Welcome to the Webinar

FDA-iRISK® 4.0
A Comparative Risk Assessment Tool

July 6, 2017

Today's Speakers

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Acknowledgements:

- Susan Mary Cahill, FDA (moderator)
- JIFSAN staff (webinar support)

Purpose of Webinar

To introduce FDA-iRISK 4.0, enhanced version of FDA's publicly available food safety risk assessment tool. Available at https://irisk.foodrisk.org.

Today's Presentation

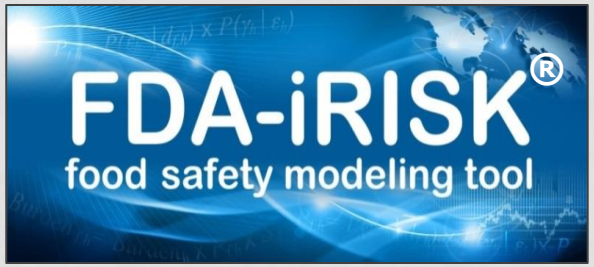
- Overview – purpose of FDA-iRISK
- How FDA-iRISK works
- New features in version 4.0
- Demonstration, examples
- Summary

Overview – Purpose of FDA-iRISK

What is FDA-iRISK?

An interactive, Web-based system that enables users to relatively rapidly conduct fully quantitative, fully probabilistic risk assessments of food-safety hazards.

- underwent three external peer reviews of the underlying structure and mathematical equations:
  1st focused on microbial risk assessments
  2nd focused on chemical risk assessments
  3rd focused on 2D simulation and other advanced features



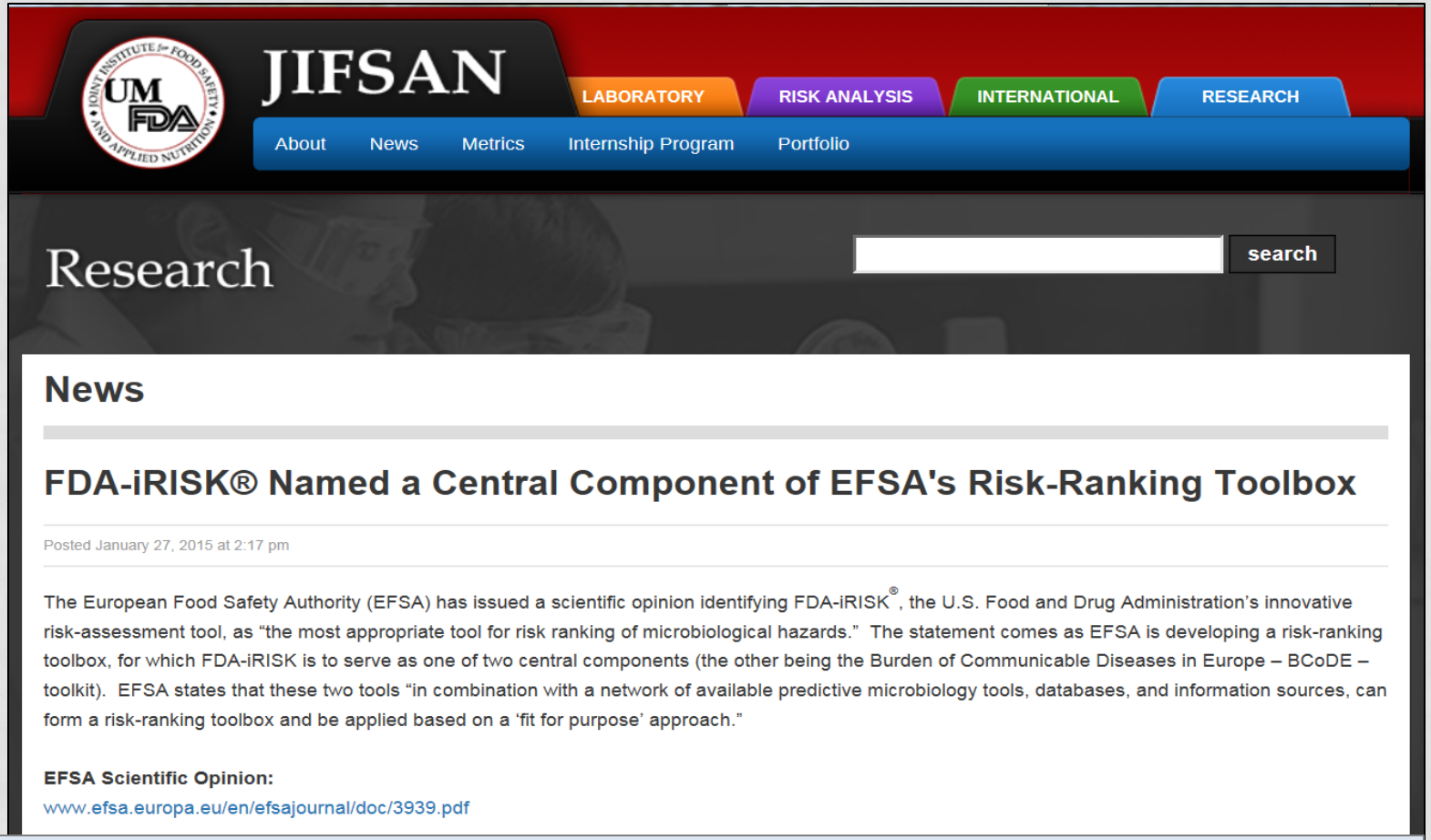
Enhancements in v4.0:
New features added to FDA-iRISK since the second launch in 2015

Why is it important to have FDA-iRISK?

- Allows risk comparisons across many dimensions
  - Hazards, foods, processing/handling practices, population groups
- Predicts risks / compares burdens of illnesses for microbial and chemical hazards
  - Ranks them, e.g. 50 food-hazard pairs, based on a common metric
- Quantifies / compares effectiveness of interventions
  - Enables users to conduct what-if scenarios to predict risk reductions
- Separates/ quantifies impact of variability from that of uncertainty in outcomes of a risk assessment

Faster, user-friendly information for timely decisions

Feedback on FDA-iRISK



Risk managers, FDA-iRISK peer review panels, and the EFSA panel, identified probabilistic uncertainty characterization as a key area for further development (now available in v4.0)

FDA-iRISK Development: A Collaboration of Experts

- Peer reviews (I,II&III) experts from:
  Univ. Maryland, Univ. Florida, Technical Univ. Denmark, George Washington Univ. Med. Center, Johns Hopkins Bloomberg Sch. Public Health, Rutgers Robert Wood Johnson Med. School, Coleman Sci. Consulting, Exponent, Texas A&M University, CFIA, ANSES

