

EUCAST recommended strains for internal quality control

<i>Escherichia coli</i>	ATCC 25922
<i>Pseudomonas aeruginosa</i>	ATCC 27853
<i>Staphylococcus aureus</i>	ATCC 29213
<i>Enterococcus faecalis</i>	ATCC 29212
<i>Streptococcus pneumoniae</i>	ATCC 49619
<i>Haemophilus influenzae</i>	NCTC 8468¹

Version number	Strain	Changes
1.1, 2009-09-26	ATCC 29212	Erythromycin corrected from 2 to 15 µg and ciprofloxacin from 30 to 5 µg.
1.2, 2010-04-27	ATCC 25922	QC ranges updated²: Cefadroxil, doripenem and nitrofurantoin. Antibiotics added: Amoxicillin, ampicillin-sulbactam, cefalexin, cefixime, ceftriaxone, colistin, fosfomycin, levofloxacin, netilmicin, ofloxacin, piperacillin, ticarcillin and ticarcillin-clavulanic acid. Antibiotics removed³: Cefoxitin and tetracycline.
	ATCC 27853	QC ranges updated²: Doripenem Antibiotics added: Colistin, fosfomycin, levofloxacin, netilmicin, piperacillin, ticarcillin and ticarcillin-clavulanic acid.
	ATCC 29213	QC ranges updated²: Moxifloxacin and vancomycin (only MIC ranges for vancomycin). Antibiotics added: Azithromycin, clarithromycin, daptomycin, doxycycline, fosfomycin, levofloxacin, minocycline, netilmicin, ofloxacin, quinupristin-dalfopristin and teicoplanin. Antibiotics removed³: Amoxicillin-clavulanic acid, cefepime, cefotaxime, cefpodoxime, cefuroxime, ertapenem, meropenem, oxacillin and piperacillin-tazobactam.
	ATCC 29212	Antibiotics added: Quinupristin-dalfopristin. Antibiotics removed³: Amoxicillin-clavulanic acid, chloramphenicol, ciprofloxacin, erythromycin, moxifloxacin, norfloxacin, piperacillin-tazobactam, rifampicin and tobramycin.
	ATCC 49619	QC ranges updated²: Tetracycline (zone) and linezolid (MIC). Azithromycin and clarithromycin (only MIC ranges). Antibiotics added: Benzylpenicillin, ciprofloxacin, daptomycin, doxycycline, minocycline, teicoplanin and telithromycin. Antibiotics removed³: Piperacillin-tazobactam.
	NCTC 8468	QC ranges updated²: Trimethoprim-sulfamethoxazole Antibiotics added: Amoxicillin, ampicillin-sulbactam, minocycline and telithromycin. Antibiotics removed³: Azithromycin, aztreonam, clarithromycin, piperacillin-tazobactam and tigecycline.

¹ NCTC 8468 is susceptible to beta-lactam antibiotics and easier to read on MH-F than the commonly recommended ATCC 49247 which is a BLNAR with variable inhibition zones for beta-lactam antibiotics.

² Updated by EUCAST and/or CLSI.

³ Antibiotics not in EUCAST Clinical Breakpoint Table or no data for MIC ranges.

