



جداول و الگوریتم های شناسایی و افتراق باکتری ها

آزمایشگاه مرجع سلامت

وزارت بهداشت، درمان و آموزش پزشکی

سال ۱۳۹۷

محل مهر تضمین کیفیت	
تاریخ :	تاریخ :

Enterobacteriaceae

TABLE 19-12 Biochemical Reactions of the Named Species and Unnamed Groups of the Family Enterobacteriaceae

Organism	Indole production	Methyl red	Voges-Proskauer	Citrate (Simmons)	Hydrogen sulfide (TSI)	Urea hydrolysis	Phenylalanine deaminase	Lysine decarboxylase	Arginine dihydrolase	Ornithine decarboxylase	Motility	Gelatin hydrolysis (22° C)	Growth in KCN	Malonate utilization	D-Glucose, acid	D-Glucose, gas	Lactose fermentation	Sucrose fermentation	D-Mannitol fermentation	Dulcitol fermentation	Salicin fermentation	Adonitol fermentation
<i>Budvicia aquatica</i>	0	93	0	0	80	33	0	0	0	0	27	0	0	0	100	53	87	0	60	0	0	0
<i>Buttiauxella agrestis</i>	0	100	0	100	0	0	0	0	0	100	100	0	80	60	100	100	100	0	100	0	100	0
<i>Buttiauxella brennerae</i>	0	100	0	0	0	0	0	0	0	33	100	0	100	100	100	100	67	0	100	0	100	67
<i>Buttiauxella ferrugutiae</i>	0	100	0	0	0	0	0	100	0	80	60	0	40	0	100	100	0	0	100	0	100	0
<i>Buttiauxella gaviniae</i>	0	100	0	20	0	0	0	0	20	0	80	0	60	100	100	40	60	0	100	0	100	100
<i>Buttiauxella izardii</i>	0	100	0	0	0	0	0	0	0	100	100	0	67	100	100	100	100	0	100	0	100	0
<i>Buttiauxella noackiae</i>	33	100	0	33	0	0	100	0	67	0	100	0	100	100	100	100	0	0	100	0	100	0
<i>Buttiauxella warmboldiae</i>	0	100	0	33	0	0	100	0	0	0	100	0	33	100	100	100	0	0	100	0	100	0
<i>Cedecea davisae</i>	0	100	50	95	0	0	0	0	50	95	95	0	86	91	100	70	19	100	100	0	99	0
<i>Cedecea lapagei</i>	0	40	80	99	0	0	0	0	80	0	80	0	100	99	100	100	60	0	100	0	100	0
<i>Cedecea neteri</i>	0	100	50	100	0	0	0	0	100	0	100	0	65	100	100	100	35	100	100	0	100	0
<i>Cedecea species 3</i>	0	100	50	100	0	0	0	0	100	0	100	0	100	0	100	100	0	50	100	0	100	0
<i>Cedecea species 5</i>	0	100	50	100	0	0	0	0	50	50	100	0	100	0	100	100	0	100	100	0	100	0
<i>Citrobacter amalonaticus</i>	100	100	0	95	5	85	0	0	85	95	95	0	99	1	100	97	35	9	100	1	30	0
<i>Citrobacter braakii</i>	33	100	0	87	60	47	0	0	67	93	87	0	100	0	100	93	80	7	100	33	0	0
<i>Citrobacter farmeri</i>	100	100	0	10	0	59	0	0	85	100	97	0	93	0	100	96	15	100	100	2	9	0
<i>Citrobacter freundii</i>	33	100	0	78	78	44	0	0	67	0	89	0	89	11	100	89	78	89	100	11	0	0
<i>Citrobacter gillenii</i>	0	100	0	33	67	0	0	0	33	0	67	0	100	100	100	100	67	33	100	0	0	0
<i>Citrobacter koseri</i> (C. diversus)	99	100	0	99	0	75	0	0	80	99	95	0	0	95	100	98	50	40	99	40	15	99
<i>Citrobacter murlinae</i>	100	100	0	100	67	67	0	0	67	0	100	0	100	0	100	100	67	33	100	100	33	0
<i>Citrobacter rodentium</i>	0	100	0	0	0	100	0	0	0	100	0	0	0	100	100	100	100	0	100	0	0	0
<i>Citrobacter sedlakii</i>	83	100	0	83	0	100	0	0	100	100	100	0	100	100	100	100	100	0	100	100	17	0
<i>Citrobacter werkmanii</i>	0	100	0	100	100	100	0	0	100	0	100	0	100	100	100	100	17	0	100	0	0	0
<i>Citrobacter youngae</i>	15	100	0	75	65	80	0	0	50	5	95	0	95	5	100	75	25	20	100	85	10	0
<i>Cronobacter sakazakii</i>	11	5	100	99	0	1	50	0	99	91	96	0	99	18	100	98	99	100	100	5	99	0
<i>Enteric Group 137</i> (5 strains)	100	100	0	0	0	70	0	0	20	100	100	0	100	0	100	0	100	100	100	0	100	0
<i>Edwardsiella hoshinae</i>	50	100	0	0	0	0	0	100	0	95	100	0	0	100	100	35	0	100	100	0	50	0
<i>Edwardsiella ictaluri</i>	0	0	0	0	0	0	0	100	0	65	0	0	0	0	100	50	0	0	0	0	0	0
<i>Edwardsiella tarda</i>	99	100	0	1	100	0	0	100	0	100	98	0	0	0	100	100	0	0	0	0	0	0
<i>Edwardsiella tarda</i> biogroup 1	100	100	0	0	0	0	0	100	0	100	100	0	0	0	100	50	0	100	100	0	0	0
<i>Enterobacter aerogenes</i>	0	5	98	95	0	2	0	98	0	98	97	0	98	95	100	100	95	100	100	5	100	98
<i>Enterobacter amnigenus</i> biogroup 1	0	7	100	70	0	0	0	0	9	55	92	0	100	91	100	100	70	100	100	0	91	0
<i>Enterobacter amnigenus</i> biogroup 2	0	65	100	100	0	0	0	0	35	100	100	0	100	100	100	100	35	0	100	0	100	0
<i>Enterobacter asburiae</i>	0	100	2	100	0	60	0	0	21	95	0	0	97	3	100	95	75	100	100	0	100	0

From the Centers for Disease Control and Prevention, Atlanta, Ga.

TSI, Triple sugar iron; KCN, potassium cyanide; ONPG, o-nitrophenyl-β-D-galactopyranoside.

*Each number is the percentage of positive reactions after 2 days of incubation at 36° C, unless noted otherwise. Most of these positive reactions occur within 24 hours. Reactions that become positive after 2 days are not considered.

	myo-Inositol fermentation	D-Sorbitol fermentation	L-Arabinose fermentation	Raffinose fermentation	L-Rhamnose fermentation	Maltose fermentation	D-Xylose fermentation	Trehalose fermentation	Cellobiose fermentation	Alpha-methyl-D-glucoside fermentation	Erythritol fermentation	Esculin hydrolysis	Mellibiose fermentation	D-Arabitol fermentation	Glycerol fermentation	Mucate fermentation	Tartrate, Jordan's	Acetate utilization	Lipase (corn oil)	DHase (25° C)	Nitrate nitrite	Oxidase, Kovacs	ONPG test	Yellow pigment	D-Mannose fermentation	Tyrosine utilization	D-Galactose	Citrate, Christensen's
	0	0	80	0	100	0	93	0	0	0	0	0	0	27	0	20	27	0	0	0	100	0	93	0	0			
	0	0	100	100	100	100	100	100	100	0	0	100	100	0	60	100	60	0	0	0	100	0	100	0	100			
	0	0	100	100	33	100	100	100	100	0	0	100	100	67	67	67	0	0	0	0	100	0	100	0	100			
	0	100	100	0	100	100	100	100	100	40	0	100	0	0	0	60	0	0	0	0	100	0	100	0	100			
	0	0	100	0	100	60	100	100	100	0	0	100	0	80	0	80	40	0	0	0	100	0	100	0	100			
	0	0	100	33	100	100	100	100	100	0	0	100	67	0	33	100	67	0	0	0	100	0	100	0	100			
	0	0	100	0	100	100	100	100	100	33	0	100	0	0	0	100	100	0	0	0	100	0	100	0	100			
67	0	100	0	100	100	100	100	100	100	0	0	100	0	0	0	0	0	0	0	0	100	0	100	0	100			
	0	0	0	10	0	100	100	100	100	5	0	45	0	100	0	0	0	0	91	0	100	0	90	0	100			
	0	0	0	0	0	100	0	100	100	0	0	100	0	100	0	0	0	60	100	0	100	0	99	0	100			
	0	100	0	0	0	100	100	100	100	0	0	100	0	100	0	0	0	0	100	0	100	0	100	0	100			
	0	0	0	100	0	100	100	100	100	50	0	100	100	100	0	0	0	50	100	0	100	0	100	0	100			
	0	100	0	100	0	100	100	100	100	0	0	100	100	100	0	0	0	50	50	0	100	0	100	0	100			
	0	99	99	5	100	99	99	100	100	2	0	5	0	0	60	96	96	86	0	0	99	0	97	0	100			
	0	100	100	7	100	100	100	100	73	33	0	0	80	0	87	100	93	53	0	0	100	0	80	0	100			
	0	98	100	100	100	100	100	100	100	75	0	0	100	0	65	100	93	80	0	0	100	0	100	0	100			
	0	100	100	44	100	100	89	100	44	11	0	0	100	0	100	100	100	44	0	0	100	0	89	0	100			
	0	100	100	0	100	100	100	100	67	0	0	0	67	0	67	67	100	0	0	0	100	0	67	0	100			
	0	99	99	0	99	100	100	100	99	40	0	1	0	98	99	95	90	75	0	0	100	0	99	0	100			
	0	100	100	33	100	100	100	100	100	0	0	0	33	0	100	100	100	33	0	0	100	0	100	0	100			
	0	100	100	0	100	100	100	100	100	0	0	0	0	0	0	100	100	0	0	0	100	0	100	0	100			
	0	100	100	0	100	100	100	100	100	0	0	17	100	0	83	100	100	83	0	0	100	0	100	0	100			
	0	100	100	0	100	100	100	100	0	0	0	0	0	0	100	100	100	100	0	0	100	0	100	0	100			
	5	100	100	10	100	95	100	100	45	0	0	5	10	5	90	100	100	65	0	0	85	0	90	0	100			
75	0	100	99	100	100	100	100	100	100	96	0	100	100	0	15	1	1	96	0	0	99	0	100	98	100			
	0	100	100	100	100	100	100	100	100	80	0	100	100	0	100	100	50	100	0	0	100	0	100	0	100	0	100	90
	0	0	13	0	0	100	0	100	0	0	0	0	0	0	65	0	0	0	0	0	100	0	0	0	100			
	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	100			
	0	0	9	0	0	100	0	0	0	0	0	0	0	0	30	0	25	0	0	0	100	0	0	0	100			
	0	0	100	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	100			
95	100	100	96	99	99	100	100	100	100	95	0	98	99	100	98	90	95	50	0	0	100	0	100	0	95			
	0	9	100	100	100	100	100	100	100	55	0	91	100	0	0	35	9	0	0	0	100	0	91	0	100			
	0	100	100	0	100	100	100	100	100	100	0	100	100	0	0	100	0	0	0	0	100	0	100	0	100			
	0	100	100	70	5	100	97	100	100	95	0	95	0	0	11	21	30	87	0	0	100	0	100	0	100			