- Beta-testing experts from:
  Rutgers Univ., Univ. Florida, Technical Univ. Denmark, ANSES/EFSA work group, BfR, Swedish National Food Agency, CFIA, Health Canada, Unilever, Nestle, USDA/FSIS

What FDA-iRISK can do – Example: Rank Risks from Hazards in Single Food and Multiple Foods

Scenario	Lifecourse Duration	Eating Occasions or Consumers	Total Illnesses	Mean Risk of Illness	Total DALYs per Year	DALYs Per EO or Consumer
L. monocytogenes in Cantaloupe	N/A	5.98E+8	40.0	6.70E-8	103	1.73E-7
Salmonella in Peanut Butter	N/A	1.70E+10	3340	1.96E-7	63.4	3.73E-9
L. monocytogenes in soft ripened cheese	N/A	1.89E+9	3.36	1.77E-9	19.2	1.02E-8
Aflatoxin B1 in Tortilla Chips	77	2.50E+7	0.811	3.24E-8	15.7	6.30E-7
C. sakazakii in Powdered Infant Formula	N/A	9.33E+6	0.870	9.33E-8	38.8	4.16E-6
Inorganic Arsenic in Multiple Foods_Apple Juice_Pear Juice_White Rice_Brown Rice	50	1.00E+6	0.802	8.02E-7	9.53	9.53E-6
Inorganic Arsenic in Apple Juice	50	1.00E+6	0.126	1.26E-7	1.50	1.50E-6

Note: risk estimates based on data and assumptions made; for illustration purposes only.
Arsenic scenarios based on FDA risk assessment for apple juice (2013,draft) and rice (2016).

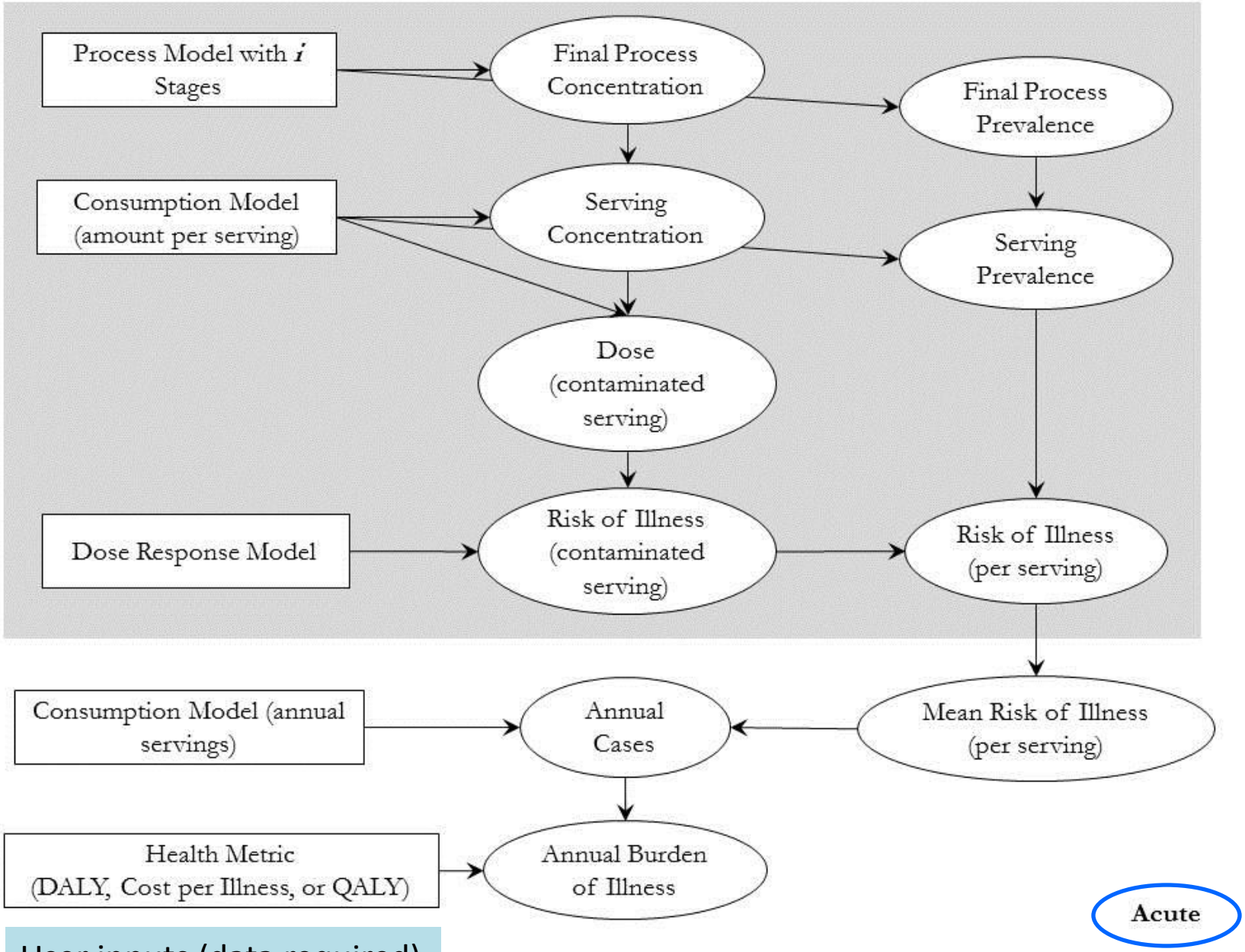
Generate a full report, including a summary of risk estimates, ranking results, data, and rationale

How does FDA-iRISK work?

