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# **senaite.ast Documentation**

***Release 1.0.0***

**Riding Bytes  
Naralabs**

**Jun 18, 2022**



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This add-on enables Antibiotic Sensitivity Testing (AST) for [SENAITE LIMS](#) by allowing the user to add analyses to a sample that are specifically designed for the measurement of the susceptibility of microorganisms to antibiotics. These analyses can be added either by means of pre-defined AST Panels or by direct assignment of Antibiotics and Microorganisms through a matrix.

[senaite.ast](#) also incorporates a default analysis for the identification of microorganisms present in a given sample. Once microorganisms are identified by means of this identification analysis, the system automatically populates the list of available AST Panels for selection with those that fit better with the identified microorganism(s).

Resistance analyses are qualitative and the supported results are in accordance with the **`new definitions of susceptibility testing categories by EUCAST 2019`**:

- S: Susceptible, standard dosing regimen
- I: Susceptible, increased exposure
- R: Resistant

Although user can configure AST Panels for the automatic addition of analyses for the capture of diameter of the zone of inhibition, the system does not automatically calculate the qualitative results based on the diameter of zone and the minimum inhibitory concentrations (MICs). However, system can infer the susceptibility testing category automatically based on pre-defined Breakpoints Tables, along with the diameter of the inhibitory zone.

Once installed, this add-on allows the laboratory to:

- Maintain microorganisms (via [senaite.microorganism](#))
- Maintain antibiotics and antibiotic classes (via [senaite.abx](#))
- Maintain pre-defined AST Panels
- Maintain pre-defined Breakpoints Tables
- Analysis for the identification of microorganisms
- Assignment of pre-defined AST Panels to a sample
- Sample-level customization of AST Panel
- Selective reporting of resistance results
- Support for and selective reporting of extrapolated antibiotics

This documentation is divided in different parts. We recommend that you get started with [Installation](#) and then head over to the [Quickstart](#).

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## INSTALLATION

Add `senaite.ast` in the eggs section of your buildout:

```
eggs =  
    ...  
    senaite.ast
```

Run `bin/buildout` afterwards. With this configuration, buildout will download and install the latest published release of `senaite.ast` from Pypi, as well as `senaite.microorganism` and `senaite.abx` if not yet installed.

Once buildout finishes, start the instance, login with a user with “Site Administrator” privileges and activate the add-on:

[http://localhost:8080/senaite/prefs\\_install\\_products\\_form](http://localhost:8080/senaite/prefs_install_products_form)

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**Note:** It assumes you have a SENAITE zeo client listening to port 8080

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## QUICKSTART

This section gives an introduction about [senaite.ast](#). It assumes you have [SENAITE LIMS](#) and `senaite.ast` already installed. Please read the [Installation](#) for further details.

## 2.1 Adding a pre-defined AST Panel

To add pre-defined AST Panels, click the “gear” icon from top right, go to “AST Panels” view.