Continued

TABLE 19-12 Biochemical Reactions of the Named Species and Unnamed Groups of the Family Enterobacteriaceae—cont'd

Organism	Indole production	Methyl red	Voges-Proskauer	Citrate (Simmons)	Hydrogen sulfide (TSI)	Urea hydrolysis	Phenylalanine deaminase	Lysine decarboxylase	Arginine dihydrolase	Ornithine decarboxylase	Motility	Gelatin hydrolysis (22° C)	Growth in KCN	Malonate utilization	D-Glucose, acid	D-Glucose, gas	Lactose fermentation	Sucrose fermentation	D-Mannitol fermentation	Dulcitol fermentation	Salicin fermentation	Adonitol fermentation
<i>Enterobacter cancerogenus</i> (<i>E. taylorae</i>)	0	5	100	100	0	1	0	0	94	99	99	0	98	100	100	100	10	0	100	0	92	0
<i>Enterobacter cloacae</i>	0	5	100	100	0	65	0	0	97	96	95	0	98	75	100	100	93	97	100	15	75	25
<i>Enterobacter dissolvens</i>	0	0	100	100	0	100	0	0	100	100	0	0	100	100	100	100	0	100	100	0	100	0
<i>Enterobacter gergoviae</i>	0	5	100	99	0	93	0	90	0	100	90	0	0	96	100	98	55	98	99	0	99	0
<i>Enterobacter hormaechei</i>	0	57	100	96	0	87	4	0	78	91	52	0	100	100	100	83	9	100	100	87	44	0
<i>Enterobacter intermedius</i>	0	100	100	65	0	0	0	0	0	89	89	0	65	100	100	100	100	65	100	100	100	0
<i>Enterobacter nimipressuralis</i>	0	100	100	0	0	0	0	0	0	100	0	0	100	100	100	100	0	0	100	0	100	0
<i>Enterobacter pyrinus</i>	0	29	86	0	0	86	0	100	0	100	43	0	0	86	100	100	14	100	100	0	100	0
<i>Escherichia albertii</i>	0	0	0	0	0	0	0	100	0	100	0	0	0	0	100	100	0	0	100	0	0	0
<i>Escherichia blattae</i>	0	100	0	50	0	0	0	100	0	100	0	0	0	100	100	100	0	0	0	0	0	0
<i>Escherichia coli</i>	98	99	0	1	1	1	0	90	17	65	95	0	3	0	100	95	95	50	98	60	40	5
<i>Escherichia coli</i> , inactive	80	95	0	1	1	1	0	40	3	20	5	0	1	0	100	5	25	15	93	40	10	3
<i>Escherichia fergusonii</i>	98	100	0	17	0	0	0	95	5	100	93	0	0	35	100	95	0	0	98	60	65	98
<i>Escherichia hermannii</i>	99	100	0	1	0	0	0	6	0	100	99	0	94	0	100	97	45	45	100	19	40	0
<i>Escherichia vulneris</i>	0	100	0	0	0	0	0	85	30	0	100	0	15	85	100	97	15	8	100	0	30	0
<i>Ewingella americana</i>	0	84	95	95	0	0	0	0	0	0	60	0	5	0	100	0	70	0	100	0	80	0
<i>Hafnia alvei</i>	0	40	85	10	0	4	0	100	6	98	85	0	95	50	100	98	5	10	99	0	13	0
<i>Hafnia alvei</i> biogroup 1	0	85	70	0	0	0	0	100	0	45	0	0	0	45	100	0	0	0	55	0	55	0
<i>Klebsiella oxytoca</i>	99	20	95	95	0	90	1	99	0	0	0	0	97	98	100	97	100	100	99	55	100	99
<i>Klebsiella ornithinolytica</i>	100	96	70	100	0	100	0	100	0	100	0	0	100	100	100	100	100	100	100	10	100	100
<i>Klebsiella planticola</i>	20	100	98	100	0	98	0	100	0	0	0	0	100	100	100	100	100	100	100	15	100	100
<i>Klebsiella pneumoniae</i> subsp. <i>ozaenae</i>	0	98	0	30	0	10	0	40	6	3	0	0	88	3	100	50	30	20	100	2	97	97
<i>Klebsiella pneumoniae</i> subsp. <i>pneumoniae</i>	0	10	98	98	0	95	0	98	0	0	0	0	98	93	100	97	98	99	99	30	99	90
<i>Klebsiella pneumoniae</i> subsp. <i>pneumoniae</i>	0	100	0	0	0	0	0	0	0	0	0	0	80	95	100	0	0	75	100	0	98	100
<i>Klebsiella pneumoniae</i> subsp. <i>rhinoscleromatis</i>	0	60	100	40	0	0	0	100	0	20	0	0	100	100	100	80	100	100	100	20	100	100
<i>Klebsiella terrigena</i>	92	100	0	96	0	0	0	97	0	100	98	0	92	96	100	93	98	98	100	25	100	0
<i>Kluyvera ascorbata</i>	90	100	0	80	0	0	0	23	0	100	90	0	86	86	100	95	95	81	95	0	100	0
<i>Kluyvera cryocrescens</i>	100	100	0	100	0	0	0	100	0	100	100	0	83	50	100	17	83	100	100	33	100	0
<i>Kluyvera georgiana</i>	100	100	0	0	0	48	0	0	0	0	79	0	97	93	100	97	93	66	100	86	100	93
<i>Leclercia adecarboxylata</i>	0	100	0	100	100	0	0	0	0	0	0	0	0	0	100	33	0	0	0	83	0	0
<i>Leminorella grimaldii</i>	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
<i>Moellerella richardii</i>	0	100	0	80	0	0	0	0	0	0	0	0	70	0	100	0	100	100	60	0	0	100
<i>Moellerella wisconsinensis</i>																						

From the Centers for Disease Control and Prevention, Atlanta, Ga.

TSI, Triple sugar iron; KCN, potassium cyanide; ONPG, o-nitrophenyl-β-D-galactopyranoside.

*Each number is the percentage of positive reactions after 2 days of incubation at 36° C unless noted otherwise. Most of these positive reactions occur within 24 hours. Reactions that become positive after 2 days are not considered.

myo-Inositol fermentation		D-Sorbitol fermentation		L-Arabinose fermentation		Raffinose fermentation		L-Rhamnose fermentation		Maltose fermentation		D-Xylose fermentation		Trehalose fermentation		Cellobiose fermentation		Alpha-methyl-D-glucoside fermentation		Erythritol fermentation		Esculin hydrolysis		Melibiose fermentation		D-Arabinol fermentation		Glycerol fermentation		Mucate fermentation		Tartrate, Jordan's		Acetate utilization		Lipase (corn oil)		DNase (25° C)		Nitrate nitrite		Oxidase, Kovacs		ONPG test		Yellow pigment		D-Mannose fermentation		Tyrosine utilization		D-Galactose		Citrate, Christensen's																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
0	1	100	0	100	99	100	100	100	1	0	90	0	0	1	75	0	35	0	0	100	0	100	0	100	0	0	1	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
15	95	100	97	92	100	99	100	99	85	0	30	90	15	40	75	30	75	0	0	99	0	99	0	100	0	0	15	40	75	30	75	0	0	99	0	99	0	100	0	100	0	100	0	100	0	100	0	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0	100	100	100	100	100	100	100	100	100	0	100	100	0	0	100	0	100	0	0	100	0	100	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Continued

TABLE 19-12 Biochemical Reactions of the Named Species and Unnamed Groups of the Family Enterobacteriaceae—cont'd

Organism	Indole production	Methyl red	Voges-Proskauer	Citrate (Simmons)	Hydrogen sulfide (TSI)	Urea hydrolysis	Phenylalanine deaminase	Lysine decarboxylase	Arginine dihydrolase	Ornithine decarboxylase	Motility	Gelatin hydrolysis (22° C)	Growth in KCN	Malonate utilization	D-Glucose, acid	D-Glucose, gas	Lactose fermentation	Sucrose fermentation	D-Mannitol fermentation	Dulcitol fermentation	Salicin fermentation	Adonitol fermentation
<i>Morganella morganii</i> subsp. <i>morganii</i>	95	95	0	0	20	95	95	1	0	95	95	0	98	1	99	90	1	0	0	0	0	0
<i>Morganella morganii</i> subsp. <i>sibirica</i>	50	86	0	0	7	100	93	29	0	64	79	0	79	0	100	86	0	7	0	0	0	0
<i>Morganella morganii</i> biogroup 1	100	95	0	0	15	100	100	100	0	80	0	0	90	5	100	93	0	0	0	0	0	0
<i>Obesumbacterium proteus</i> biogroup 2	0	15	0	0	0	0	0	100	0	100	0	0	0	0	100	0	0	0	0	0	0	0
<i>Pantoea agglomerans</i>	20	50	70	50	0	20	20	0	0	0	85	2	35	65	100	20	40	75	100	15	65	7
<i>Pantoea dispersa</i>	0	82	64	100	0	0	9	0	0	0	100	0	82	9	100	0	0	1	100	0	0	0
<i>Photobacterium luminescens</i> (all tests at 25° C)	50	0	0	50	0	25	0	0	0	0	100	50	0	0	75	0	0	0	0	0	0	0
<i>Photobacterium</i> DNA hybridization group 5	0	0	0	20	0	60	0	0	0	0	100	80	20	0	100	0	0	0	0	0	0	0
<i>Pragia fontium</i>	0	100	0	89	89	0	22	0	0	0	100	0	0	0	100	0	0	0	0	0	78	0
<i>Proteus mirabilis</i>	2	97	50	65	98	98	98	0	0	99	95	90	98	2	100	96	2	15	0	0	0	0
<i>Proteus myxofaciens</i>	0	100	100	50	0	100	100	0	0	0	100	100	100	0	100	100	0	100	0	0	0	0
<i>Proteus penneri</i>	0	100	0	0	30	100	99	0	0	0	85	50	99	0	100	45	1	100	0	0	0	0
<i>Proteus vulgaris</i>	98	95	0	15	95	95	99	0	0	0	95	91	99	0	100	85	2	97	0	0	50	0
<i>Providencia alcalifaciens</i>	99	99	0	98	0	0	98	0	0	1	96	0	100	0	100	85	0	15	2	0	1	98
<i>Providencia heimbachae</i>	0	85	0	0	0	0	100	0	0	0	46	0	8	0	100	0	0	0	0	0	0	92
<i>Providencia rettgeri</i>	99	93	0	95	0	98	98	0	0	0	94	0	97	0	100	10	5	15	100	0	50	100
<i>Providencia rustigianii</i>	98	65	0	15	0	0	100	0	0	0	30	0	100	0	100	35	0	35	0	0	0	0
<i>Providencia stuartii</i>	98	100	0	93	0	30	95	0	0	0	85	0	100	0	100	0	2	50	10	0	2	5
<i>Rahnella aquatilis</i>	0	88	100	94	0	0	95	0	0	0	6	0	0	100	100	98	100	100	88	100	0	0
<i>Salmonella bongori</i>	0	100	0	94	100	0	0	100	94	100	100	0	100	0	100	94	0	0	100	94	0	0
<i>Salmonella enterica</i> subsp. <i>arizonae</i>	1	100	0	99	99	0	0	99	70	99	99	0	1	95	100	99	15	1	100	0	0	0
<i>Salmonella enterica</i> subsp. <i>diarizonae</i>	2	100	0	98	99	0	0	99	70	99	99	0	1	95	100	99	85	5	100	1	0	0
<i>Salmonella enterica</i> subsp. <i>enterica</i>	1	100	0	95	95	1	0	98	70	97	95	0	0	0	100	96	1	1	100	96	0	0
<i>Salmonella enterica</i> subsp. <i>houstenae</i>	0	100	0	98	100	2	0	100	70	100	98	0	95	0	100	100	0	0	98	0	60	5
<i>Salmonella enterica</i> subsp. <i>indica</i>	0	100	0	89	100	0	0	100	67	100	100	0	0	0	100	100	22	0	100	67	0	0
<i>Salmonella enterica</i> subsp. <i>salamae</i>	2	100	0	100	100	0	0	100	90	100	98	2	0	95	100	100	1	1	100	90	5	0
<i>Salmonella</i> serotype Choleraesuis	0	100	0	25	50	0	0	95	55	100	95	0	0	0	100	95	0	0	98	5	0	0
<i>Salmonella</i> serotype Gallinarum	0	100	0	0	100	0	0	90	10	1	0	0	0	0	100	0	0	0	100	90	0	0

From the Centers for Disease Control and Prevention, Atlanta, Ga.