Risk Scenarios in FDA-iRISK

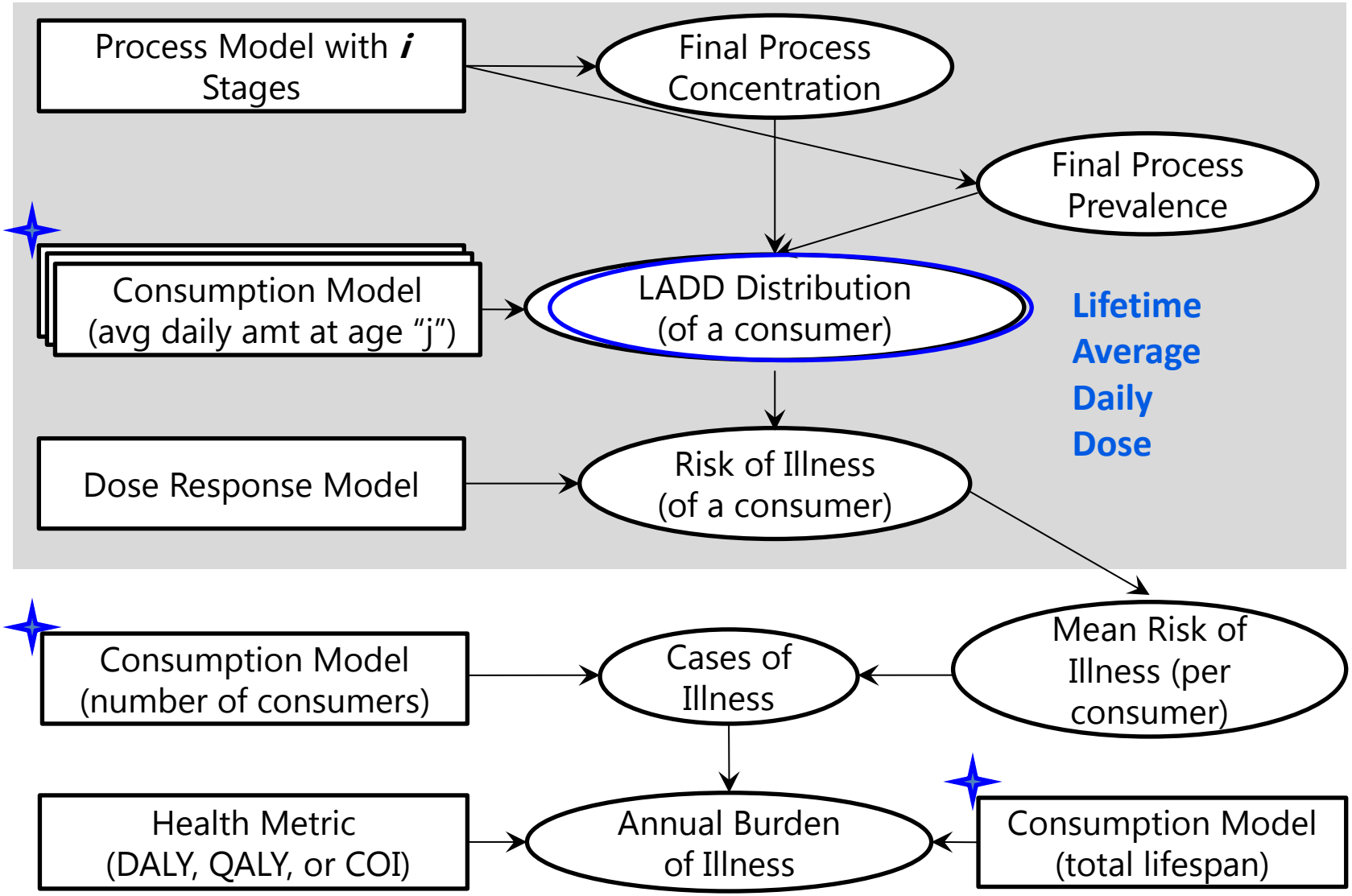
- FDA-iRISK directly connects probability and consequence through specification of a Risk Scenario (a risk assessment model)
  - Specific to food-hazard combinations
  - Describing various key aspects of the hazard, the food, and the processing of the food as it relates to the fate of the hazard within the food.

FDA-iRISK Model Structure (Microbial Hazards)



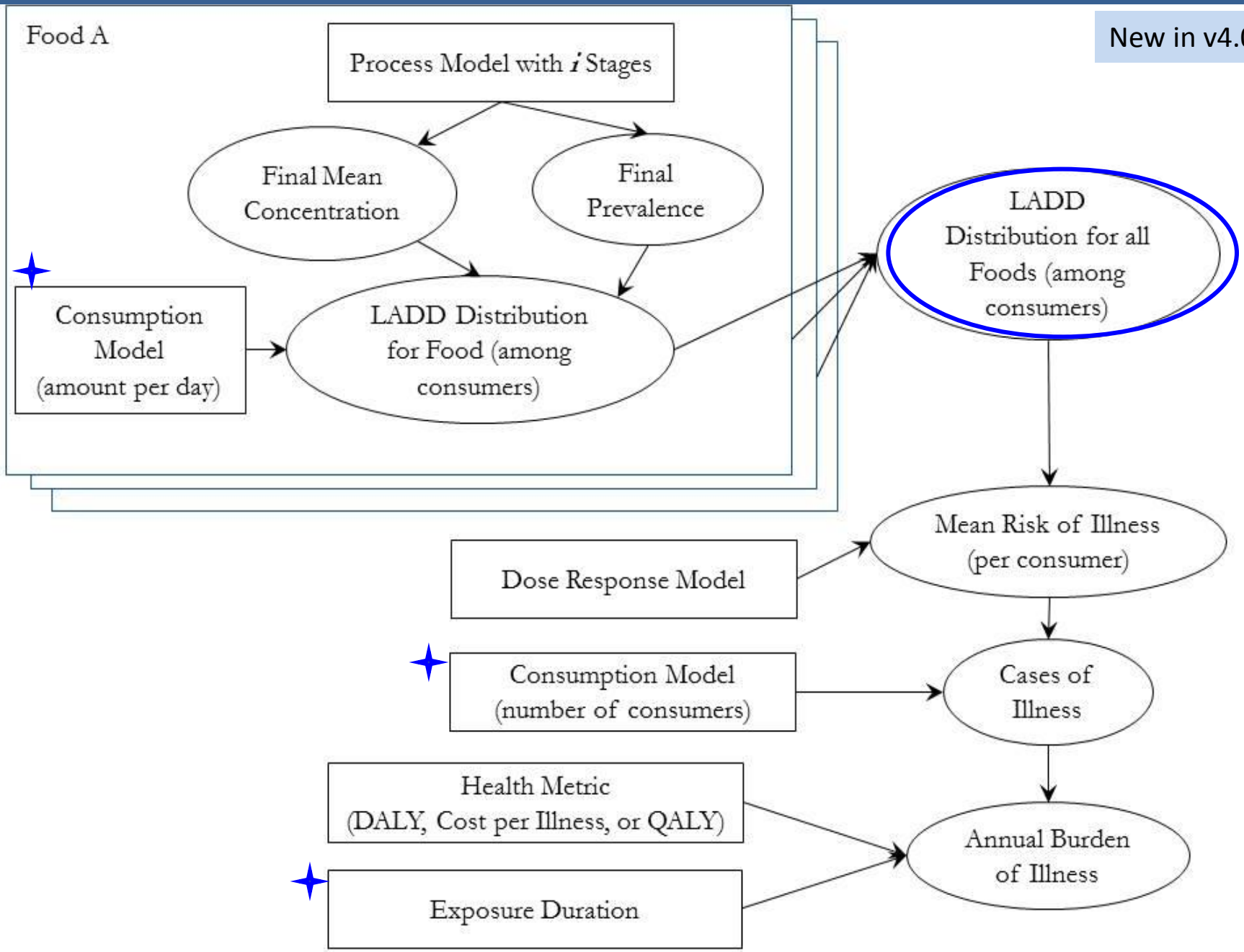
User inputs (data required)

FDA-iRISK Model Structure (Chronic Chemical Hazards)



FDA-iRISK Model Structure (Chronic Chemical Multifood)

New in v4.0



Any questions about the overview and how FDA-iRISK works?