⚙ AST Panels ⊕ Add

Active Inactive All

Search 🔍

<input type="checkbox"/>	Title	Description	Microorganisms	Antibiotics
<input type="checkbox"/>	Acinetobacter	Store isolates of Acinetobacter baumannii resistant to Meropenem at -20 deg C and refer to NRL	Acinetobacter baumannii, Acinetobacter baumannii (meropenem-resistant)*, Acinetobacter spp, Acinetobacter spp (meropenem-resistant)*	CN, CIP, SXT, TOR, MEM, AK
<input type="checkbox"/>	Enterococcus		Enterococcus faecium, Enterococcus faecalis (Vancomycin-resistant - VRE)*, Enterococcus faecium (Vancomycin-resistant - VRE)*, Enterococcus spp, Enterococcus faecalis	AMP2, Va, F
<input type="checkbox"/>	GNB	Store isolates R to ceftriaxone, ceftazidime or meropenem at -20 deg C and refer to NRL	Aeromonas spp, Burkholderia cepacia complex (presumptive), Citrobacter spp, Citrobacter koseri (diversus), Citrobacter freundii, Elizabethkingia meningoseptica, Enterobacter cloacae, Enterobacter spp, Escherichia coli, Escherichia coli (ceftriaxone-resistant - ESBL)*, Escherichia coli (meropenem-resistant - CRE)*, Gram negative organism (other), Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae, Klebsiella pneumoniae (ceftriaxone-resistant - ESBL)*, Klebsiella pneumoniae (meropenem-resistant - CRE), Klebsiella spp, Moraxella spp, Morganella morganii, Pantoea spp, Pasteurella multocida, Proteus mirabilis, Proteus penneri, Proteus vulgaris, Providencia spp, Raoultella spp, Serratia marcescens, Stenotrophomonas maltophilia, Vibrio spp	AMC, CRO, CN, CIP, F, SXT, TOR, MEM, CAZ, TZP, AK, C
<input type="checkbox"/>	GNB 1		Aeromonas spp, Burkholderia cepacia complex (presumptive), Citrobacter freundii, Citrobacter koseri (diversus), Citrobacter spp, Elizabethkingia meningoseptica, Enterobacter cloacae, Enterobacter spp, Escherichia coli, Escherichia coli (ceftriaxone-resistant - ESBL)*, Escherichia coli (meropenem-resistant - CRE)*, Gram negative organism (other), Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae, Klebsiella pneumoniae (ceftriaxone-resistant - ESBL)*, Klebsiella pneumoniae (meropenem-resistant - CRE), Klebsiella spp, Moraxella spp, Morganella morganii, Pantoea spp, Pasteurella multocida, Proteus mirabilis, Proteus penneri, Proteus vulgaris, Providencia spp, Raoultella spp, Serratia marcescens, Stenotrophomonas maltophilia, Vibrio spp	AMC, CRO, CN, CIP, F, SXT
<input type="checkbox"/>	GNB 2		Aeromonas spp, Burkholderia cepacia complex (presumptive), Citrobacter freundii, Citrobacter koseri (diversus), Citrobacter spp, Elizabethkingia meningoseptica, Enterobacter spp, Enterobacter cloacae, Escherichia coli, Escherichia coli (ceftriaxone-resistant - ESBL)*, Escherichia coli (meropenem-resistant - CRE)*, Gram negative organism (other), Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae, Klebsiella pneumoniae (ceftriaxone-resistant - ESBL)*, Klebsiella pneumoniae (meropenem-resistant - CRE), Klebsiella spp, Moraxella spp, Morganella morganii, Pantoea spp, Pasteurella multocida, Proteus mirabilis, Proteus penneri, Proteus vulgaris, Providencia spp, Raoultella spp, Serratia marcescens, Stenotrophomonas maltophilia, Vibrio spp	TOR, MEM, CAZ, TZP, AK, C
<input type="checkbox"/>	Haemophilus influenzae	Store all CSF and blood isolates at -20 deg C and refer to NRL	Haemophilus influenzae, Haemophilus parainfluenzae	P, CRQ, SXT, TE, C
<input type="checkbox"/>	Pseudomonas species	Store isolates of Pseudomonas aeruginosa Resistant to meropenem at -20 deg C and refer to NRL	Pseudomonas aeruginosa, Pseudomonas spp	CN, CIP, TOR, MEM, CAZ, TZP, AK
<input type="checkbox"/>	SS	Ciprofloxacin sensitivity for Salmonella is extrapolated from Pefloxacin Store isolates Resistant to meropenem ceftriaxone or pefloxacin at -20deg C and refer to NRL	Salmonella spp, Shigella spp, Salmonella paratyphi A, Salmonella typhi, Shigella flexneri, Shigella sonnei	AMI, G, CRO, SXT, C, PEF, AZM, MEM

From this view, you can either create a new AST Panel or edit an existing one:

## Edit AST Panel

**Title** -

**Summary**  
 Used in item listings and search results.  
 Store isolates R to ceftriaxone, ceftazidime or meropenem at -20 deg C and refer to NRL