TSI, Triple sugar iron; KCN, potassium cyanide; ONPG, o-nitrophenyl-β-D-galactopyranoside.

*Each number is the percentage of positive reactions after 2 days of incubation at 36° C unless noted otherwise. Most of these positive reactions occur within 24 hours. Reactions that become positive after 2 days are not considered.

myo-Inositol fermentation	D-Sorbitol fermentation	L-Arabinose fermentation	Raffinose fermentation	L-Rhamnose fermentation	Maltose fermentation	D-Xylose fermentation	Trehalose fermentation	Cellobiose fermentation	Alpha-methyl-D-glucoside fermentation	Erythritol fermentation	Esculin hydrolysis	Melibiose fermentation	D-Arabinitol fermentation	Glycerol fermentation	Mucate fermentation	Tartrate, Jordan's	Acetate utilization	Lipase (corn oil)	DHase (25° C)	Nitrate nitrite	Oxidase, Kovacs	ONPG test	Yellow pigment	D-Mannose fermentation	Tyrosine utilization	D-Galactose	Citrate, Christensen's
0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	95	0	0	0	90	0	10	0	98			
0	0	0	0	0	0	0	100	0	0	0	0	0	0	7	7	100	0	0	0	100	0	0	0	100			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	100	0	0	0	90	0	20	0	100			
0	0	0	0	15	50	15	85	0	0	0	0	0	0	0	0	15	0	0	0	100	0	0	0	85			
15	30	95	30	85	89	93	97	55	7	0	60	50	50	30	40	25	30	0	0	85	0	90	75	98			
0	0	100	0	91	82	100	100	55	0	0	0	0	100	27	0	9	100	0	0	91	0	91	27	100			
0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	50	100			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	20	0	0	0	0	0	60	100			
0	0	0	0	0	0	0	0	0	0	0	78	0	0	0	0	0	0	0	0	100	0	0	0	0			
0	0	0	1	1	0	98	98	1	0	0	0	0	0	70	0	87	20	92	50	95	0	0	0	0			
0	0	0	0	0	0	100	0	100	0	100	0	0	0	100	0	100	0	100	50	100	0	0	0	0			
0	0	0	1	0	100	100	55	0	80	0	0	0	0	55	0	85	5	45	40	90	0	1	0	0			
0	0	0	1	5	97	95	30	0	60	1	50	0	0	60	0	80	25	80	80	98	0	1	0	0			
1	1	1	1	0	1	1	2	0	0	0	0	0	0	15	0	90	40	0	0	100	0	1	0	100			
46	0	0	0	100	54	8	0	0	0	0	0	0	92	0	0	69	0	0	0	100	0	0	0	100			
90	1	0	5	70	2	10	0	3	2	75	35	5	100	60	0	95	60	0	0	100	0	5	0	100			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	50	25	0	0	100	0	0	0	100			
95	1	1	7	0	1	7	98	5	0	0	0	0	0	50	0	90	75	0	10	100	0	10	0	100			
0	94	100	94	94	94	94	100	100	0	0	100	100	0	13	30	6	6	0	0	100	0	100	0	100			
0	100	94	0	88	100	100	100	0	0	0	0	94	0	0	88	0	100	0	0	100	0	94	0	100			
0	99	99	1	99	98	100	99	1	1	0	1	95	1	10	90	5	90	0	2	100	0	100	0	100			
0	99	99	1	99	98	100	99	1	1	0	1	95	1	10	30	20	75	0	2	100	0	92	0	100			
35	95	99	2	95	97	97	99	5	2	0	5	95	0	5	90	90	90	0	2	100	0	2	0	100			
0	100	100	0	98	100	100	100	50	0	0	0	100	5	0	0	65	70	0	0	100	0	0	0	100			
0	0	100	0	100	100	100	100	0	0	0	0	89	0	33	89	100	89	0	0	100	0	44	0	100			
5	100	100	0	100	100	100	100	0	8	0	15	8	0	25	96	50	95	0	0	100	0	15	0	95			
0	90	0	1	100	95	98	0	0	0	1	0	45	1	0	0	85	1	0	0	98	0	0	0	95			
0	1	80	10	10	90	70	50	10	0	1	0	0	0	0	50	100	0	0	10	100	0	0	0	100			

Continued

TABLE 19-12 Biochemical Reactions of the Named Species and Unnamed Groups of the Family Enterobacteriaceae—cont'd

Organism	Indole production	Methyl red	Voges-Proskauer	Citrate (Simmons)	Hydrogen sulfide (TSI)	Urea hydrolysis	Phenylalanine deaminase	Lysine decarboxylase	Arginine dihydrolase	Ornithine decarboxylase	Motility	Gelatin hydrolysis (22° C)	Growth in KCN	Malonate utilization	D-Glucose, acid	D-Glucose, gas	Lactose fermentation	Sucrose fermentation	D-Mannitol fermentation	Dulcitol fermentation	Salicin fermentation	Adonitol fermentation
<i>Salmonella</i> serotype Paratyphi A	0	100	0	0	10	0	0	0	15	95	95	0	0	0	100	99	0	0	100	90	0	0
<i>Salmonella</i> serotype Pullorum	0	90	0	0	90	0	0	100	10	95	0	0	0	0	100	90	0	0	100	0	0	0
<i>Salmonella</i> serotype Typhi	0	100	0	0	97	0	0	98	3	0	97	0	0	0	100	0	1	0	100	0	0	0
<i>Serratia entomophila</i>	0	20	100	100	0	0	0	0	0	0	100	100	100	0	100	0	0	100	100	0	100	0
<i>Serratia ficaria</i>	0	75	75	100	0	0	0	0	0	0	100	100	55	0	100	0	15	100	100	0	100	0
<i>Serratia fonticola</i>	0	100	9	91	0	13	0	100	0	97	91	0	70	88	100	79	97	21	100	91	100	100
<i>Serratia liquefaciens</i>	1	93	93	90	0	3	0	95	0	95	95	90	90	2	100	75	10	98	100	0	97	5
<i>Serratia marcescens</i>	1	20	98	98	0	15	0	99	0	99	97	90	95	3	100	55	2	99	99	0	95	40
<i>Serratia marcescens</i> biogroup 1	0	100	60	30	0	0	0	55	4	65	17	30	70	0	100	0	4	100	96	0	92	30
<i>Serratia odorifera</i> biogroup 1	60	100	50	100	0	5	0	100	0	100	100	95	60	0	100	0	70	100	100	0	98	50
<i>Serratia odorifera</i> biogroup 2	50	60	100	97	0	0	0	94	0	0	100	94	19	0	100	13	97	0	97	0	45	55
<i>Serratia plymuthica</i>	0	94	80	75	0	0	0	0	0	0	50	60	30	0	100	40	80	100	100	0	94	0
<i>Serratia rubidua</i>	0	20	100	95	0	2	0	55	0	0	85	90	25	94	100	30	100	99	100	0	99	99
<i>Shigella boydii</i>	25	100	0	0	0	0	0	0	18	2	0	0	0	0	100	0	1	0	97	5	0	0
<i>Shigella dysenteriae</i>	45	99	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	100	0	0	0
<i>Shigella flexneri</i>	50	100	0	0	0	0	0	0	5	0	0	0	100	0	100	3	1	1	95	1	0	0
<i>Shigella sonnei</i>	0	100	0	0	0	0	0	0	2	98	0	0	0	0	100	0	2	1	99	0	0	0
<i>Tatumella ptyseos</i>	0	0	5	2	0	0	90	0	0	0	0	0	0	0	100	0	0	98	0	0	55	0
<i>Trabulsiella guamensis</i>	40	100	0	88	100	0	0	100	50	100	100	0	100	0	100	100	0	0	100	0	13	0
<i>Xenorhabdus nematophilus</i>	40	0	0	0	0	0	0	0	0	0	100	80	0	0	80	0	0	0	0	0	0	0
<i>Yersinia aldovae</i>	0	80	0	0	0	60	0	0	0	40	0	0	0	0	100	0	0	20	80	0	0	0
<i>Yersinia bercovieri</i>	0	100	0	0	0	60	0	0	0	80	0	0	0	0	100	0	20	100	100	0	20	0
<i>Yersinia enterocolitica</i>	50	97	2	0	0	75	0	0	0	95	2	0	2	0	100	5	5	95	98	0	20	0
<i>Yersinia frederiksenii</i>	100	100	0	15	0	70	0	0	0	95	5	0	0	0	100	40	40	100	100	0	92	0
<i>Yersinia intermedia</i>	100	100	5	5	0	80	0	0	0	100	5	0	10	5	100	18	35	100	100	0	100	0
<i>Yersinia kristensenii</i>	30	92	0	0	0	77	0	0	0	92	5	0	0	0	100	23	8	0	100	0	15	0
<i>Yersinia mollaretii</i>	0	100	0	0	0	20	0	0	0	80	0	0	0	0	100	0	40	100	100	0	20	0
<i>Yersinia pestis</i>	0	80	0	0	0	5	0	0	0	0	0	0	0	0	100	0	0	0	97	0	70	0
<i>Yersinia pseudotuberculosis</i>	0	100	0	0	0	95	0	0	0	0	0	0	0	0	100	0	0	0	100	0	25	0
<i>Yersinia ruckeri</i>	0	62	0	0	0	62	0	0	0	25	0	0	0	0	100	0	0	100	100	0	0	0
<i>Yersinia ruckeri</i>	0	97	10	0	0	0	0	50	5	100	0	30	15	0	100	5	0	0	100	0	0	0
<i>Yokenella regensburgei</i> (<i>Kosserella trabulsii</i>)	0	100	0	92	0	0	0	100	8	100	100	0	92	0	100	100	0	0	100	0	8	0
Enteric Group 58	0	100	0	85	0	70	0	100	0	85	100	0	100	85	100	85	30	0	100	85	100	0
Enteric Group 59	10	100	0	100	0	0	30	0	60	0	100	0	80	90	100	100	80	0	100	0	100	0
Enteric Group 60	0	100	0	0	0	50	0	0	0	100	75	0	0	100	100	100	0	0	50	0	0	0
Enteric Group 68	0	100	50	0	0	0	0	0	0	0	0	0	100	0	100	0	0	100	100	0	50	0
Enteric Group 69	0	0	100	100	0	0	0	0	100	100	100	0	100	100	100	100	100	25	100	100	100	0

From the Centers for Disease Control and Prevention, Atlanta, Ga.