Send a note to the Q&A box

New Features in FDA-iRISK 4.0

Web Interface: Users Access, Create, Save and Share Scenarios

Home

FDA-iRISK is a web-based system designed to analyze data concerning microbial and chemical hazards in food and return an estimate of the resulting health burden on a population level.

The data required to execute this analysis include the food and its associated consumption data and processing/preparation methods, the hazard and its dose-response curve, and the anticipated health effects of the hazard when ingested by humans. Each of these elements contributes an essential piece of information to the model on which the final estimate of risk is based.

When you register, you will be assigned your own personal workspace in which to model food/hazard risk scenarios. You may also share this workspace with others to view.

For a complete description, review the Quick Start Tutorial and User Guide on the Help page before beginning.

For a list of major changes from Version 4.0, view the What's New in FDA-iRISK 4.0 page.

Please Login or Register.

Suggested Citation

Where the FDA-iRISK system is used in risk assessment research and other food safety activities, reference to the system should be made as follows:

Food and Drug Administration Center for Food Safety and Applied Nutrition (FDA/CFSAN), Joint Institute for Food Safety and Applied Nutrition (JIFSAN) and Risk Sciences International (RSI). 2017. FDA-iRISK® version 4.0. FDA CFSAN. College Park, Maryland. Available at https://irisk.foodrisk.org/.

Major New Features added to FDA-iRISK 4.0

- Advanced modeling capacities
- Data importing/uploading and sharing
- Results reporting
- Ease of use and web interface navigation

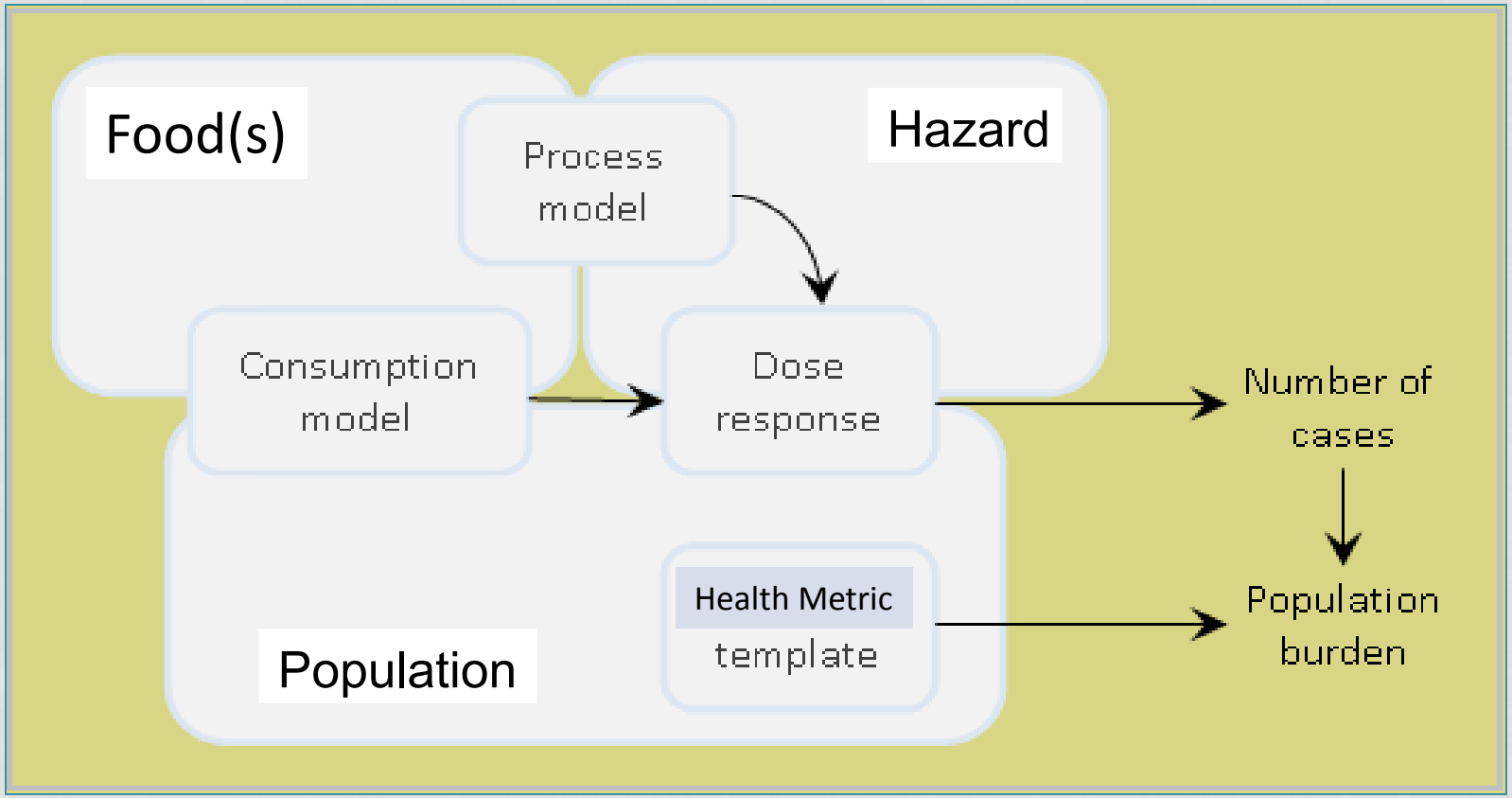
… in response to peer review III, and comments on long term development from peer reviews I&II

New Features in FDA-iRISK 4.0

- Enhancement of 2D Monte-Carlo simulation engine
  - probabilistic variability and uncertainty analysis (single food or multifood scenarios)
- Incorporation of predictive microbiology models
- Data import utility
- Exposure-only ranking
- Descending dose-response curves (to evaluate benefit)
- Definition of a diet and shift in patterns
- Process type for cross-contamination and sampling
- Parallel process models
- Linked process models
- Microbial concentration to toxin linkage for toxigenesis
- General improvements to user interaction with interface
- Enhanced reporting and graphics

And more…

Seven Elements of a Risk Scenario (Risk Model) in FDA-iRISK



Simulation in FDA-iRISK: Parameter Sets

- A model consists of a "set" of parameters, e.g.

  {Initial Unit Size, Initial Prevalence, Initial Concentration,
  Mean Log Increase, Amount Consumed/Eating Occasion,
  Number of Eating Occasions, DR Model parameter(s),
  P_{ill} | Response, DALY/case}.

