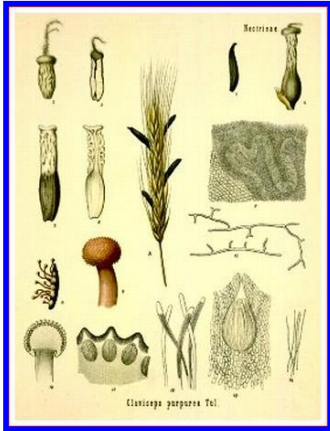
1096, 1565, 1690 ...

St Anthony's fire / ardens' evil



**Qualitative impact
of a plant disease
> humans & animals**

And an increasingly serious issue...



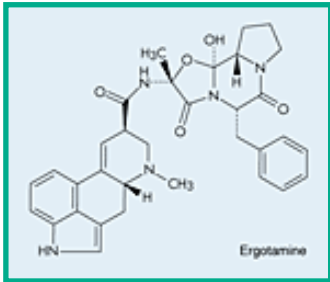
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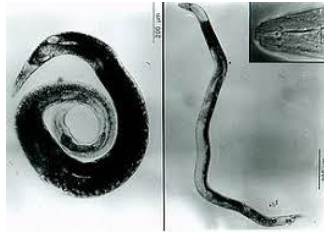
**Qualitative impact
of a plant disease
> humans & animals**

And in all continents...

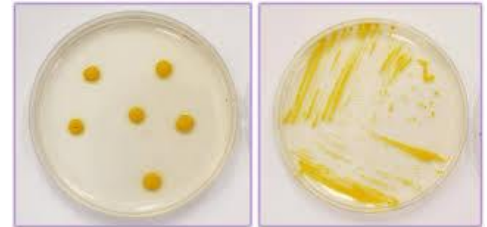
The plant parasitic nematode *Anguina funesta* in Australia and in the USA



Ryegrass annual
Lolium rigidum



Anguina funesta



Rathayibacter toxicus



**A cascade of infections:
nematode>plant>animal**

From the environment to agriculture + human health: invasive exotic weeds

The ragweed *Ambrosia artemisiifolia*



Highly allergenic pollen
5 pollens/m³ of air
Rhinitis, conjunctivitis, asthma
From summer to fall



A weed which impact both crops cultivation and human health

From agriculture to human medicine:

Resistance to azoles

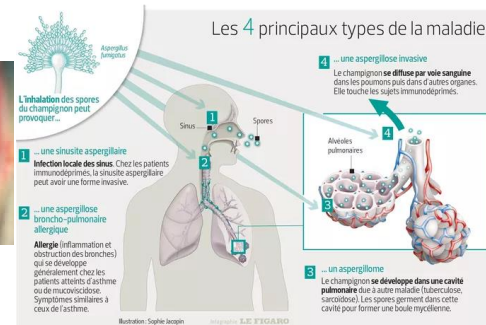
Nosocomiales infections : fungi *Candida albicans* (yeast) + *Aspergillus fumigatus*

Ranks 10 in diseases linked to treatments 4e

Induces sepsis in hospital, 40% 30 days lethality



Candida albicans



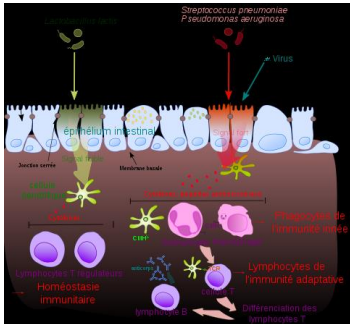
lefigaro.fr

Selection pressure induced by antifungals extensively sprayed in the environnement
Emergence of resistant strains

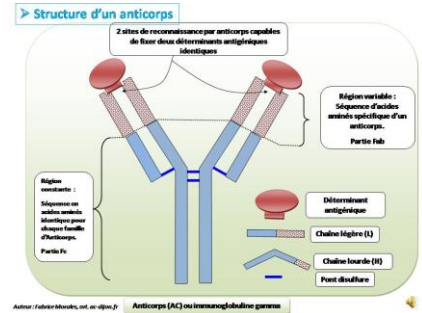
3. A set of common defence features: One Immunity?



Distinct immunities: to what extent?