**Microorganisms** -  
 The names of selected microorganisms are displayed as row headers in the sensitivity results entry view. From all microorganisms selected here, only those identified in the Sample are added in results entry view

Acinetobacter baumannii	→	Aeromonas spp	↑
Acinetobacter baumannii (meropenem-resistant)	→	Burkholderia cepacia complex (presumptive)	↑
Acinetobacter spp	→	Citrobacter spp	↓
Acinetobacter spp (meropenem-resistant)	→	Citrobacter koseri (diversus)	↓
Bacillus spp	→	Citrobacter freundii	↓

**Antibiotics** -  
 The abbreviations of selected antibiotics are displayed as column headers in the sensitivity results entry view

Amoxicillin	→	Amoxy + clavulanate	↑
Ampicillin	→	Ceftriaxone	↑
Ampicillin	→	Gentamicin	↓
Azithromycin	→	Ciprofloxacin	↓
Cefazolin	→	Nitrofurantoin	↓

**Clinical breakpoints table**  
 Default clinical breakpoints table to use for this panel. If set, the system will automatically calculate the susceptibility testing category as soon as the zone diameter in mm is submitted by the user. If the "Include clinical breakpoints selector" is enabled for this panel, users will also be able to overwrite the clinical breakpoints table breakpoints table for each antibiotic-microorganism pair.

☐ Include disk content in µg  
 When enabled, an additional row for the introduction of the disk content (potency) in µg is displayed in the results entry view, above resistance call options

☒ Include zone diameter in mm  
 When enabled, an additional row for the introduction of the zone diameter (in mm) is displayed in the results entry view, above resistance call options

☒ Selective reporting  
 When enabled, an additional row to indicate whether the resistance result for each microorganism-antibiotic tuple has to be reported in results report or not

From this view, you can choose both the Microorganisms and the Antibiotics. Please read the [documentation of senaite.microorganism](#) and the [documentation of senaite.abx](#) for further details.

If a “Clinical breakpoints table” is selected, the system will automatically use this breakpoints table to calculate the susceptibility testing category (S/I/R) when the diameter of the inhibition zone is submitted by the user. Still, user can change the breakpoints table to use for any given antibiotic and microorganism later, on susceptibility testing results introduction.

If the option “Include disk content in ug” is selected, an additional row for the introduction of the disk content (potency) in g is displayed in the results entry view, above resistance call options.

If the option “Include zone diameter in mm” is checked, besides the qualitative analysis for antibiotic susceptibility, the system will also add analyses for the capture of the zone of inhibition in mms automatically when this panel is selected.

If the option “Selective reporting” is checked, the system will also add an analysis to allow the user to indicate the resistance results to be displayed in results report. If unchecked, all resistance results will be rendered. Besides, this option also allows the user to choose the extrapolated antibiotics to be reported.

## 2.2 Microorganism identification analysis

Besides AST Panels, this add-on creates a new analysis service with name “Microorganism identification” and the category “Antibiotic Sensitivity Testing (AST)” as well.

When this “Microorganism identification” service is assigned to a Sample (either from Sample Add form or later, through “Manage analyses”), a new analysis with pre-defined result options is added.

**Analyses**

Valid Invalid All

<input checked="" type="checkbox"/>	Analysis	Method	Instrument	Analyst	Status	Result	Specification	Retested	Attachments	Captured	Submitter	Due Date	Hidden
<input checked="" type="checkbox"/>	Microorganism identification	None	Manual	admin	Unassigned	<div>Enterobacter cloacae</div> <div>Enterococcus faecium</div> <div></div>		No				2020-12-03	<input type="checkbox"/>

Save Reject

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**Note:** The selection list of this type of analysis is populated with the microorganisms registered in the system that are in “active” status.

This analysis behaves as a multi-selection list, so the user can choose as many microorganisms as required.

## 2.3 Assignment of an AST Panel to a Sample

For the assignment of an AST Panel to a sample, go to sample view. Below the analyses listing, a section for Sensitivity Testing is displayed:

**Antibiotic Sensitivities**

Panel Select panel Add panel Customize Selective reporting

Valid Invalid All

<input checked="" type="checkbox"/>	Microorganism	Result	Captured	Submitter	Status

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Select one of the available AST Panels and press the button “Add”. Analyses are added automatically based on the settings of the AST Panel of choice.