- Each parameter can be defined as a fixed, variable, or uncertain value. Uncertainty can be also be applied to parameters of a variability distribution.

Simulation in FDA-iRISK: Parameter Sets

- Example: this scenario has 2 variable parameters and 2 uncertain parameters

Parameter Name	Definition Type	Definition
Initial Unit Size	Fixed	100 g
Initial Prevalence	**Uncertain**	**beta(3, 99)**
Initial Log Concentration	**Variable**	**triangular(0,0,1)**
***Mean* Log Increase (growth)**	**Uncertain**	**uniform(1,2)**
StdDev Log Increase	Fixed	0.03
Amount / Eating Occasion	**Variable**	**triangular(30,60,90) g**
Number Eating Occasions	Fixed	2E8
Beta-Poisson alpha	Fixed	0.15
Beta-Poisson beta	Fixed	550
P Illness given Response	Fixed	100%
DALY/case	Fixed	0.031

2D Monte Carlo Simulation in FDA-iRISK

- Variability parameters vary iteration by iteration
- Uncertainty parameters vary Variability Simulation to Variability Simulation (each is thousands of iterations)
- Evaluates convergence

		Simulation 1: 2 different iterations		**Simulation 2:** 2 different iterations	
Fixed	100 g	100	100	100	100
Uncertain	beta(3, 99)	**0.041**	**0.041**	**0.015**	**0.015**
Variable	triangular(0,0,1)	0.006	0.910	0.055	0.014
Uncertain	uniform(1,2)	**1.11**	**1.11**	**1.07**	**1.07**
Variable	triangular(30,60,90) g	72.2	43.5	59.0	61.8
Fixed	2E8	2E8	2E8	2E8	2E8
Fixed	0.031	0.031	0.031	0.031	0.031

2D Monte Carlo Simulation in FDA-iRISK

- Simulation Settings (default settings below)
- Settings are user-customizable; can define multiple sets of settings

Instructions | Report History | New Report | Simulation Settings

Use the fields below to manage the settings used for variability and uncertainty for risk estimates and ranking reports.

Variability Settings		Uncertainty Settings	
Variability Initial Batch Size:	9,000	Uncertainty Batch Size:	100
Variability Running Batch Size:	3,000	Uncertainty Convergence Tests:	1
Variability Convergence Tests:	3	Uncertainty Maximum Batches:	100
Variability Maximum Batches:	100	Uncertainty Convergence Criterion - Mean (%):	5
Variability Convergence Criterion (%):	1	Test Uncertainty Median:	Yes
Endpoint to Test:	Risk (if available)	Uncertainty Convergence Criterion - Median (%):	5
		Test Uncertainty Confidence Interval:	Yes
		Uncertainty Confidence Interval:	90%
		Uncertainty Convergence Criterion - Confidence Interval (%):	10

2D Monte Carlo Convergence in FDA-iRISK

9000 iterations — Batch 1: mean #1

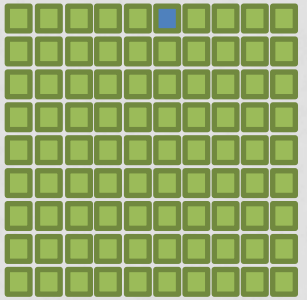
+3000 iterations — Batch 1&2: mean #2

+3000 iterations — Batch 1,2&3: mean #3

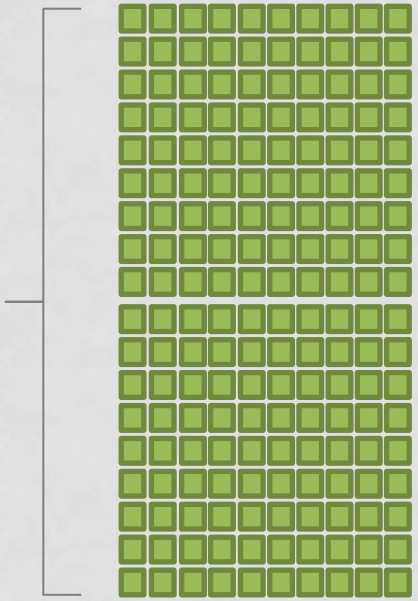
+3000 iterations — Batch 1,2,3&4: mean #4

Converged (variability) if:
mean #(n) = mean #(n+1) ±1%
mean #(n+1) = mean #(n+2) ±1%
mean #(n+2) = mean #(n+3) ±1%

1 Uncertainty Simulation ✓



Batch 1:
100 iterations of converged simulations
mean #1,
median #1,
interval 90% #1



Converged (uncertainty) if:
mean #(n) = mean #(n+1) ±5%
median#(n) = median#(n+1) ±5%
interval90% #(n) =
interval90% #(n+1) ±5%

Batch 1&2: +100 iterations of converged simulations
mean #2, median #2, interval 90% #2

What v4.0 can do – example: probabilistic modeling of uncertainty

Risk estimates show uncertainty results in percentiles

Ranking Summary

All reported summary values are per year. For chronic scenarios, results for the total lifecourse have been divided by the lifecourse duration (e.g. 70 years) specified for the life stages included in the scenario.

Scenario or Scenario Group	Total DALYs per Year	Uncertainty Results
Salmonella in Peanut Butter	64.6	Min:61.8, 5th:61.9, Median: 64.6, Mean: 65.2, 95th: 69.8, Max: 71.5
Inorganic Arsenic in Multiple Foods_Apple Juice_Pear Juice_White Rice_Brown Rice	9.53	Min:8.55, 5th:8.66, Median: 9.53, Mean: 9.53, 95th: 10.4, Max: 10.5

Note: All chronic results have been computed by dividing the total for the lifecourse by the duration of the lifecourse in years to provide a yearly value for ranking. See the detailed results sections for the complete lifecourse results, or multiply the values shown in this summary by the duration of the lifecourse.