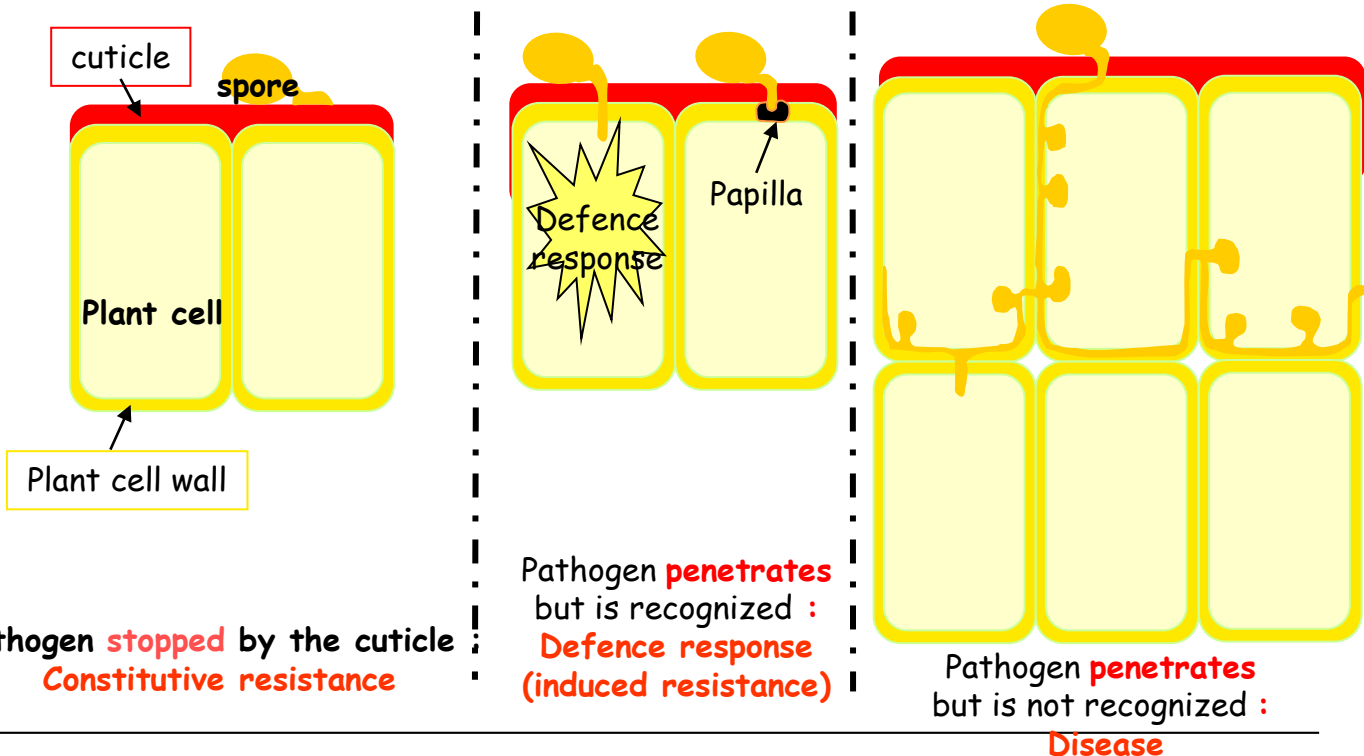
Animal immunity:
 mobility
 diversity
 specificity



Innate & acquired immunities
 Circulating dedicated cells
 MHC and Ag/Ab immunity

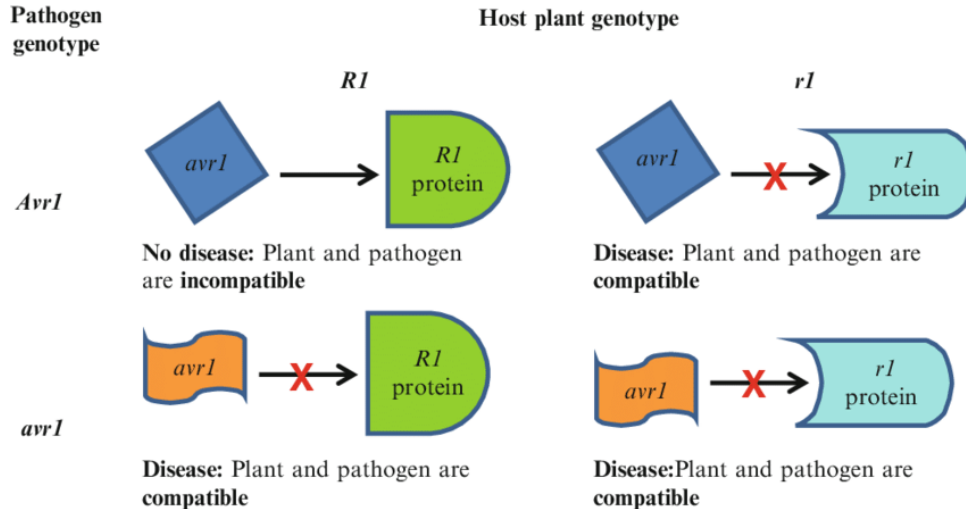
Distinct immunities: to what extent?