TSI, Triple sugar iron; KCN, potassium cyanide; ONPG, o-nitrophenyl- β -D-galactopyranoside.

*Each number is the percentage of positive reactions after 2 days of incubation at 36° C unless noted otherwise. Most of these positive reactions occur within 24 hours. Reactions that become positive after 2 days are not considered.

	myo-Inositol fermentation			D-Sorbitol fermentation			L-Arabinose fermentation			Raffinose fermentation			L-Rhamnose fermentation			Maltose fermentation			D-Xylose fermentation			Trehalose fermentation			Cellobiose fermentation			Alpha-methyl-D-glucoside fermentation			Erythritol fermentation			Esculin hydrolysis			Melibiose fermentation			D-Arabitol fermentation			Glycerol fermentation			Mucate fermentation			Tartrate, Jordan's			Acetate utilization			Lipase (corn oil)			DNase (25° C)			Nitrate nitrite			Oxidase, Kovacs			ONPG test			Yellow pigment			D-Mannose fermentation			Tyrosine utilization			D-Galactose			Citrate, Christensen's																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
	0	95	100	0	100	95	0	100	90	90	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0</

TABLE 6-10 Differentiation of Species Within the Genus *Shigella*

Biochemical Test	<i>S. dysenteriae</i>	<i>S. flexneri</i>	<i>S. boydii</i>	<i>S. sonnei</i>
Serogroup	A	B	C	D
ONPG	—	—	—	+
Ornithine decarboxylase	—	—	—	+
Fermentation of:				
Lactose	—	—	—	—
Mannitol	—	+	+	+
Raffinose	—	d	—	—
Sucrose	—	—	—	—
Xylose	—	—	d	—
Indole production	d	d	d	—

+, 90% or more strains positive; —, 90% or more strains negative; d, different strains positive/negative.

TABLE 6-15 Differentiation of Species Within the Genus *Citrobacter*^a

Biochemical Test	<i>Citrobacter</i>										
	<i>koseri</i>	<i>werkmanii</i>	<i>sedlakii</i>	<i>rodentium</i>	<i>gillenii</i>	<i>amalon- aticus</i>	<i>farmeri</i>	<i>braakii</i>	<i>freundii</i>	<i>murlinae</i>	<i>youn- gae</i>
Adonitol	+	—	—	—	—	—	—	—	—	—	—
Malonate	+	+	+	+	+	—	—	—	—	—	—
Ornithine	+	—	+	+	—	+	+	+	—	—	—
Melibiose	—	—	+	—	V (67)	—	+	V (78)	+	V (33)	—
Sucrose	V (44)	—	—	—	V (33)	V (13)	+	—	+	V (33)	V (19)
Indole	+	—	+	—	—	+	+	V (33)	V (38)	+	V (14)
Dulcitol	V (38)	—	+	—	—	—	—	V (33)	V (13)	+	V (86)
H ₂ S	—	+	—	—	V (67)	V (13)	—	V (60)	V (75)	V (67)	V (67)

^aData obtained from reference 67.

+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive; numbers in parentheses are percentage of strains giving positive reaction.

TABLE 6-16 Differentiation of the Major Genera and Species Within the Tribe *Klebsiellae*

Biochemical Test	<i>Klebsiella</i>		<i>Enterobacter</i>		<i>Pantoea</i>	<i>Hafnia</i>	<i>Serratia</i>	
	<i>K. pneumoniae</i>	<i>K. oxytoca</i>	<i>E. aerogenes</i>	<i>E. cloacae</i>	<i>P. agglomerans</i>	<i>H. alvei</i>	<i>S. marcescens</i>	<i>S. liquefaciens</i>
Indole	—	+	—	—	V (20)	—	—	—
Motility	—	—	+	+	V (85)	V (85)	+	+
Lysine	+	+	+	—	—	+	+	+
Arginine	—	—	—	+	—	—	—	—
Ornithine	—	—	+	+	—	+	+	+
DNase (25°C)	—	—	—	—	—	—	+	V (85)
Gelatinase (22°C)	—	—	—	—	—	—	+	+
Fermentation of:								
Lactose	+	+	+	+	V (40)	—	—	—
Sucrose	+	+	+	+	V (75)	—	+	+
Sorbitol	+	+	+	+	V (30)	—	+	+
Adonitol	+	+	+	V (25)	—	—	V (40)	—
Arabinose	+	+	+	+	+	+	—	+

+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive.

TABLE 6-20 Differentiation of Clinically Important Species Within the Genus *Serratia*^a

Biochemical Test	<i>S. marcescens</i>	<i>S. liquefaciens</i>	<i>S. rubidaea</i>	<i>S. plymuthica</i>	<i>S. ficaria</i>	<i>S. fonticola</i>	<i>S. odorifera</i> Biogroup	
							1	2
DNase (25°C)	+	V (85)	+	+	+	—	+	+
Lipase (corn oil)	+	V (85)	+	V (70)	V (77)	—	V (35)	V (65)
Gelatinase (22°C)	+	+	+	V (60)	+	—	+	+
Lysine (Moeller's)	+	+	V (55)	—	—	+	+	+
Ornithine (Moeller's)	+	+	—	—	—	+	+	—
Odor of potatoes	—	—	V	—	+	—	+	+
Red, pink, or orange pigment	V	—	V	V	—	—	—	—
Fermentation of:								
L-Arabinose	—	+	+	+	+	+	+	+
D-Arabitol	—	—	V (85)	—	+	+	—	—
D-Sorbitol	+	+	—	V (65)	+	+	+	+
Sucrose	+	+	+	+	+	V (21)	+	—
Raffinose	—	V (85)	+	+	V (70)	+	+	—
Malonate utilization	—	—	+	—	—	+	—	—

+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive.

Table includes only those *Serratia* species that have been isolated from human clinical specimens.

^aData obtained from reference 253 and Table 6-7.

TABLE 6-21 Differentiation of Species Within the Members of the Genus *Proteus*^a

TEST	<i>P. mirabilis</i>	<i>P. myxofaciens</i>	<i>P. penneri</i>	<i>P. vulgaris</i>	<i>P. hauseri</i>	<i>Proteus vulgaris</i> biogroup 3		
						DNA Group 4	DNA Group 5	DNA Group 6
Ornithine	+	—	—	—	—	—	—	—
Indole	—	—	—	+	+	+	+	+
Esculin	—	—	—	+	—	—	—	V (9)
Salicin	—	—	—	+	—	—	—	V (9)
Lipase	+	+	V (35)	V (14)	—	+	+	V (90)
Tartrate	V (87)	+	V (89)	V (14)	—	+	+	+
Rhamnose	—	—	—	—	—	+	V (17)	—
DNase 25°C	V (50)	V (50)	V (12)	+	—	+	+	V (55)
Acetate	V (20)	—	V (12)	V (14)	—	—	V (12)	V (18)

^aData obtained from reference 478.
+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive; numbers in parentheses are the percentages of strains giving positive reactions.

TABLE 6-22 Differentiation of Species Within the Genus *Morganella*^a

Biochemical Test	<i>M. Morganii</i> subsp. <i>morganii</i> Biogroups				<i>M. morganii</i> subsp. <i>sibonii</i> Biogroups		
	A	B	C	D	E	F	G
Lysine	—	+	—	+	+	d+	—
Ornithine	+	+	—	—	+	—	+
Trehalose	—	—	—	—	+	+	+
Tetracycline (% susceptible)	100 ^b	100	14	100	0	0	21
Motility	+	—	d+	—	+	+	+

^aData obtained from reference 328.
^bStrains with a zone of ≥28 mm around tetracycline were considered susceptible (minimal inhibitory concentration [MIC] correlate, ≤2 µg/mL), and those with a zone diameter ≤15 mm were considered tetracycline-resistant (MIC correlate, ≥32 µg/mL).
+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive; d+, delayed reaction, 50%–89% positive within 48 hour.

TABLE 6-23 Differentiation of Species Within the Genus *Providencia*^a

Biochemical Test	<i>P. alcalifaciens</i>	<i>P. rustigianii</i>	<i>P. heinbachae</i>	<i>P. stuartii</i>	<i>P. rettgeri</i>
Urea hydrolysis	—	—	—	V (30)	+
Citrate utilization	+	—	—	+	+
Fermentation of:					
Inositol	—	—	V (46)	+	1
Adonitol	+	—	+	—	+
Arabitol	—	—	+	—	+
Trehalose	—	—	—	+	—
Galactose	—	+	+	+	+

+, 90% or more strains are positive; —, 90% or more strains are negative.
^aData obtained from reference 450 and other sources.

TABLE 6-24 Differentiation of Species Within the Genus *Yersinia*^a

Biochemical Test	<i>Y. pestis</i>	<i>Y. pseudotuberculosis</i>	<i>Y. enterocolitica</i>	<i>Y. frederiksenii</i>	<i>Y. intermedia</i>	<i>Y. kristensenii</i>	<i>Y. aldovae</i>	<i>Y. bercovieri</i>	<i>Y. mollaretii</i>	<i>Y. rohdei</i>
Indole	—	—	V (50)	+	+	V (30)	—	—	—	—
Ornithine	—	—	+	+	+	+	V (40)	V (80)	V (80)	V (25)
Motility 25–28°C	—	+	+	+	+	+	+	+	+	NA
Fermentation of:										
Sucrose	—	—	+	+	+	—	V (20)	+	+	+
Rhamnose	—	V (70)	—	+	+	—	—	—	—	—
Cellobiose	—	—	V (75)	+	+	+	—	+	+	V (25)
Sorbitol	V(50)	—	+	+	+	+	V (60)	+	+	+
Melibiose	V(50)	V (70)	—	—	V (80)	—	—	—	—	V (50)

^aData obtained from references 43, 660, and other sources. All tests were done at 25°C–28°C.
 +, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive; NA, results not available.