Available Process Types

Microbial Hazards

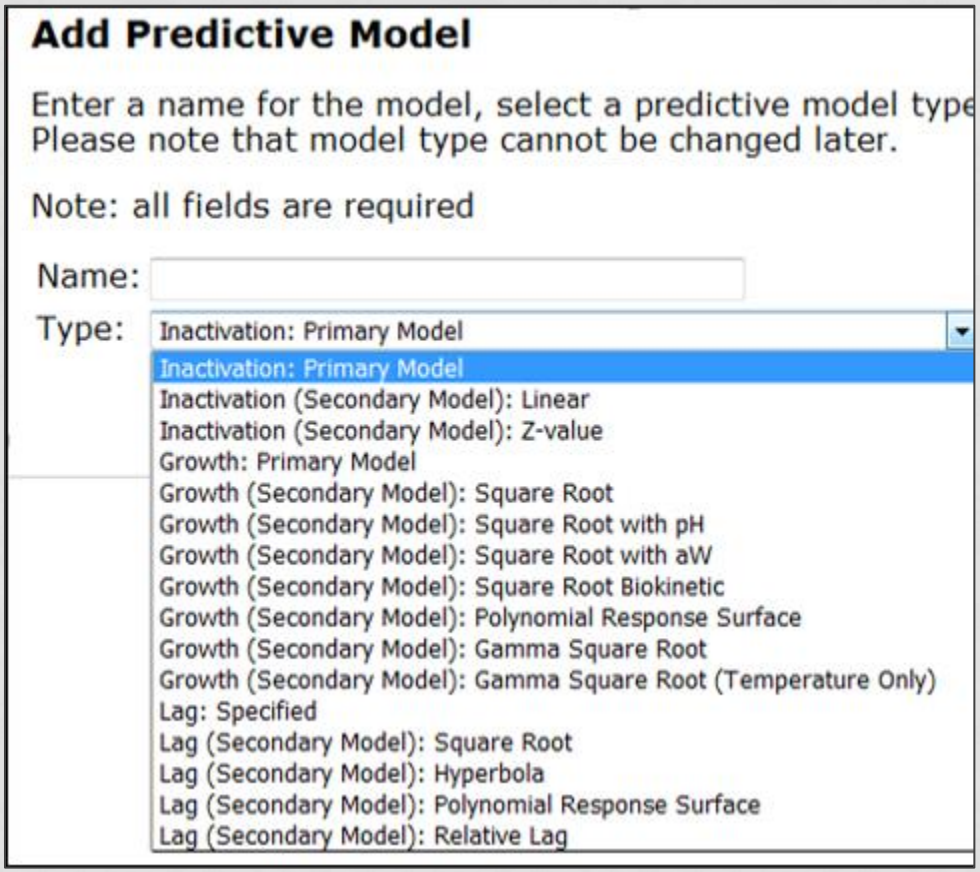
- No Change
- **Growth (2 options)** new
- Addition (e.g., rare events)
- **Cross contamination (2 options)** new
- **Decrease (2 options)** new
- Pooling
- Partitioning
- Evaporation/dilution
- Redistribution (partial or total)
- **Sampling (2 options)** new
- Set maximum population density

Chemical Hazards

- No Change
- Addition
- Decrease
- Pooling
- Partitioning
- Evaporation/dilution
- Redistribution (partial or total)
- **Sampling** new

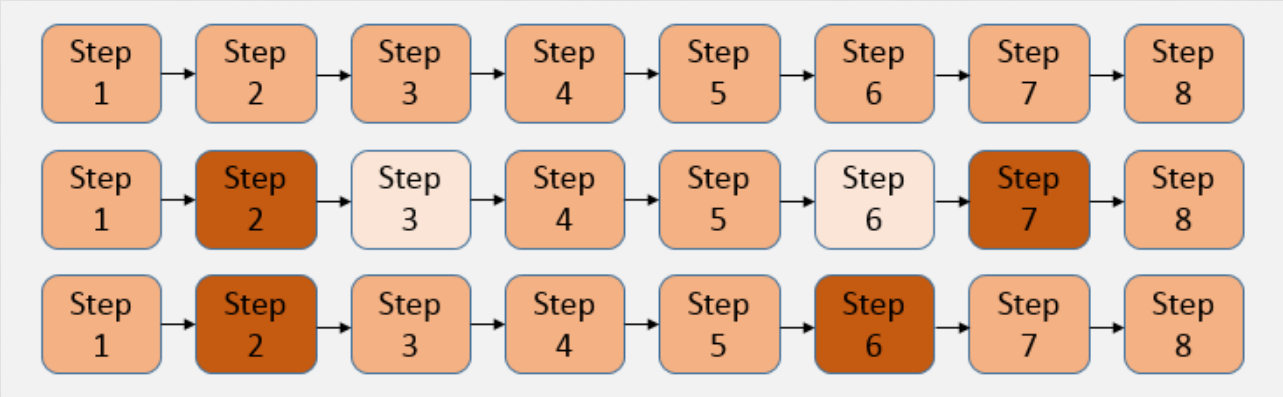
Predictive Models in FDA-iRISK

- FDA-iRISK supports a wide range of mathematical models predicting growth or inactivation based on user-defined conditions.
- Predictive models are defined as a part of the hazard model, and are implemented in the process model as process stages.



New Options Example: the Parallel Process Model

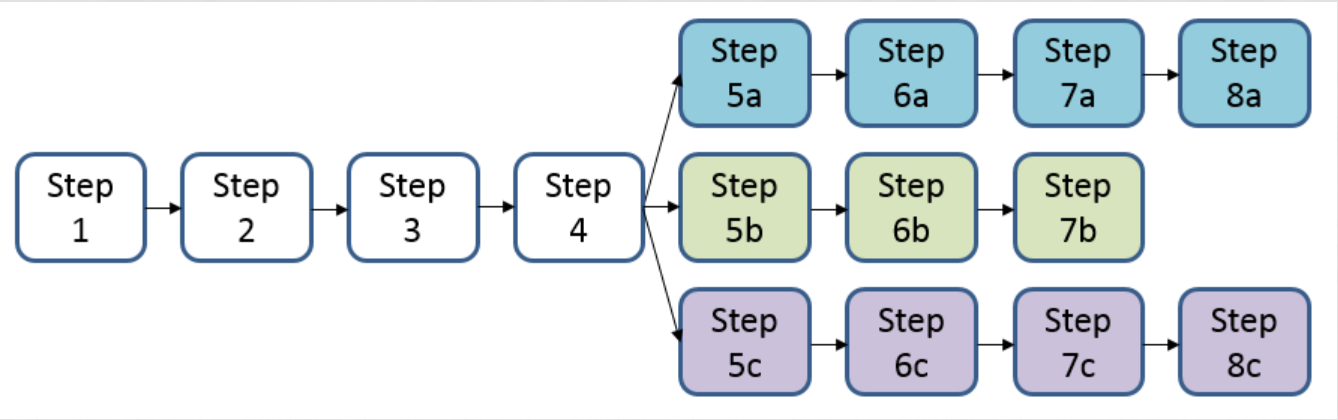
- ***Challenge:*** The sequence of processing steps are substantially the same, but details vary over several facilities (or sites, or consumers)



- ***Option:*** Define a single (baseline) model, and variations are added as required

New Options Example: Linked Process Models

- ***Challenge:*** An ingredient or raw material is made into different products, or a food product is subjected to diverse practices in consumer preparation.