**Note:** If no AST Panels are displayed, please check that at least one of the microorganisms identified (see *Microorganism identification analysis*) is assigned to a pre-defined AST Panel.

**Antibiotic Sensitivities**

Panel GNB 1 Add panel Customize Selective reporting

Valid Invalid All

<input type="checkbox"/>	Microorganism	Result	AMC	CRO	CN	CIP	F	SXT	Captured	Submitter	Status
<input type="checkbox"/>	Escherichia coli	Breakpoints table	Ev12	Ev12	Ev12	Ev12	Ev12	Ev12			Unassigned
<input type="checkbox"/>		Zone diameter (mm)	AMC	CRO	CN	CIP	F	SXT			Unassigned
<input type="checkbox"/>		Category									Unassigned
<input type="checkbox"/>		Report	N	N	N	N	N	N			Unassigned

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You can add as many AST Panels as you wish, but only identified microorganisms will be added by default. Microorganisms are displayed in rows and Antibiotics (abbreviations) in columns.

## 2.4 Custom AST Panel for a Sample

Sometimes user might want to add additional microorganisms, even if they were not initially identified or add new Antibiotics, even if they weren't defined in the pre-defined AST Panel of choice.

From same view, press the “Custom” button and a matrix with microorganisms as rows and antibiotics as columns is displayed for easy selection. By default, only microorganisms identified are displayed. However, user can press “All microorganisms” button to extend the list with the rest of microorganisms registered in the system:

[illegible]

**Note:** System allows unbalanced entries, so user can choose different antibiotics for different microorganisms at will.

Once the button “Save” is pressed, the user is redirected to the Sample view and the list of AST analyses is updated accordingly:

Antibiotic Sensitivities

Panel

Select panel

Add panel

Customize

Selective reporting

Valid

Invalid

All

Microorganism	Result	FOX	SXT	F	AMC	CRO	AK	CIP	CN	Captured	Submitter	Status
Escherichia coli (ceftriaxone-resistant - ESBL)	Breakpoints table	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S			Unassigned
	Zone diameter (mm)	FOX	SXT	F	AMC	CRO	AK	CIP	CN			Unassigned
	Category											Unassigned
Escherichia coli	Breakpoints table	N/S	E.v12	E.v12	E.v12	E.v12	N/S	E.v12	E.v12			Unassigned
	Zone diameter (mm)	FOX	SXT	F	AMC	CRO	AK	CIP	CN			Unassigned
	Category											Unassigned
	Report	N	N	N	N	N	N	N	N			Unassigned

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Export

2.5 Selective reporting

User can easily set the resistance results to be included in the results report by means of the “Report” analysis. However, there is also the option to define the selective reporting all-at-once. Press the “Selective reporting” button and a matrix with microorganisms as rows and antibiotics as columns is displayed for easy selection.

AST Panel Selective Reporting

Full

Grid

Help

Microorganism	AK	AMC	Cefazolin	FOX	CRO	Cephalexin	CIP	Flucloxacillin	CN	F	SXT
Escherichia coli	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Escherichia coli (ceftriaxone-resistant - ESBL)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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Export

Save

Cancel

From this view, user can choose the tuples Microorganism-Antibiotic to be reported in results. Once the button “Save” is pressed, the value for analyses with name “Report” for all microorganisms are updated accordingly.



## CHANGELOG

### 3.1 1.0.0 (2022-06-18)

- #17 Selective reporting for extrapolated antibiotics
- #15 Support for extrapolated antibiotics
- #13 Allow addition of new antibiotics to submitted/verified AST analyses
- #12 Negative values for diameter and zone size tests not permitted
- #12 Do not allow to submit AST analyses with empties
- #11 Better styling of AST Panel selector in Sample view
- #10 Allow to remove retracted AST analyses retests
- Initial Release





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