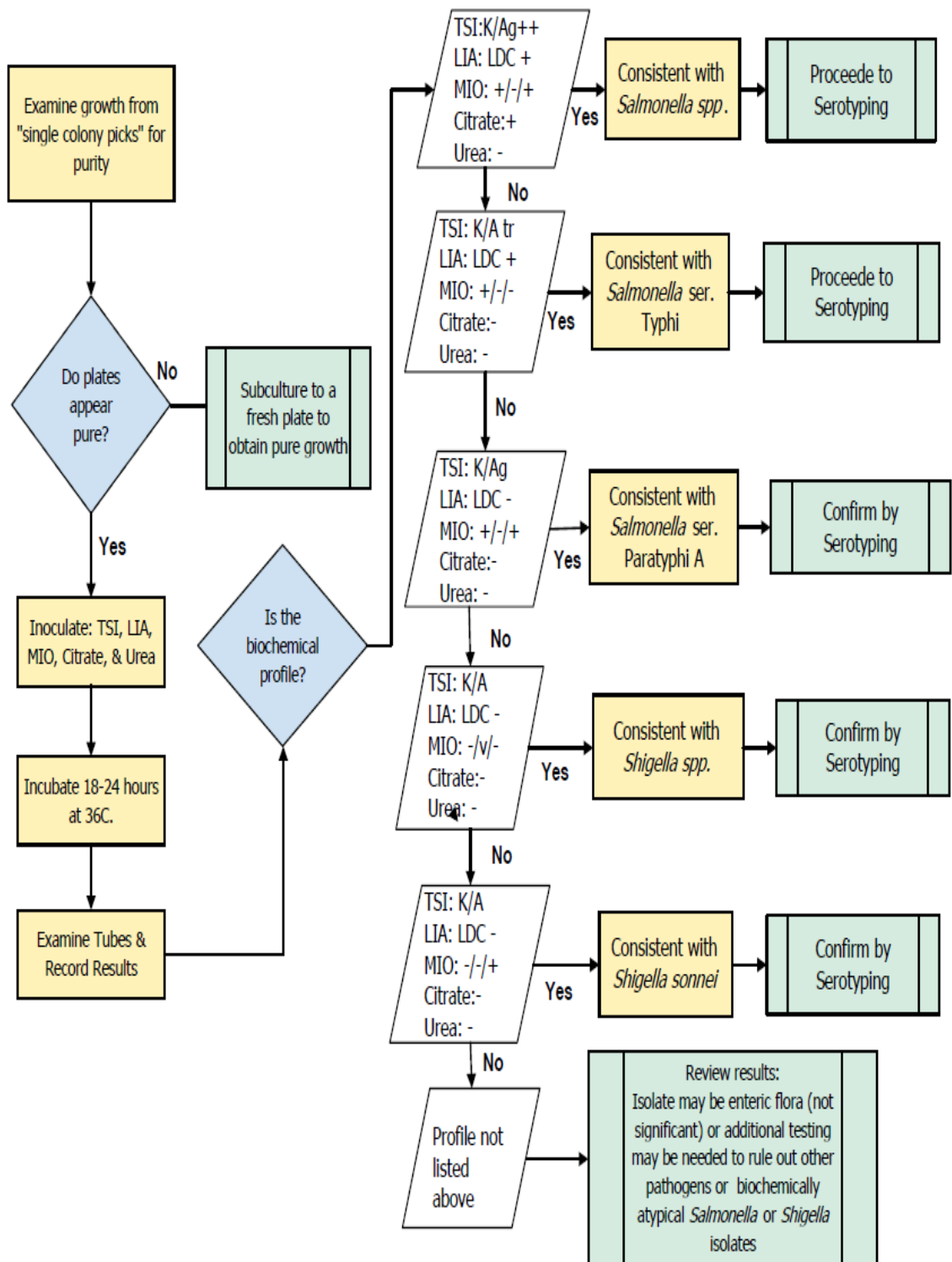


TABLE 19-11 Stool Culture Screening for Enteric Pathogens Utilizing TSI and LIA in Combination

LIA Reactions	TSI Reactions							
	K/A H ₂ S	K/AG H ₂ S	K/AG	K/A	A/A H ₂ S	A/AG	A/A	K/K
R/A		<i>P. vulgaris</i> <i>P. mirabilis</i>	<i>M. morganii</i> <i>Providencia</i>	<i>M. morganii</i> <i>Providencia</i>	<i>P. vulgaris</i> <i>P. mirabilis</i>	—	<i>Providencia</i>	—
K/K H ₂ S	<i>Salmonella</i> *	<i>Salmonella</i> *	<i>Salmonella</i> *	<i>Salmonella</i> *	—	—	—	—
K/K	<i>Edwardsiella</i> <i>Salmonella</i>	<i>Edwardsiella</i> *	<i>Hafnia</i> <i>Klebsiella</i> <i>Serratia</i>	<i>Salmonella</i> *	—	<i>Klebsiella</i> <i>Enterobacter</i> <i>E. coli</i>	<i>Serratia</i>	<i>Pseudomonas</i> *
K/A H ₂ S	—	<i>Salmonella</i> *	—	<i>Serratia</i>	—	—	—	—
K/A	—	<i>Citrobacter</i>	<i>Salmonella</i> *	<i>Shigella</i> *	<i>Citrobacter</i>	<i>Aeromonas</i> *† <i>E. coli</i> <i>Citrobacter</i> <i>Enterobacter</i>	<i>Aeromonas</i> *† <i>Yersinia</i> <i>Citrobacter</i> <i>Enterobacter</i>	—
			<i>Shigella</i> <i>Aeromonas</i> † <i>E. coli</i> <i>Enterobacter</i> <i>Citrobacter</i>	<i>Yersinia</i> <i>Aeromonas</i> † <i>E. coli</i> <i>Enterobacter</i>				

Data from the Microbiology Laboratory, The Ohio State University Hospitals and Maureta Ott, Columbus, Ohio.

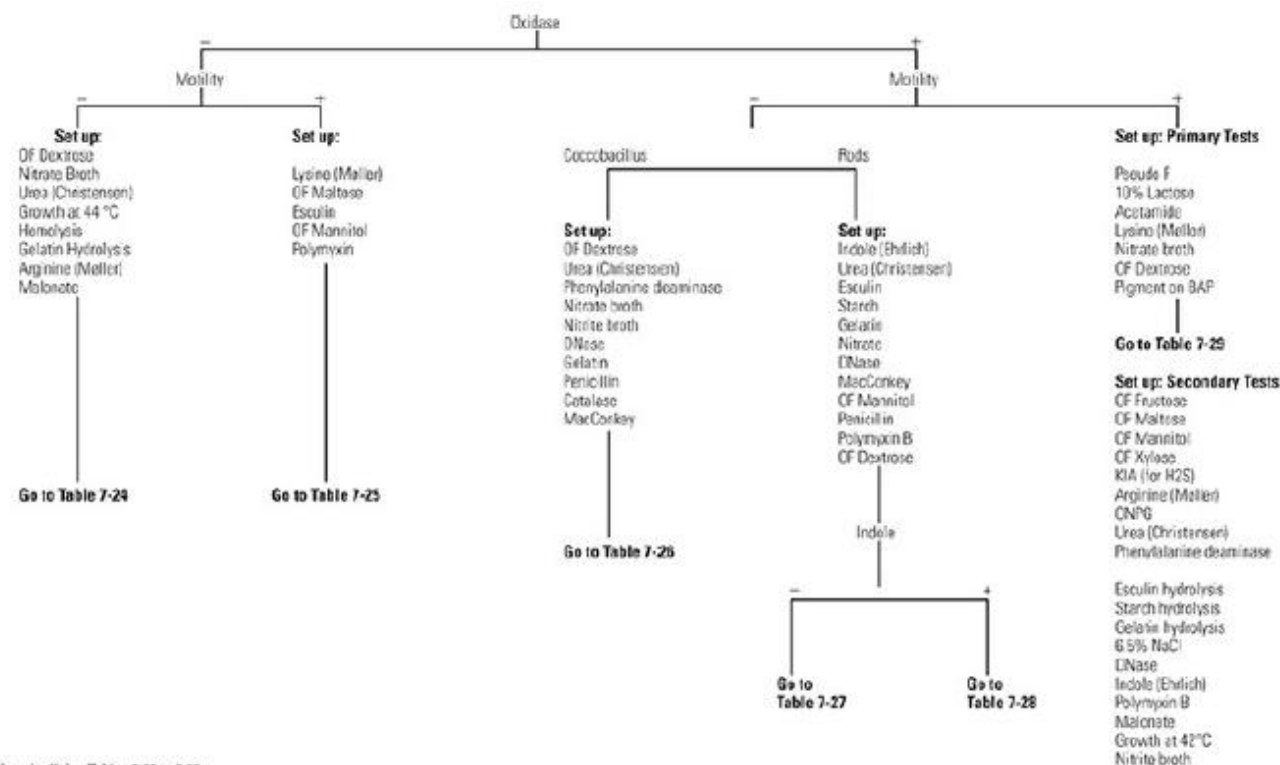
LIA, lysine-iron agar; TSI, triple sugar iron; K, alkaline; A, acid; G, gas; R, deamination (red slant).

*Results of TSI and LIA reactions in this category indicate a potential pathogen; additional tests must be performed.

†Oxidase positive.

Nonfermentative Gram Negative Bacilli

TABLE 7-23 Practical Approach to the Identification of Nonfermenters



Instructions for Using Tables 7-23 to 7-37

This approach to the identification of nonfermenters is designed to minimize the number of biochemical tests needed for identification based on a preliminary assessment of the oxidase and motility reactions of organisms to be identified. Once this information is known, a specific battery of tests is performed to complete the identification of the organism. For those organisms that are both oxidase positive and motile, a two-step approach is used based on the reactions obtained in a primary test battery followed by additional supplemental tests that are specified in the designated Tables. Depending on the needs and resources available, the user of this guide may wish to set up all of the tests included in the primary and secondary batteries whenever a motile, oxidase-positive nonfermenter is encountered in order to obtain a definitive identification in the shortest time possible. As a general rule when working with NFBs, a heavy inoculum should be used and reactions should be held 48 hours before the final reading is taken.

Steps to Follow

1. Determine the motility and oxidase reactions and follow the flow diagram in Table 7-23.
2. Set up the specified biochemical tests and go to the Table indicated to complete the identification.
3. To utilize Tables 7-24 to 7-37, begin with the first biochemical test listed on the left hand side of the Table and locate the shaded box or boxes in the upper left hand corner.
4. If a single box is shaded, and if the reaction given matches the reaction obtained with your specimen, you are done. The organism identification is listed in the same row to the left of the box.
5. If multiple boxes are shaded and the reaction matches that of your specimen, use the reactions to the right of the shaded boxes to determine the correct identification.
6. If the reaction obtained with your specimen does not match that in the shaded box or boxes, proceed to the next column on the right and find the shaded box or boxes in this column. Repeat steps 4 and 5 until you reach a definitive identification.
7. Special consideration must be given to shaded boxes that contain a variable (V) reaction sign. In these rare cases, you must treat the variable reaction in the shaded box as both a match and a nonmatch.

TABLE 7-24 Oxidase-Negative, Nonmotile Nonfermenters^a

Organism ^b	Genomosppecies	Yellow Pigment	Urease	Nitrate Reduced	Brown Soluble Pigment	Growth at 37°C	Growth at 44°C	Hemolysis Sheep Blood	Gelatin Hydrolysis	OF Dextrose	Arginine	Malonate
CDC E0-5		+	+	—	—	+	—	NA	—	+	—	NA
<i>Bordetella parapertussis</i>		—	+	—	—	+	NA	+	NA	—	NA	NA
CDC NO-1		—	—	+	—	+	NA	—	—	—	—	NA
<i>Bordetella holmesii</i> (NO-2)		—	—	—	+	+	—	—	—	—	—	NA
<i>Acinetobacter johnsonii</i>	7	—	—	—	—	—	—	—	—	—	V (35)	V (13)
<i>Acinetobacter baumannii</i>	2	—	—	—	—	+	+	—	—	+	+	+
<i>Acinetobacter haemolyticus</i>	4	—	—	—	—	+	—	+	+	V (52)	+	—
<i>Acinetobacter</i> sp.	6	—	—	—	—	+	—	+	+	V (66)	+	—
<i>Acinetobacter bereziniae</i>	10	—	—	—	—	+	—	—	—	+	—	—
<i>Acinetobacter calcoaceticus</i>	1	—	—	—	—	+	—	—	—	+	+	+
<i>Acinetobacter pittii</i>	3	—	—	—	—	+	—	—	—	+	+	V (87)
<i>Acinetobacter radiorisistens</i>	12	—	—	—	—	+	—	—	—	V (33)	+	+
<i>Acinetobacter junii</i>	5	—	—	—	—	+	—	—	—	—	+	—
<i>Acinetobacter lwoffii</i>	8/9	—	—	—	—	+	—	—	—	—	—	—
<i>Acinetobacter guillouiae</i>	11	—	—	—	—	+	—	—	—	—	—	—

^aData from references 117, 249, 450, and 1171.
^bAll organisms included in this chart appear as gram-negative coccobacilli on Gram's stain.
^cAlso consider *Granulibacter bethesdaensis* (see Table 7-18).
^dBrown soluble pigment produced when grown at 35°C heart infusion tyrosine agar.
^eMust also be OF dextrose positive.
^f+, 90% or more of strains are positive; —, 90% or more of strains are negative; V, 11%–89% strains positive; NA, results not available; numbers in parentheses are percentage of strains giving positive reaction. Instructions for interpreting table using shaded boxes are provided under heading "Steps to Follow" on p.392.