- ***Option:*** Use linked process models with a single upstream model linked to diverse downstream models

Consumption Models

- Acute exposure
  - Assume illness can follow any single eating occasion
  - Dose depends on amount of food eaten per person per eating occasion
  - Eating occasions per year used to scale illness
  - Microbial pathogens, in certain situations: chemicals
- Chronic exposure
  - Assume long-term exposure precedes illness
  - Dose depends on avg. amount of food eaten per person per day
  - Number of consumers used to calculate illness
  - Most chemicals

What v4.0 can do – Example: Importing Consumption Data

Name: Children_1-6 year

Age and Gender (end age must be greater than start age):

Gender	Start: Year	Month	End: Year	Month
Both	1	0	6	11

Average Daily Consumption:

Units:	g per kg-day
Distribution:	Empirical (linear) Import

The cumulative empirical distribution (cubic or linear) is used to enter a distribution using cumulative probability/value pairs.

It may be entered as a table (default) or in a textbox.

When entered as a table, insert, delete or add rows as required. When entered in a textbox, each pair must be on a separate line and the format must be "cumulative probability,value" (e.g. 0.1, -3).

Enter as Table

Probability	Value	Actions
0	0	Insert Delete
0.1	0	Insert Delete
0.2	0	Insert Delete
0.25	0.002	Insert Delete

Import Empirical Distribution

Specify the file type and parameters, then select a file to import.

Note: all fields are required

File Type: Excel Update

Start Row:	1
Start Column:	1
Number of Header Rows:	1
Number of Rows to Import:	18
Number of Columns to Import:	2
Select file:	H:\FDA-iRISK\Roll Out\La Browse...

Preview Data Cancel

Import Empirical Distribution

Column 1	Column 2
0	0
0.1	0
0.2	0
0.25	0.002
0.3	0.024
0.4	0.082
0.5	0.593
0.6	3.247
0.7	5.436

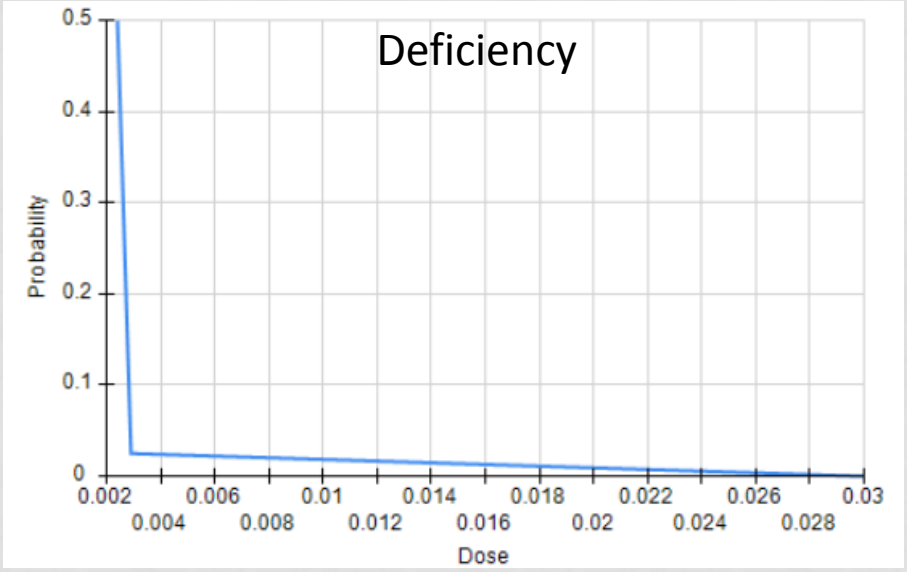
Specify the probability column:	Column 1
Specify the value column:	Column 2

Previous Import Data Cancel

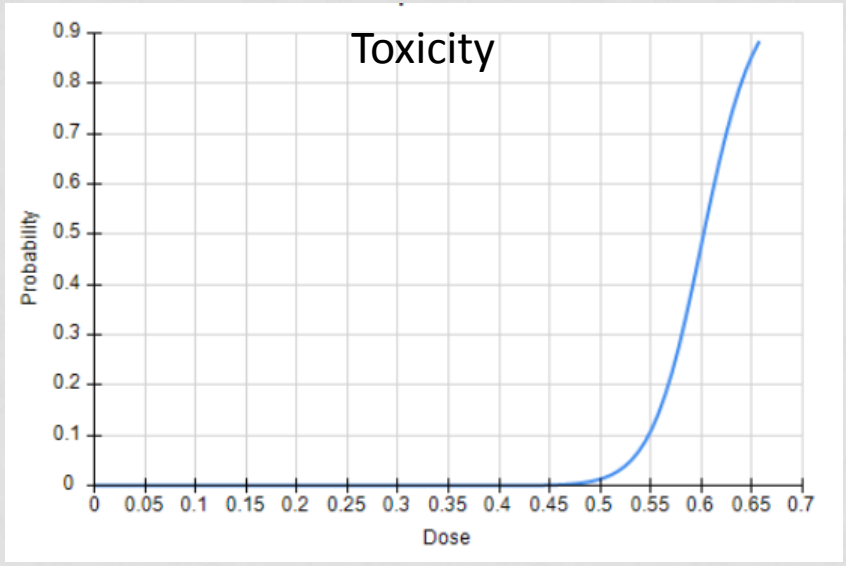
What v4.0 can do – Example:
New Features Enable Comparing Risks from Different Dietary Patterns

Instructions | Name and Parameters | Consumption Models (13/13) | Dose Responses (2/2) | Diets | Notes (0)

Dose Response	Health Metric	Include
Chronic Manganese Deficiency	Chronic Manganese Deficiency (6.50E-6)	☑
Log-logistic DR for Manganese Toxicity	Chronic Manganese Toxicity (0.110)	☑



mg/kg-day



mg/kg-day

monotonically decreasing dose response coupled with increasing dose response

What v4.0 can do – Example: Comparing Risks among Consumers with Different Dietary Patterns

Dose Response	Health Metric	Probability of Illness for Life Course	Number of Illness for Lifecourse	Total Metric for Lifecourse (DALYs)
Chronic Manganese Deficiency (Hazard: Manganese) Empirical (Dose unit: mg/kg-day) ((0.0024,0.5), (0.0029,0.025), (0.03,0.0)) Probability of adverse effect: 100%	Chronic Manganese Deficiency (6.50E-6 DALYs)			
	Baseline :	0.000454	1.43E+5	0.929
	0.5 x baseline :	0.00131	4.13E+5	2.68
	2 x baseline :	4.55E-6	1430	0.00932
Log-logistic DR for Manganese Toxicity (Hazard: Manganese) Log-Logistic (Dose unit: mg/kg-day) Intercept: 11.79 Slope: 23.23 Probability of adverse effect: 100%	Chronic Manganese Toxicity (0.110 DALYs)			
	Baseline :	4.29E-31	1.35E-22	1.49E-23
	0.5 x baseline :	1.83E-31	5.77E-23	6.35E-24
	2 x baseline :	2.40E-30	7.56E-22	8.32E-23

Note: for illustration purpose only. Based on data used and assumptions made.