***Escherichia coli* ATCC 25922**
(NCTC 12241, CIP 76.24, DSM 1103, CCUG 17620)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth from the back of the plate against a black background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone size (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amikacin	1-2	0.5-4	30	23	19-26
Amoxicillin	8	4-16	10	IP	IP
Amoxicillin-clavulanic acid	4/2	2/1-8/4	20-10	21	18-24
Ampicillin	4	2-8	10	19	16-22 ⁴
Ampicillin-sulbactam	4/2	2/1-8/4	10-10	22	19-24
Aztreonam	0.12	0.06-0.25	30	32	28-36
Cefadroxil	-	-	30	17	14-20
Cefalexin	-	-	30	IP	IP
Cefepime	0.03-0.06	0.015-0.12	30	34	31-37
Cefixime	0.5	0.25-1	5	25	23-27
Cefotaxime	0.06	0.03-0.12	5	28	25-31
Cefpodoxime	0.5	0.25-1	10	26	23-28
Ceftazidime	0.12-0.25	0.06-0.5	10	26	23-29
Ceftibuten	0.25	0.12-0.5	30	31	27-35
Ceftriaxone	0.06	0.03-0.12	30	32	29-35
Cefuroxime	4	2-8	30	23	20-26
Chloramphenicol	4	2-8	30	24	21-27
Ciprofloxacin	0.008	0.004-0.015	5	35	30-40
Colistin	1	0.5-2 ³	-	-	-
Doripenem	0.03	0.015-0.06	10	31	27-35
Fosfomycin ⁵	1	0.5-2 ³	-	-	-
Ertapenem	0.008	0.004-0.015	10	33	29-36
Gentamicin	0.5	0.25-1	10	23	19-26
Imipenem	0.12	0.06-0.25	10	29	26-32
Levofloxacin	0.015-0.03	0.008-0.06	5	33	29-37
Mecillinam	0.06-0.12	0.03-0.25	10	27	24-30
Meropenem	0.015-0.03	0.008-0.06	10	31	28-34
Moxifloxacin	0.015-0.03	0.008-0.06	5	32	28-35
Nalidixic acid	2	1-4	30	25	22-28
Netilmicin	-	≤0.5-1	10	IP	IP
Nitrofurantoin	8	4-16	100	20	17-23
Norfloxacin	0.06	0.03-0.12	10	32	28-35
Ofloxacin	0.03-0.06	0.015-0.12	5	31	29-33
Piperacillin	2	1-4	30	24	21-27
Piperacillin-tazobactam	2/4	1/4-4/4	30-6	24	21-27
Ticarcillin	8	4-16	75	27	24-30
Ticarcillin-clavulanic acid	8/2	4/2-16/2	75-10	27	24-30
Tigecycline ⁵	0.12	0.03-0.25	15	24	20-27
Tobramycin	0.5	0.25-1	10	22	18-26
Trimethoprim	1	0.5-2	5	25	21-28
Trimethoprim-sulfamethoxazole	≤0.5/9.5 ²	-	1.25-23.75	26	23-29

¹ Calculated by EUCAST

² International Standard ISO 20776-1: 2006.

³ Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010. (Data in bold/italics from repeated testing by EUCAST. Inhibition zone diameters were measured on at least 20 different occasions on more than five batches of Mueller-Hinton agar from several manufacturers.)

⁴ Ignore growth that may appear as a thin inner zone with ampicillin on some batches of Mueller-Hinton agars.

⁵ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010.

IP = In Preparation

***Pseudomonas aeruginosa* ATCC 27853**

(NCTC 12903, CIP 76.110, DSM 1117, CCUG 17619)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth from the back of the plate against a black background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone size (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amikacin	2	1-4	30	22	18-26
Aztreonam	4	2-8	30	26	23-29
Cefepime	2-4	1-8	30	27	24-30
Ceftazidime	2	1-4	10	24	21-27
Ciprofloxacin	0.5	0.25-1	5	29	25-33
Colistin	1-2	0.5-4 ³	-	-	-
Doripenem	0,25	0.12-0.5	10	32	28-35
Fosfomycin ⁴	4	2-8 ³	-	-	-
Gentamicin	1	0.5-2	10	19	16-21
Imipenem	2	1-4	10	24	20-28
Levofloxacin	1-2	0.5-4	5	23	19-26
Meropenem	0.5	0.25-1	10	30	27-33
Netilmicin	2	0.5-8	10	18	15-21
Piperacillin	2-4	1-8	-	-	-
Piperacillin-tazobactam	2-4/4	1/4-8/4	30-6	26	23-29
Ticarcillin	16	8-32	-	-	-
Ticarcillin-clavulanic acid	16/2	8/2-32/2	75-10	24	20-28
Tobramycin	0.5	0.25-1	10	22	19-25

¹ Calculated by EUCAST² International Standard ISO 20776-1: 2006.³ Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010. (Data in bold/italics from repeated testing by EUCAST. Inhibition zone diameters were measured on at least 20 different occasions on more than five batches of Mueller-Hinton agar from several manufacturers.)⁴ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010.

Staphylococcus aureus* ATCC 29213
(NCTC 12973, CIP 103429, DSM 2569, CCUG 15915)