Plant immunity: a question of frames in plant pathogen interactions



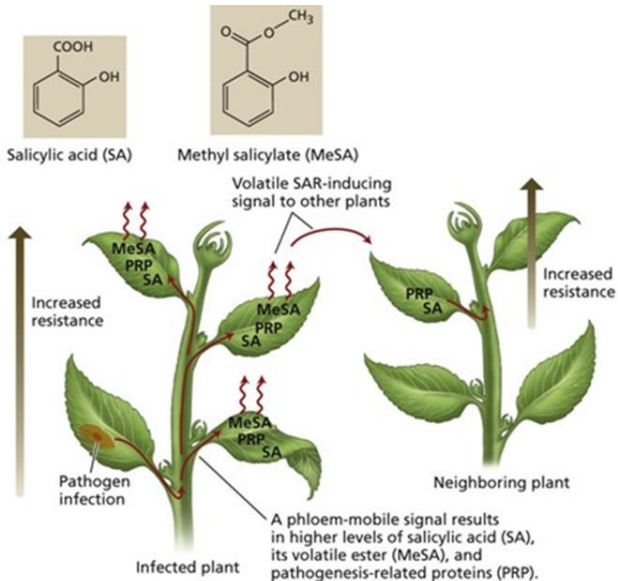
Distinct immunities: to what extent?

Plant immunity: no antibody, but **specificity takes place**



The gene-for-gene relationship Flor (1947)
(modified from Hammond-Kosack and Jones, 2000)

A question of scales and levels...



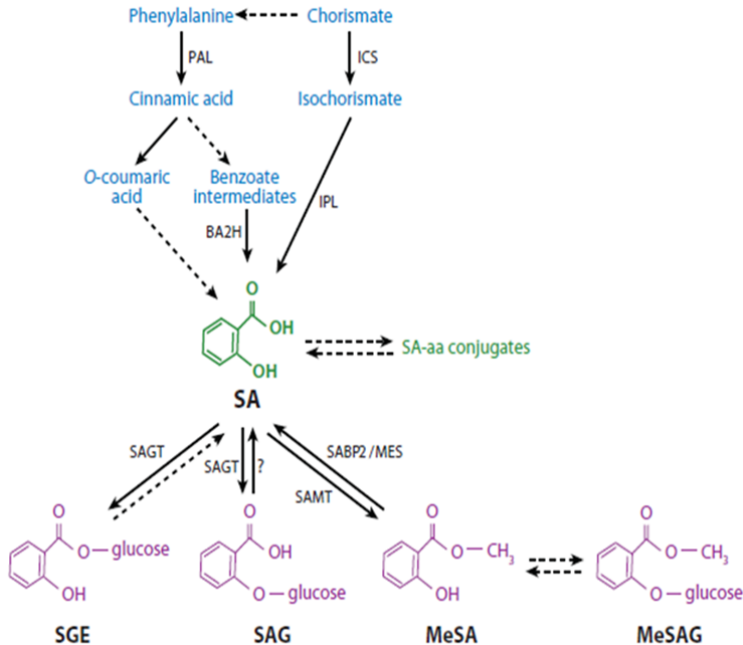
(Erika Keshishian)

At the physiological scale

No circulating cells
but **systemic acquired** resistance (SAR) &
immunity **signaling** in plants

A question of scales and levels...