TABLE 7-25 Oxidase-Negative, Motile Nonfermenters^a

Organism	Lysine Decarboxylase	Esculin	OF Maltose	OF Mannitol	Polymyxin B	Pigment	Additional Characteristics
<i>Stenotrophomonas maltophilia</i>	+	+	+	—	S	Yellow Lavender	DNase positive
<i>Burkholderia cepacia</i> complex	+	V (67)	+	+	R	White or yellow	DNase negative Lipase positive
<i>Sphingomonas paucimobilis</i>	—	+	+	—	V (89)	Deep yellow	Vancomycin sensitive
<i>Pseudomonas luteola</i>	—	+	+	+	S	Dull yellow	
<i>Pseudomonas oryzae</i>	—	—	+	+	S	Dull yellow	
<i>Burkholderia multivorans</i>	V (53)	—	+	+	R	Grayish white	Lipase Pos
<i>Burkholderia gladioli</i>	—	—	—	+	R	Yellow	Lipase Pos
<i>Bordetella trematum</i>	—	—	—	—	NA	Grayish white	Acetamide and malonate Pos
<i>Kerstersia gyiorum</i>	—	—	—	—	NA	White to light brown	Acetamide and malonate Neg
<i>Pandoraea</i> species	—	—	—	—	R	Grayish white	Lipase Neg

^aData from references 209, 217, 250, 367, 438, and 1105.
^b+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive; NA, results not available; numbers in parentheses are percentage of strains giving positive reaction; R, resistant; S, susceptible. Instructions for interpreting table using shaded boxes are provided under heading "Steps to Follow" on p.392.

TABLE 7-26 Identification of Oxidase-Positive, Nonmotile Coccobacilli^a

Organism	Characteristic Odor or Appearance	OF Dextrose	DNase	Urease	Phenylalanine Deaminase	Gelatin Hydrolysis	Nitrate Reduced	Growth on MacConkey	Nitrite Reduced	Catalase	Growth at 35°C
<i>Psychrobacter immobilis</i> (saccharolytic)	Odor of FEA agar (reses)	+	—	+	+	—	V (86)	V	NA	+	—
<i>Paracoccus yeii</i> (CDC EO-2)	O-shaped cells ^b	+	—	+	NA	—	+	V (82)	NA	V (82)	+
CDC EO-3	Yellow colonies (100)	+	—	+	NA	—	—	+	NA	+	+
CDC EO-4	Yellow colonies (83)	+	NA	+	NA	—	—	+	NA	+	+
CDC EF-4b		+	NA	—	NA	—	+	V (65)	V	+	+
<i>M. canis</i>		—	+	—	—	—	+	+	V	+	+
<i>M. cetarhalis</i>		—	+	—	V	—	+	—	+	+	+
<i>Psychrobacter phenylpyruvicus</i> ^c		—	—	+	+	—	V (89)	+	—	Weak	+
<i>D. urethralis</i>	Small coccoid cells	—	—	—	+	—	—	V (83)	+	+	+
<i>M. lacunata</i>		—	—	—	—	+	+	—	—	Weak	+
<i>M. nonliquefaciens</i>		—	—	—	—	—	+	V (17)	—	+	+
<i>M. osloensis</i>		—	—	—	—	—	V (26)	V (49)	—	Weak	+
<i>M. atlantae</i>	Spreading or pitting colonies	—	—	—	—	—	—	+	V (20)	Weak or —	+
<i>M. lincolnii</i>	Coccus-like to plump rods	—	—	—	NA	—	—	—	V	+	+

^aData obtained from references 251, 367, 493, 754, 1102, 1170, and 1172.^bGram's stain smears show coccoid to short thick rods that are frequently vacuolated. Cells have unstained centers but are peripherally stained and appear as O's.^c*Brucella* species may be misidentified as *Psychrobacter phenylpyruvicus* in some commercial identification systems.

+, 90% or more strains positive; —, 90% or more strains negative; V, 11%–89% of strains positive; NA, results not available; numbers in parentheses are percentage of strains giving positive reaction. Instructions for interpreting table using shaded boxes are provided under heading "Steps to Follow" on p.352.

TABLE 7-11 Key Characteristics of *S. maltophilia* and *B. cepacia* complex^a

Test	<i>S. maltophilia</i>	<i>B. cepacia</i> Complex
Oxidase	–	+ (93)
Motility	+	+
Growth on MacConkey	+	+
OF glucose	A or Wk	A
OF maltose	A	A
OF lactose	V (86)	A
OF mannitol	–	A
NO ₃ reduction	V (42)	V (37)
NO ₃ to gas	–	–
Arginine	–	–
Lysine	+	V
Esculin hydrolysis	+	V (67)
ONPG	+ (93)	V (79)
DNase	+	–
Polymyxin B	S	R
Pigment	gray, slight yellow, lavender	gray, chartreuse, yellow

^a Data from reference 1172.

+, 90% or more strains positive; –, 90% or more strains negative; V, 11%–89% of strains positive; A, acid reaction; Wk, weak acid; S, susceptible; R, resistant; NA, not available. Numbers in parentheses are percentage of strains giving positive reaction.

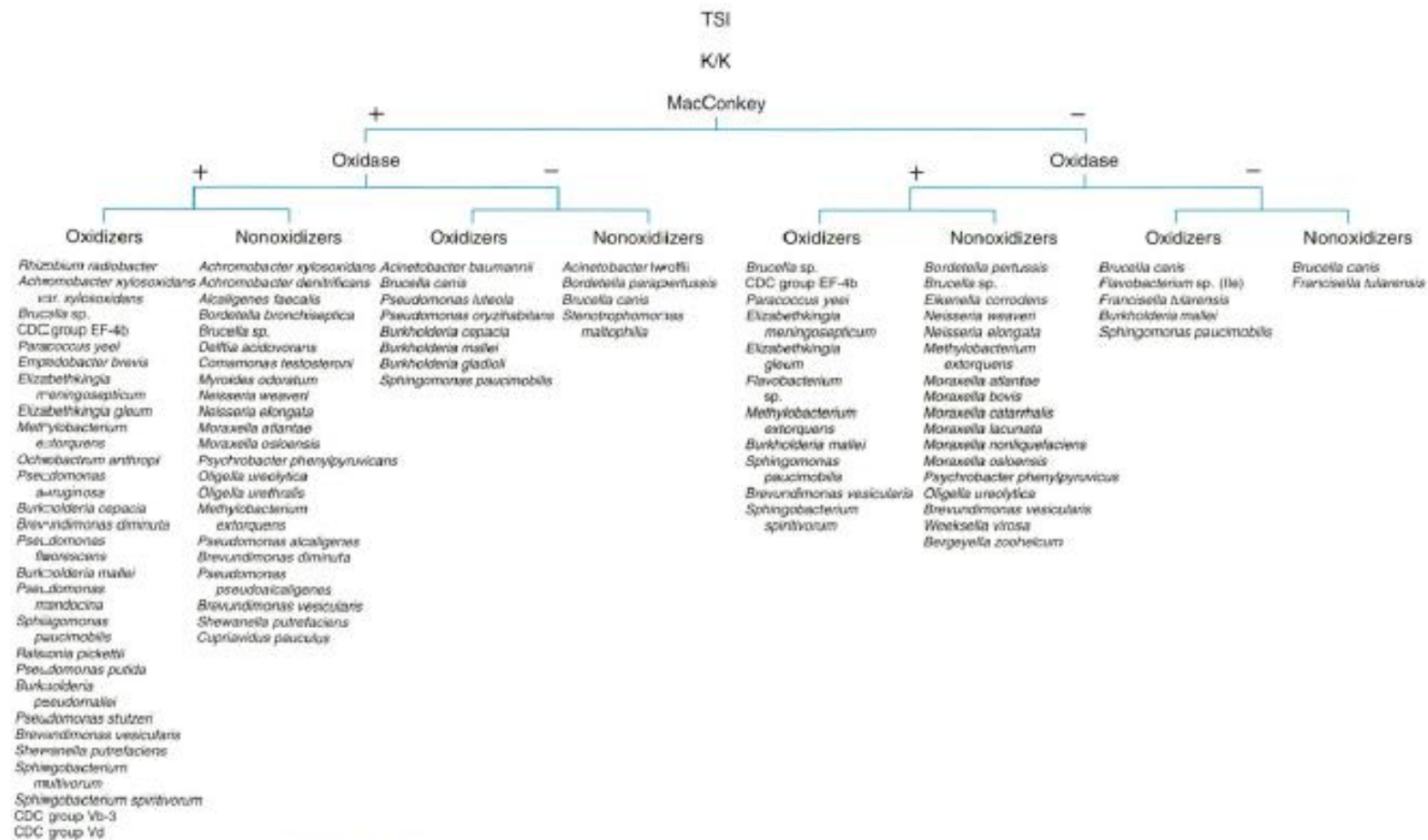


FIGURE 21-1 Grouping of nonfermenters based on eight possible results. TSI, Triple sugar iron; K/K, alkaline/alkaline. Some bacteria have variable results and belong to more than one group.