* β -lactamase-producing strain (weak)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth from the back of the plate against a black background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (μ g)	Inhibition zone size (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amikacin	2	1-4	30	21	18-24
Azithromycin	1	0.5-2	-	-	-
Benzylpenicillin	-	-	1 unit	15	12-18
Cefoxitin	2	1-4	30	27	24-30
Chloramphenicol	4-8	2-16	30	24	20-28
Ciprofloxacin	0,25	0.12-0.5	5	24	21-27
Clarithromycin	0,25	0.12-0.5	-	-	-
Clindamycin	0,12	0.06-0.25	2	26	23-29
Daptomycin ⁴	0.25-0.5	0.12-1 ³	-	-	-
Doxycycline	0,25	0.12-0.5	-	-	-
Erythromycin	0,5	0.25-1	15	26	23-29
Fosfomicin ⁴	1-2	0.5-4 ³	-	-	-
Fusidic acid	0,12	0.06-0.25	10	29	26-32
Gentamicin	0.25-0.5	0.12-1	10	22	19-25
Levofloxacin	0.12-0.25	0.06-0.5	5	IP	IP
Linezolid	2	1-4	10	24	21-27
Minocycline	0.12-0.25	0.06-0.5	30	IP	IP
Moxifloxacin	0.03-0.06	0.015-0.12	5	28	25-31
Netilmicin	$\leq 0.25^2$	-	10	23	20-26
Nitrofurantoin	16	8-32	100	20	17-23
Norfloxacin	1	0.5-2	10	21	18-24
Ofloxacin	0.25-0.5	0.12-1	5	24	21-27
Quinupristin-dalfopristin	0,5	0.25-1	15	IP	IP
Rifampicin	0,008	0.004-0.015	5	33	30-36
Teicoplanin	0,5	0.25-1	-	-	-
Tetracycline	0.25-0.5	0.12-1	30	27	23-31
Tigecycline ⁴	0.06-0.12	0.03-0.25	15	22	19-25
Tobramycin	0.25-0.5	0.12-1	10	23	20-26
Trimethoprim	2	1-4	5	25	22-28
Trimethoprim-sulfamethoxazole	$\leq 0.5/9.5^2$	-	1.25-23.75	29	26-32
Vancomycin	1	0.5-2	-	-	-

¹ Calculated by EUCAST

² International Standard ISO 20776-1: 2006.

³ Data in bold/italics from repeated testing by EUCAST. Inhibition zone diameters were measured on at least 20 different occasions on more than five batches of Mueller-Hinton agar from several manufacturers.

⁴ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010.

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***Enterococcus faecalis* ATCC 29212**
(NCTC 12697, CIP 103214, DSM 2570, CCUG 9997)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth from the back of the plate against a black background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone size (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Ampicillin	1	0.5-2	2	18	15-21
Gentamicin	8	4-16	30 ⁴	15	12-18
Imipenem	1	0.5-2	10	27	24-30
Linezolid	2	1-4	10	22	19-25
Nitrofurantoin	8	4-16	100	21	18-24
Quinupristin-dalfopristin	4	2-8	15	14	11-17
Teicoplanin	0,12	0.06-0.25	30	18	15-21
Tetracycline	16	8-32	30	13	10-16
Tigecycline ⁵	0,06	0.03-0.12	15	23	20-26
Trimethoprim	≤1 ²	-	5	28	24-32
Trimethoprim-sulfamethoxazole	≤0.5/9.5 ²	-	1.25-23.75	30	26-34
Vancomycin	2	1-4	5	13	10-16

¹ Calculated by EUCAST

² International Standard ISO 20776-1: 2006.

³ Data in bold/italics from repeated testing by EUCAST. Inhibition zone diameters were measured on at least 20 different occasions on more than five batches of Mueller-Hinton agar from several manufacturers.

⁴ Screening disk for high-level aminoglycoside-resistance in enterococci.

⁵ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010.

***Streptococcus pneumoniae* ATCC 49619^{*/**}**
(NCTC 12977, CIP 104340, DSM 11967, CCUG 33638)

* Penicillin-intermediate strain

** Zone edges for *S. pneumoniae* on MH-F may be accompanied by α -haemolysis extending approximately 1 mm into the zone. Read growth, not haemolysis. With some batches of agar and some antibiotics the colonies at the zone edge lyse and the apparent width of haemolysis is considerably greater. The zone edge should be read as the edge of the lysed colonies indicated by a haze just inside the α -haemolysis.