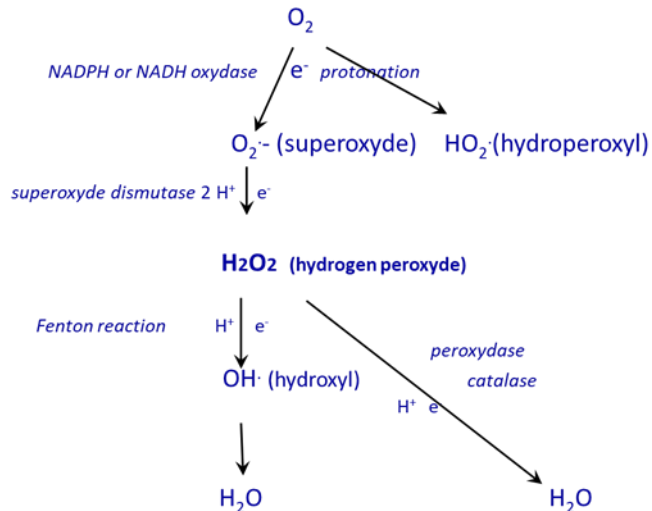
At the biochemical level



Salicylic acid (SA)
&
phenylpropanoid pathway

A question of scales and levels...

At the biochemical level



Reactive oxygen species (ROS)

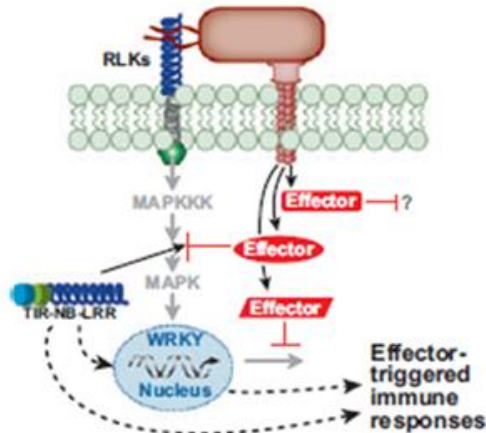
From Hammond-Kosack and Jones, 1996)

A question of scales and levels...

At the molecular level

R proteins recognize
effector activities

Resistance



TIR: Toll-interleukin 1 receptor
Toll-homologue

R gene-mediated resistance: R products recognize effectors and induce ETI

1. Contribution of Anses to One Health at the plant level



onehealthjp.eu

One Health EJP

2018-2023 : Anses coordinates 'One Health' EJP

44 partners

20 MSs from the UE

In France : INRAE, Institut Pasteur & Santé Publique France

29 projects – 90 M€

Knowledge & expertise progress :

Food-related zoonosis

Antibioresistance



Corresponding emerging risks



EFSA & One Health: a plant focus



SIDE EVENT: HOW DOES ANTIBIOTIC RESISTANCE IN PLANT PATHOGENIC BACTERIA IMPACT 'ONE HEALTH'?