	MOTILE, STRONGLY SACCHAROLYTIC NONFERMENTERS										MOTILE, WEAK, OR NONSACCHAROLYTIC NONFERMENTERS										
	<i>Pseudomonas aeruginosa</i>	<i>Pseudomonas fluorescens/pulida</i>	<i>Burkholderia cepacia</i>	<i>Achromobacter xylosoxidans</i>	<i>Stenotrophomonas maltophilia</i>	<i>Burkholderia pseudomallei</i>	<i>Pseudomonas stutzeri</i>	<i>Sphingomonas paucimobilis</i>	<i>Pseudomonas mendocina</i>	<i>Ralstonia pickettii</i>	<i>Deftia acidovorans</i>	<i>Pseudomonas pseudoalcaligenes</i>	<i>Alcaligenes faecalis</i>	<i>Achromobacter denitrificans</i>	<i>Oligella ureolytica</i>	<i>Bordetella bronchiseptica</i>	<i>Pseudomonas alcaligenes</i>	<i>Brevundimonas diminuta</i>	<i>Brevundimonas vesicularis</i>	<i>Comamonas testosteroni</i>	<i>Shewanella putrefaciens</i>
Oxidase	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pyocyanin	+/-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorescein	+	-/+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glucose	+	+	+	+/-	+/-	+	+	+/-	+	+	-	-/+	-	-	-	-	-	-	+	-	-
Xylose	+	+	+/-	+	-	+	-/+	+/-	+	+	-	-	-	-	-	-	-	-	-	-	-
Mannitol	+/-	+/-	+/-	-	-	+	-/+	-	-	-	+/-	-	-	-	-	-	-	-	-	-	-
Lactose	-	-	+/-	-	-	+	+/-	+/-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maltose	-	-	+/-	-	+	+	+/-	+/-	-	-	-	-/+	-	-	-	-	-	-	+	-	-
42° C	+	-	+/-	+	+/-	+	+	-	+	+/-	-	+	+/-	-/+	-	+	+/-	-/+	+/-	+/-	+/-
Esculin	-	-	-/+	-	+	+/-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-
Urea	+	-/+	+/-	-	+/-	-/+	-/+	-/+	+/-	+	-	-	-/+	-	+	+	-/+	+/-	-	-	+/-
DNase	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	+	-	+
ONPG	-	-	+/-	-	+	-	-	+/-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indole	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Motility	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Flagella	1	>1	>1	P	>1	>1	1	1	1	1	>1	1	P	P	P	P	1	1	1	>1	1
H ₂ S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
N ₂ gas	+/-	-	-	-	-	+	+	-	+	-/+	-	-	+	+/-	+	-	-	-	-	-	-
Pigment	B,F,G	F	Y	-	Y	-	B,Y	Y	-	-	-	-	-	-	-	-	-	-	B,Y	-	B
Growth on MacConkey	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-/+	+/-	+

FIGURE 21-2 Biochemical and morphologic characteristics of selected nonfermentative gram-negative bacilli. ONPG, o-Nitrophenyl- β -D-galactopyranoside; +, most strains positive; -, most strains negative; B, brown; F, fluorescein; G, green; Y, yellow. (Data from the Ohio State University Hospital, Columbus, Ohio.)

	NONMOTILE, PIGMENTED, INDOLE-POSITIVE NONFERMENTERS				NONMOTILE COCCOBACILLI	
					Oxidase negative	
	<i>Elizabethkingia meningosepticum</i>	<i>Myroides odoratus</i>	<i>Bergeyella zoohelcum</i>	<i>Weeksella virosa</i>	<i>Moraxella</i> sp.	<i>Acinetobacter lwoffii</i>
						<i>Acinetobacter baumannii</i>
Oxidase	+	+	+	+	+	-
Pyocyanin	-	-	-	-	-	-
Fluorescein	-	-	-	-	-	-
Glucose	+/-	-	-	-	-	+
Xylose	-	-	-	-	-	+
Mannitol	-/+	-	-	-	-	-
Lactose	-	-	-	-	-	+
Maltose	-/+	-	-	-	-	+/-
42° C	+/-	-	-	-/+	-/+	+
Esculin	+	-	-	-	-	-
Urea	-/+	+	+	-/+	-	-/+
DNase	+	+	+	+	-	-/+
ONPG	+/-	-	-	-	-	-
Indole	+	-	-/+	+	-	-
Motility	-	-	-	-	-	-
Flagella	-	-	-	-	-	-
H ₂ S	-	-	-	-	-	-
N ₂ gas	-	-/+	-	-	-	-
Pigment	Y	Y	B	B	-	-
Growth on MAC	+	+	-	-	+/-	+

Flagella

1, Polar monotrichous



>1, Polar tuft (>1 flagellum)



P, Peritrichous

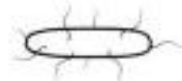


FIGURE 21-2, cont'd.

Gram Positive Cocci

TABLE 12-2 Phenotypic Characteristics for the Differentiation of *Staphylococcus*, *Micrococcus* and Related Species, and *Macrococcus*

Characteristic	Reaction/Description for:		
	<i>Staphylococcus</i>	<i>Micrococcus</i> and Related Species ^a	<i>Macrococcus</i>
Organism size	0.6–1.6 µm	1–1.8 µm	1.3–2.5 µm
Colony profile	Raised, low convex	Convex	Low convex, domed
Growth rate	Slow to rapid	Very slow	Slow
Fermentation of glucose	+	–	–
Furazolidone susceptibility (100 µg furazolidone disk)	S	R	S
Bacitracin susceptibility (0.04 unit TaxoA disk)	R	S	R
Modified oxidase test	– ^b	+	+
Susceptibility to lysostaphin	S	R	S
Facultative growth under a coverslip on blood agar	1+ to 4+	–/1+	NA
Acid production aerobically from glycerol in the presence of 0.4 µg/mL erythromycin	+	–	NA

^aIncludes the genera *Micrococcus*, *Kytococcus*, *Dermacoccus*, *Nesterenkonia*, and *Kocuria*.

^bAll *Staphylococcus* species are modified oxidase-negative except for *S. vitulinus*, *S. sciuri*, and *S. lentus*.
+, positive reaction; –, negative reaction; S, susceptible; R, resistant; NA, data not available.

TABLE 13-2 Phenotypic Characteristics for Presumptive Identification of Catalase-Negative, Gram-Positive Cocci

Genus	Gram Stain Morphology in Thioglycollate Broth	Hemolysis, SBA	Catalase	Growth, 10°C	Growth, 45°C	Motility	LAP	PYR	Growth, 6.5% NaCl Broth	Gas, MRS Broth	Vancomycin
<i>Streptococcus</i>	Chains	α, β, γ	–	–	V	–	+	–	V	–	S
<i>Enterococcus</i>	Pairs, chains	α, γ	–	+	+	V	+	+	+	–	S/R
<i>Abiotrophia</i>	Chains	α, γ	–	–	V	–	+	+	–	–	S
<i>Glanvilleella</i>	Chains	α, γ	–	–	V	–	+	+	–	–	S
<i>Aerococcus</i>	Tetrads, clusters	α	–	–	–	–	V	V	+	–	S
<i>Halococcus</i>	Tetrads, clusters	γ	–	–	–	–	–	+	+	–	S
<i>Leuconostoc</i>	Chains	α, γ	–	+	+	–	–	–	V	+	R
<i>Weissella</i>	Chains	α, γ	–	V	V	–	–	–	+	+	R
<i>Pediococcus</i>	Tetrads, clusters	α	–	–	+	–	+	–	V	–	R
<i>Tetragenococcus</i>	Tetrads, clusters	α	–	–	+	–	+	–	+	–	S
<i>Gemella</i>	Tetrads, clusters, chains	α, γ	–	–	–	–	V	+	–	–	S
<i>Vagococcus</i>	Chains	α, γ	–	+	–	+	+	+	+	–	S
<i>Alloivococcus</i>	Clusters, tetrads	α	+	–	–	–	+	+	+	–	S
<i>Globochaeta</i>	Chains	α	–	–	–	–	–	+	+	–	S
<i>Facklamia</i>	Clusters, chains	α	–	–	–	–	+	+	+	–	S
<i>Ureoplasma</i>	Clusters, tetrads	α	–	–	–	–	+	+	+	–	S
<i>Ignavigranum</i>	Clusters, chains	α	–	–	–	–	+	+	+	–	S
<i>Dolalicoccus</i>	Chains	α	–	–	–	–	–	+	–	–	S
<i>Emmococcus</i>	Chains	α	–	–	+	–	–	NA	+	–	S
<i>Catalicoccus</i>	Pairs, short chains	γ	–	–	NA	–	+	–	NA	–	S
<i>Lactococcus</i>	Chains	α, γ	–	+	V	–	+	+	V	–	S

+, positive reaction; –, negative reaction; V, variable reaction; +°, weak-positive reaction; S, susceptible; R, resistant; NA, data not available; LAP, leucine aminopeptidase; PYR, pyrrolidonyl arylamidase; MRS broth, Mann–Sharpe–Rogosa broth.

Gram Positive Cocci

Staphylococci

TABLE 12-5 Phenotypic Characteristics for Identification of Staphylococci Commonly Isolated From Human Clinical Specimens

Test	<i>S. aureus</i>	<i>S. epidermidis</i>	<i>S. saprophyticus</i>	<i>S. haemolyticus</i>	<i>S. warneri</i>	<i>S. hominis</i> subsp. <i>hominis</i>	<i>S. hominis</i> subsp. <i>novobioceticus</i>	<i>S. lugdunensis</i>	<i>S. schlegelii</i> subsp. <i>schlegelii</i>
Clumping factor	+	—	—	—	—	—	—	+ ^{sl}	+
Coagulase	+	—	—	—	—	—	—	—	—
Novobiocin	S	S	R	S	S	S	R	S	S
Polymyxin B	R	R	S	S	S	S	NA	S/R	S
PYR	—	—	—	+	—	—	—	+	+
ODC	—	V—	—	—	—	—	—	+	—
URE	V	+	+	—	+	+	+	V	—
ACET	+	+	+	+	+	V	V	+	+
PAL	+	+	—	—	—	—	—	—	+
Heat-stable nuclease	+	—	—	—	—	—	—	—	+
β-GAL	—	—	+	—	—	—	—	—	+ ^{sl}
Acid produced aerobically from:									
GLU	+	+	+	+	+	+	+	+	+
MAL	+	+	+	+	+ ^{sl}	+	+	+	—
SUC	+	+	+	+	+	+ ^{sl}	+ ^{sl}	+	—
MNTL	+	—	V	V	V	—	—	—	—
MANN	+	+ ^{sl}	—	—	—	—	—	+	+
TREH	+	—	+	+	+	V	—	+	V

+ , positive reaction; — , negative reaction; +^{sl} , slow or delayed positive reaction; V , variable reaction; V— , variable reaction, most strains negative; S , susceptible; R , resistant; NA , data not available; PYR , Pyrrolidonyl arylamidase; ODC , Ornithine decarboxylase; URE , Urease; PAL , Alkaline phosphatase; ACET , Acetoin (VP); β-GAL , β-Galactosidase; GLU , Glucose; MAL , Maltose; SUC , Sucrose; MNTL , Mannitol; MANN , Mannose; TREH , Trehalose