Mueller-Hinton agar + 5% horse blood and 20 mg/L β -NAD, McFarland 0.5, 5% CO₂, 35 \pm 1°C, 18 \pm 2h.
Read zone edges as the point showing no growth from the front with the lid removed and reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (μ g)	Inhibition zone size (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Ampicillin	0,12	0.06-0.25	2	28	25-31
Azithromycin	0,12	0.06-0.25	-	-	-
Benzylpenicillin	0,5	0.25-1 ⁴	1 unit	18	15-21
Cefaclor	2	1-4	30	28	25-31
Cefepime	0.06-0.12	0.03-0.25	30	34	31-37
Cefotaxime	0,06	0.03-0.12	5	31	28-34
Cefpodoxime	0,06	0.03-0.12	10	32	29-35
Ceftriaxone	0,06	0.03-0.12	30	35	32-38
Cefuroxime	0,5	0.25-1	30	31	28-34
Chloramphenicol	4	2-8	30	27	24-30
Ciprofloxacin	-	-	5	25	22-28
Clarithromycin	0,06	0.03-0.12	-	-	-
Clindamycin	0,06	0.03-0.12	2	25	22-28
Daptomycin ⁵	0.12-0.25	0.06-0.5	-	-	-
Doripenem	0,06	0.03-0.12	10	34	31-37
Doxycycline	0.03-0.06	0.015-0.12	-	-	-
Ertapenem	0.06-0.12	0.03-0.25	10	31	28-34
Erythromycin	0,06	0.03-0.12	15	29	26-32
Imipenem	0,06	0.03-0.12	10	38	34-42
Levofloxacin	1	0.5-2	5	24	21-27
Linezolid	0.5-1	0.25-2	10	26	23-29
Meropenem	0,12	0.06-0.25	10	34	30-38
Minocycline	-	-	30	28	25-31
Moxifloxacin	0,12	0.06-0.25	5	27	24-30
Norfloxacin	4	2-8	10	21	18-24
Ofloxacin	2	1-4	5	21	18-24
Oxacillin	-	-	1	11	8-14
Rifampicin	0,03	0.015-0.06	5	29	26-32
Teicoplanin	-	-	30	21	18-24
Telithromycin	0.008-0.016	0.004-0.03	15	30	27-33
Tetracycline	0,25	0.12-0.5	30	31	28-34
Tigecycline ⁵	0.03-0.06	0.015-0.12	15	27	24-30
Trimethoprim-sulfamethoxazole	0.25/4.75-0.5/9.5	0.12/2.4-1/19	1.25-23.75	23	20-26
Vancomycin	0,25	0.12-0.5	5	20	17-23

¹ Calculated by EUCAST

² International Standard ISO 20776-1: 2006.

³ Data in bold/italics from repeated testing by EUCAST. Inhibition zone diameters were measured on at least 20 different occasions on more than five batches of Mueller-Hinton agar from several manufacturers.

⁴ Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010.

⁵ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S20: 30:1, 2010.

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Haemophilus influenzae NCTC 8468

(CIP 54.94, CCUG 23946)

Mueller-Hinton agar + 5% horse blood and 20 mg/L β -NAD, McFarland 0.5, 5% CO₂, 35±1°C, 18±2h.
Read zone edges as the point showing no growth from the front with the lid removed and reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (μ g)	Inhibition zone size (mm)	
	Target	Range		Target ¹	Range ¹
Amoxicillin	IP	IP	10	24	21-27
Amoxicillin-clavulanic acid	IP	IP	20-10	27	24-30
Ampicillin	IP	IP	2	22	19-25
Ampicillin-sulbactam	IP	IP	10-10	27	24-30
Cefaclor	IP	IP	30	27	24-30
Cefepime	IP	IP	30	32	29-35
Cefixime	IP	IP	5	30	27-33
Cefotaxime	IP	IP	5	32	29-35
Cefpodoxime	IP	IP	10	31	28-34
Ceftibuten	IP	IP	30	32	29-35
Ceftriaxone	IP	IP	30	37	33-41
Cefuroxime	IP	IP	30	28	25-31
Chloramphenicol	IP	IP	30	34	30-38
Ciprofloxacin	IP	IP	5	35	31-39
Doripenem	IP	IP	10	29	26-32
Ertapenem	IP	IP	10	30	27-33
Erythromycin	IP	IP	15	15	12-18
Imipenem	IP	IP	10	28	25-31
Levofloxacin	IP	IP	5	35	32-38
Meropenem	IP	IP	10	31	28-34
Minocycline	IP	IP	30	IP	IP
Moxifloxacin	IP	IP	5	32	29-35
Nalidixic acid	IP	IP	30	30	27-33
Ofloxacin	IP	IP	5	33	30-36
Phenoxymethylpenicillin	IP	IP	10	18	15-21
Rifampicin	IP	IP	5	23	20-26
Telithromycin	IP	IP	15	IP	IP
Tetracycline	IP	IP	30	31	28-34
Trimethoprim-sulfamethoxazole	IP	IP	1.25-23.75	30	26-34

¹ Calculated by EUCAST² Data in bold/italics from repeated testing by EUCAST. Inhibition zone diameters were measured on at least 20 different occasions on more than five batches of Mueller-Hinton agar from several manufacturers.

IP = In Preparation