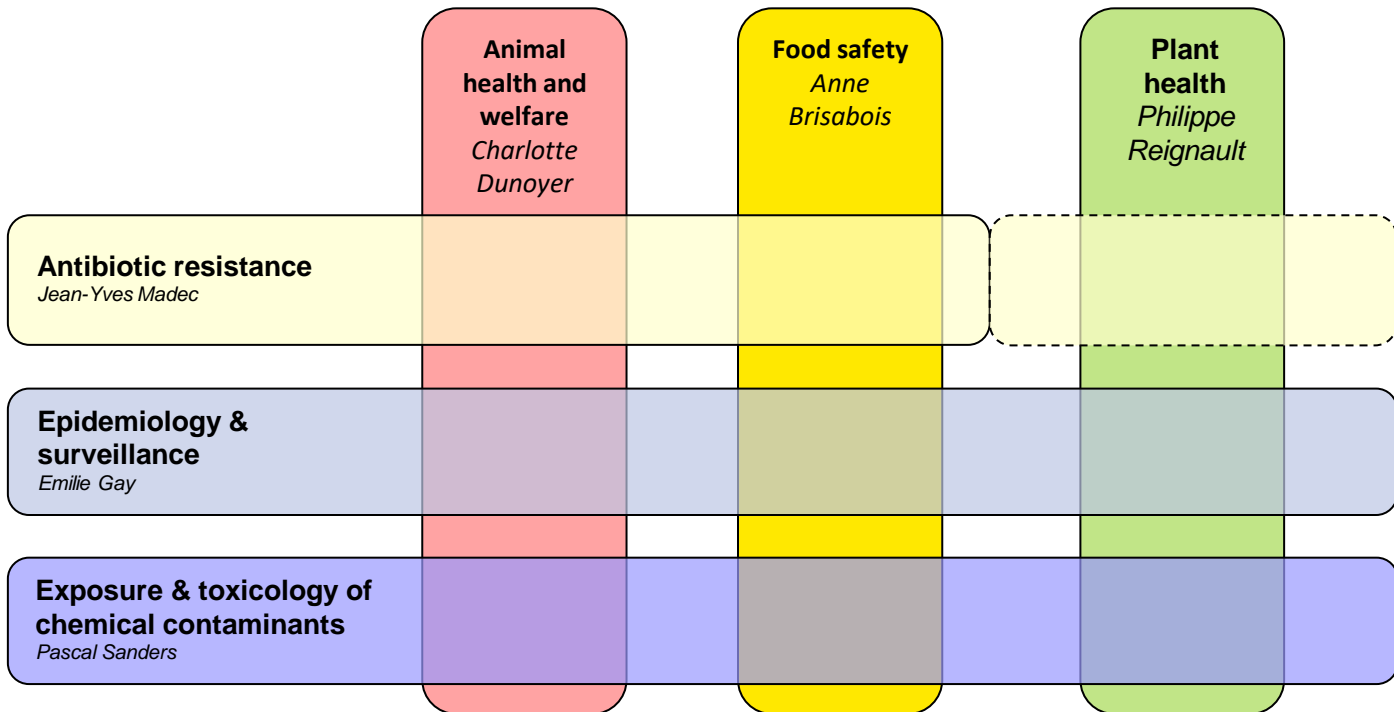
PLANT

Exchange and collection of data on:

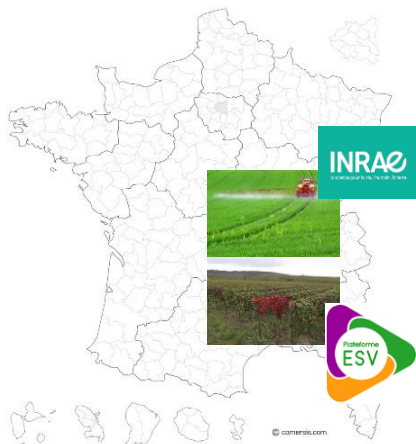
- i) the **use** of antibiotics for controlling plant pathogenic bacteria
- ii) the antibiotic **resistance** in plant pathogenic bacteria
- iii) **alternative measures** for controlling plant pathogenic bacteria

+ connection with established networks in the areas of **animal & human health**

6 strategic transversal lines for the 9 Anses laboratories



Plant Health in 2 Anses labs



1 theme

4 distincts missions:

- Reference
- Research
- Contribution to surveillance
- Risk assesement & expertise

2 laboratories : PHL(LSV) & Lyon Laboratory

6 + 2 + 2 units : USC CASPER & EAS

USC INRAE CASPER: CAractérisation et Suivi des PhEnomènes de Résistance aux produits de protection des cultures

CHARACTERIZATION AND MONITORING OF RESISTANCE TO CROP PROTECTION PRODUCTS

EAS unit: Epidémiologie et Appui à la Surveillance - **EPIDEMIOLOGY & SURVEILLANCE SUPPORT**

The Plant Health laboratory: geographical and disciplinary distributed organization

NEMATOLOGY

Rennes

EURL PLANT PARASITIC NEMATODES

MYCOLOGY

Nancy

EURL FUNGI & OOMYCETES

Angers

- DIRECTION & GENERAL AFFAIRS
- 2 transversal units :
- REFERENCE COORDINATION (UCR)
- **EXPERTISE ON BIOLOGICAL RISKS (ERB)**
- 1 thematic et technical unit:
- BACTERIOLOGY, VIROLOGY, **GMO**
- **detection (BVO)**