Live Demonstration

Any questions about the new features and demonstration?

Send a note to the Q&A box

Summary

Intended Users and Audiences

Risk assessors and food safety professionals

Risk managers and decision makers

- need risk assessments to inform their decisions

Academia

- Students, professors, researchers

… and others who need a platform on which to collaborate and share risk scenarios

Consumers

Example of Users: Risk Assessors and Food Safety Professionals

- Who are *knowledgeable about the hazards, foods and processes they are describing*
  - Users may or may not be familiar with risk assessment methodology, particularly as it pertains to developing quantitative estimates of risk (may need training)
- Who are interested in a tool capable of simultaneously and separately considering variability and uncertainty

The structured, mathematically rigorous tool allows

- New/developing analysts to quickly become capable of developing quantitative risk assessments
- Experienced risk assessors to more quickly develop simple or complex risk assessments

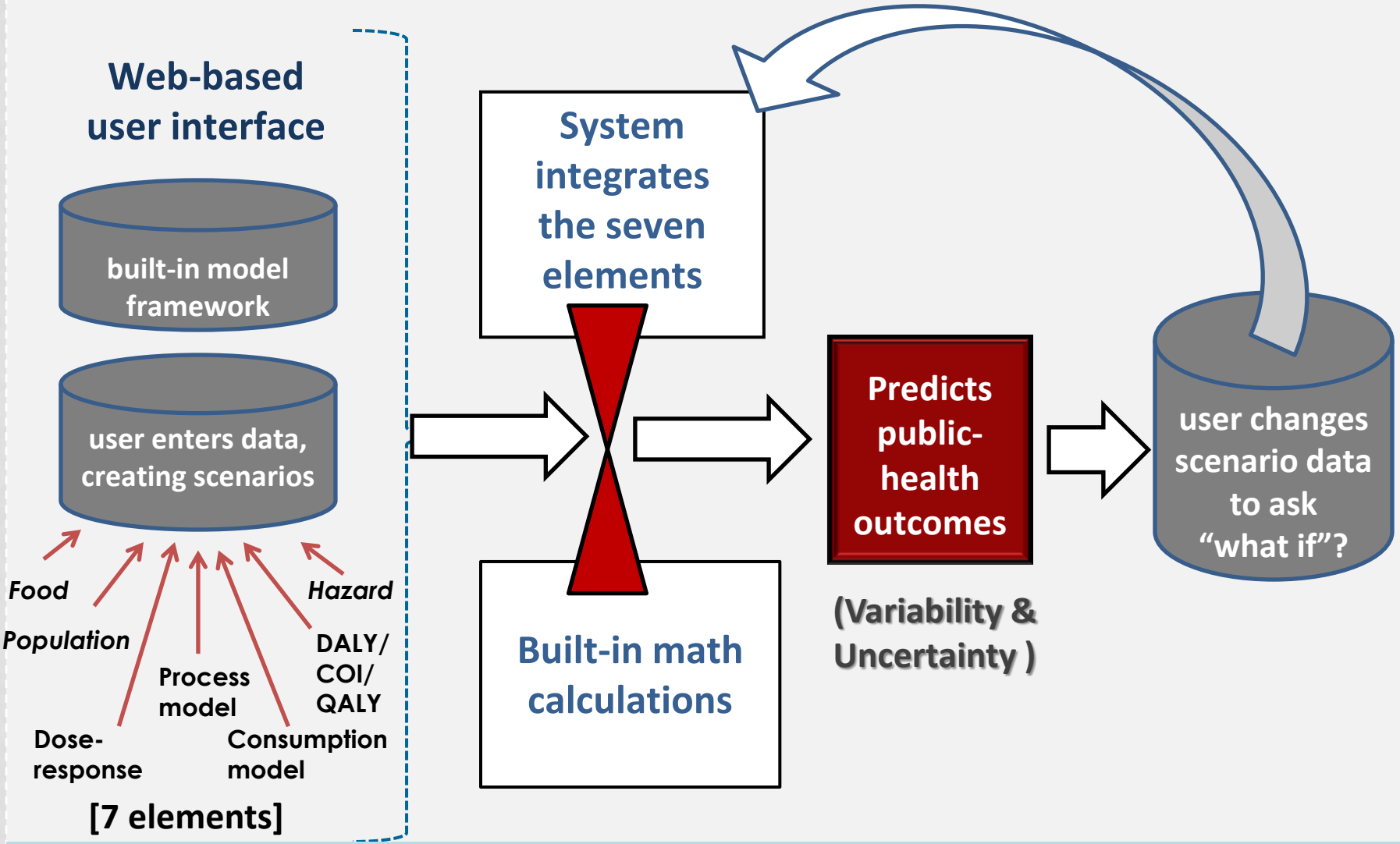
Risk Scenarios in FDA-iRISK

- Once the user has described a risk scenario (including initial conditions, process steps, consumption, dose response, …), FDA-iRISK combines the inputs into a fully quantitative risk assessment model
  - Variability only (1D) or Variability and Uncertainty (2D) Monte Carlo integration
  - Estimates the health burden to the consumer (and its confidence interval if 2D)
- A number of risk scenarios can be developed in parallel
  - Ranks risks across different foods, hazards, populations
  - Predicts effectiveness of food safety interventions

How is FDA-iRISK being used by FDA?

- Building new scenarios and expanding our library of data to address risk management questions
  - e.g., *Salmonella* in shell eggs; pathogens and chemical contaminants in produce; supporting FSMA
- Linking to external modules/tools to answer new questions
  - e.g., automated access to FDA Total Diet Study data
- Enhancing collaborations
  - e.g., with other federal agencies, other countries, private sectors

Summary: Overarching View of FDA-iRISK



FDA-iRISK captures data from scenarios & outcomes to build a global picture of risks & interventions.

Acknowledgements

- FDA: Sherri Dennis, Régis Pouillot*, and other colleagues. (*formerly FDA)
- RSI: Emma Hartnett, and Todd Ruthman.
- The many experts who provided invaluable input and critique to assist in the development and refinement of the FDA-iRISK system, from v1.0 to v4.0, including Risk Sciences International (RSI), members of the IFT expert panel, RTI International, external peer reviewers, and beta-testing experts.

Further information about FDA-iRISK 4.0

Visit FoodRisk.org

http://foodrisk.org/exclusives/fda-irisk-a-comparative-risk-assessment-tool/

https://irisk.foodrisk.org

Visit FDA risk assessment web page

http://www.fda.gov/Food/FoodScienceResearch/RiskSafetyAssessment/default.htm