QUARANTINE

Clermont-Ferrand

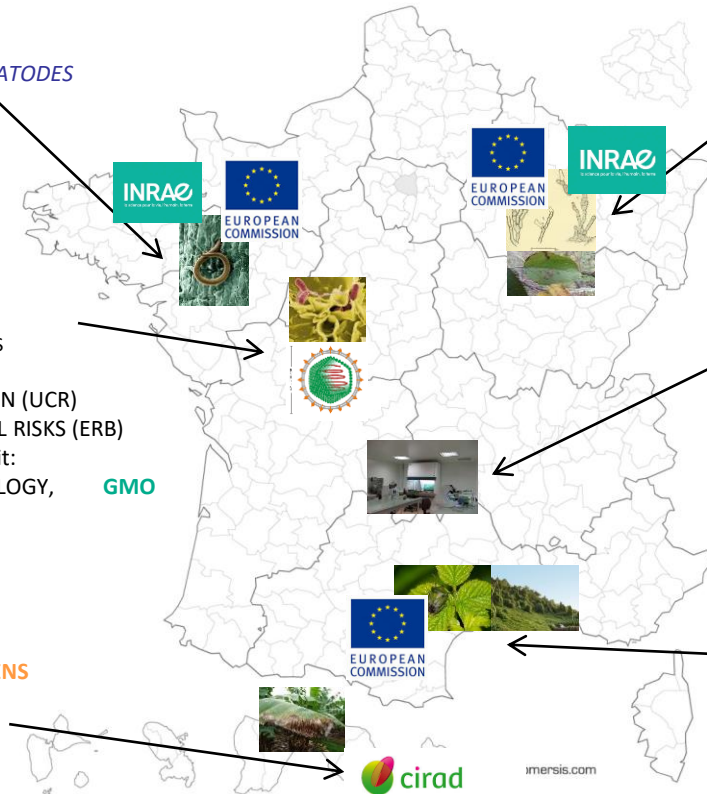
TROPICAL PESTS & PATHOGENS (RAPT)

Saint-Pierre (La Réunion)

ENTOMOLOGY & BOTANY

Montpellier

EURL INSECTS & MITES



3 specific missions, 3 EURLs, 3 research partnerships

LSV research projects with a OH approach

EVAGlobal (H2020 - UE structure)

- 38 partners (BVO unit)
- Provision of viral strains (human, animals & plants)
- 10 isolates provided by LSV

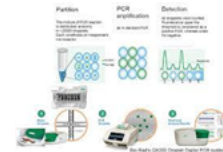


DIGIDIAG (internal AMI Trans):

Contribution of digital PCR to diagnostic – OH approach

BVO + RAPT, 5 Anses laboratories – 7 units

Plant, animals, food, water



PARAVIR (internal AMI Trans): detection of viruses in parasites (nematodes)

5 laboratories (LSV)



LSV research projects with a OH approach

Anses-INRAE PhD to start on September 2020:



**Conditions for the emergence of an invading fungal pathogen:
Cryptostroma corticale on sycamore maple (Syco-Protect)**

**Sooty bark disease (SBD)
spores induce human respiratory pathologies (asthma, pulmonary
granulomatosis)**



- **From endophyte to pathogen?**
- **Maple tree microbiote?**
- **Genetic diversity of *C. corticale*?**

From vector control to insect pests control



Network of research infrastructures on vectors of emerging diseases and crop pests – Montpellier

Vector and pest control

Insecticides/biocides

Mechanical approaches: traps

Biological control : bacteria & viruses

Steril insect technique : *Drosophila suzukii* & *Ceratitis capitata*



The contribution of risk assessment

December 2015

<https://www.anses.fr/fr/system/files/SANTVEG2014SA0199Ra.pdf>

Assessment of plant health risks associated with *Ophraella communa*, an insect pest for
ambrosia ragweed

June 2019

<https://www.anses.fr/fr/system/files/SANTVEG2015SA0078Ra.pdf>

Effectiveness of the beetle *Ophraella communa* used as a biological control agent against
ragweed and assessment of possible associated risks



The contribution of risk assessment

December 2018

<https://www.anses.fr/fr/system/files/SANTVEG2016SA0066Ra.pdf>

Pest risk Assessment of giant hogweed



<https://www.dec.ny.gov/animals/72556.html>

The contribution of risk assessment

On going: request No. °2020-SA-0005

Analysis of data from Poison Control Centers concerning exposure to armyworms emitting stinging hairs and analysis of the health risks associated with exposure to these caterpillars and development of management recommendations



Thaumetopoea pityocampa



Thaumetopoea processionea



Thank you so much!