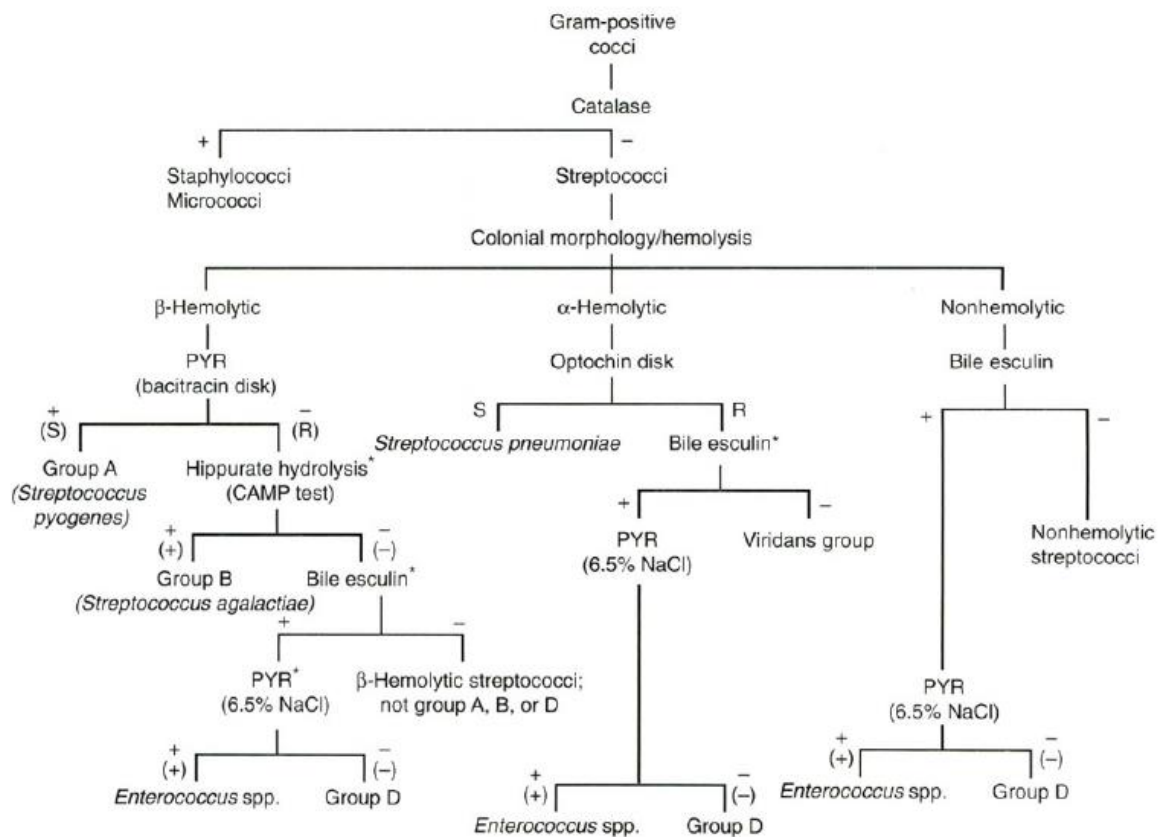
Gram Positive Cocci

Streptococci & Enterococci

TABLE 13-3 Phenotypic Criteria for Presumptive Identification of Clinically Significant Streptococci and Enterococci

Organism	Hemolysis, SBA	LAP	Bacitracin	SXT	CAMP Test	HIPP	Growth, BE Agar	PYR	Growth, 6.5% NaCl Broth	Optochin	Bile Solubility
Group A <i>Streptococcus</i>	β	+	S	R	–	–	–	+	–	R	–
Group B <i>Streptococcus</i>	β, γ	+	R	R	+	+	–	–	V	R	–
Groups C, F, and G streptococci	β, γ	+	V	S	–	–	–	–	–	R	–
Group D <i>Enterococcus</i>	α, β, γ	+	R	R	–	V	+	+	+	R	–
Group D <i>Streptococcus</i>	α, γ	+	R	S	–	–	+	–	–	R	–
<i>Viridans streptococci</i>	α, γ	+	V	S	–	V	V	–	–	R	–
<i>Pneumococcus</i>	α	+	V	S	–	–	–	–	–	S	+

+, positive reaction; –, negative reaction; V, variable reaction; S, Susceptible; R, Resistant; LAP, leucine aminopeptidase; SXT, trimethoprim-sulfamethoxazole; HIPP, hippurate hydrolysis; BE agar, bile esculin agar; PYR, pyrrolidonyl arylamidase.



*Perform additional tests if isolate is from nonrespiratory source.

FIGURE 15-15 Schematic diagram for the presumptive identification of gram-positive cocci. S, Susceptible; R, resistant.

TABLE 15-5 Phenotype and Biochemical Characteristics of Enterococcal Species

<i>Enterococcus</i> Species	MOT	MAN	SOR	ARA	RAF	TEL	ARG	PYU	MGP
<i>E. faecalis</i>	—	+	—	—	—	+	+	+	—
<i>E. faecium</i>	—	+	—	+	V	—	+	—	—
<i>E. durans</i>	—	—	—	—	—	—	+	—	—
<i>E. avium</i>	—	+	+	+	—	—	—	+	+
<i>E. casseliflavus</i>	+	+	—	+	+	—	+	V	+
<i>E. gallinarum</i>	+	+	—	+	+	—	+	—	+
<i>E. raffinosus</i>	—	+	+	+	+	—	—	+	+

Data from Teixeira LM et al: *Enterococcus*. In Murray PR et al, editors: *Manual of clinical microbiology*, ed 9, Washington, DC, 2007, ASM Press.

MOT, Motility; MAN, mannitol; SOR, sorbose; ARA, arabinose; RAF, raffinose; TEL, tellurite; ARG, arginine; PYU, pyruvate; MGP, methyl α -D-glucopyranoside; +, positive test; —, negative test; V, variable test.

*Occasional exceptions occur.

TABLE 13-10 Phenotypic Characteristics for Identification of *Enterococcus* and Related Species

Group/Species	Group D Antigen	Growth, BE Agar	Growth, 5.5% NaCl	Growth, 10° C	Growth, 45° C	LAP	PYR	MOT	YELLOW PIGM	ADH	HIP	GLU	MNTL	Acid Produced From:									
														SOR	ARAB	SRTL	RAFF	SUC	PYRV	MGP			
Group I																							
<i>E. avium</i>	+	+	+	NA	+	+	+	-	-	-	V	+	+	+	+	+	-	+	+	V			
<i>E. gilvus</i>	+	+	+	+	+	+	+	-	+	-	-	+	+	+	+	+	+	+	+	+			
<i>E. malodoratus</i>	+	+	+	NA	-	+	+	-	-	-	V	+	+	+	-	+	+	+	+	V			
<i>E. pallens</i>	+	+	+	+	+	+	-	-	+	-	+	+	+	+	+	+	+	+	+	-			
<i>E. pseudovirium</i>	-	+	-	+	+	+	+	-	-	-	+	+	+	+	-	+	-	+	+	+			
<i>E. raffinosus</i>	+	+	+	+	+	+	+	-	-	-	-	+	+	+	+	+	+	+	+	V			
<i>E. saccharovorans</i>	-	NA	+	NA	NA	+	-	-	-	-	-	+	+	+	-	+	+	+	-	+			
<i>E. hawaiiensis</i>	-	-	+	+	-	+	-	-	-	-	-	+	+	+	-	+	-	-	+	-			
<i>E. duriae</i>	NA	+	+	+	-	V	V	-	-	-	NA	+	+	V	V	V	+	+	NA	-			
Group II																							
<i>E. faecalis</i>	+	+	+	+	+	+	+	-	-	+	+	+	+	-	-	+	-	+	+	-			
<i>E. faecium</i>	+	+	+	+	+	+	+	-	-	+	-	+	+	-	+	V	V	+	-	-			
<i>E. casseliflavus</i>	+	+	+	NA	+	+	+	+	+	+	-	+	+	-	+	V	+	+	V	+			
<i>E. gallinarum</i>	+	+	+	+	+	+	+	+	-	+	+	+	+	-	+	-	+	+	-	+			
<i>E. mundtii</i>	+	+	+	+	+	+	+	-	+	+	-	+	+	-	+	V	+	+	-	-			
<i>E. haemophysodes</i>	+	+	+	+	-	+	+	-	+	+	+	+	+	-	-	-	-	+	-	+			
<i>E. silvestris</i>	NA	+	+	+	-	+	+	-	-	+	-	+	-	-	-	-	-	-	NA	-			
<i>E. termis</i>	NA	+	+	+	+	+	-	-	-	-	-	+	-	-	-	-	-	-	NA	+			
<i>E. cameliae</i>	NA	NA	-	+	+	NA	NA	-	-	-	NA	+	+	-	-	-	-	+	NA	-			
<i>E. thailandicus</i>	NA	NA	+	+	+	NA	NA	-	-	+	NA	+	+	-	-	-	-	+	NA	-			
<i>Lactococcus</i> spp.	-	-	-	-	-	-	-	-	-	+	V	+	+	-	-	-	-	V	-	-			
Group III																							
<i>E. dispar</i>	-	+	+	+	-	+	+	-	-	+	V	+	-	-	-	-	+	+	+	+			
<i>E. durus</i>	+	+	+	NA	+	+	+	-	-	+	V	+	-	-	-	-	-	-	-	-			
<i>E. hirae</i>	+	+	+	+	+	+	+	-	-	+	+	+	-	-	-	-	+	+	-	-			
<i>E. rotii</i>	+	+	+	+	+	+	+	-	-	+	V	+	-	-	-	-	-	-	-	-			
<i>E. villorum</i>	+	+	+	+	+	+	+	-	-	+	-	+	-	-	-	-	-	-	-	-			
<i>F. ruminantium</i>	-	+	+	-	+	V	V	-	-	+	-	+	-	-	-	-	-	-	NA	+			
Group IV																							
<i>E. asini</i>	+	+	-	V	V	+	+	-	-	-	+	+	-	-	-	-	-	-	-	V			
<i>E. cecorum</i>	-	NA	-	-	+	+	-	-	-	-	-	+	-	-	-	-	+	+	+	-			
<i>E. sulfureus</i>	-	+	+	+	-	+	+	-	+	-	-	+	-	-	-	-	+	+	-	+			
<i>E. phoeniccola</i>	NA	-	-	-	-	NA	NA	-	-	-	-	+	-	-	-	-	-	+	+	+			
<i>E. carceae</i>	+	+	+	+	+	+	+	-	-	-	-	+	-	-	-	-	-	+	+	+			
<i>E. aquamarinus</i>	NA	+	+	+	+	NA	+	-	-	-	-	+	-	-	+	-	+	+	NA	-			
Group V																							
<i>E. columbae</i>	-	+	-	-	NA	+	-	-	-	-	-	+	+	-	+	+	+	+	+	-			
<i>E. canis</i>	NA	+	+	NA	NA	+	+	-	-	-	-	+	+	-	+	-	-	V	+	+			
<i>E. marianensis</i>	+	+	+	+	-	+	V	-	-	-	+	+	+	-	+	-	-	-	+	+			
<i>E. hermaphrodensis</i>	-	+	V	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	NA	NA			
<i>E. italicus</i>	+	+	+	+	+	+	+	-	-	-	-	+	-	-	-	-	-	-	+	+			
<i>Vagococcus</i> spp.	-	NA	+	+	-	+	+	+	+	-	V-	-	+	+	-	-	+	-	+	+			
New Species																							
<i>E. riuorum</i>	V	+	-	+	-	NA	NA	-	-	V	-	+	+	-	-	+	-	+	NA	+			
<i>E. urelyticus</i> (urease +)	+	+	+	+	-	+	+	-	+	-	+	+	-	+	-	-	-	+	NA	-			
<i>E. rotii</i> (urease +)	+	+	+	+	-	+	+	-	+	-	+	+	-	-	-	-	-	+	NA	-			
<i>E. brasiliensis</i> (urease +)	NA	+	-	NA	+	+	+	-	-	-	+	+	V	NA	-	-	-	+	NA	+			
<i>E. quebecensis</i>	NA	+	-	NA	-	+	+	-	-	-	+	+	+	NA	-	-	-	+	NA	+			
<i>E. plantarum</i> (catalase +, urease +)	+	+	+	+	+	+	+	-	+	-	+	+	+	-	-	-	-	+	NA	-			
<i>E. lucis</i>	NA	+	+	+	+	+	+	-	-	+	-	+	+	-	V	-	-	-	NA	-			
<i>E. lentus</i>	-	+	+	+	+	+	+	-	-	-	-	+	+	NA	+	-	+	+	NA	+			
<i>E. eumekensis</i>	-	+	+	+	+	+	+	-	-	-	-	+	-	NA	-	-	+	+	NA	NA			
<i>E. alexandriae</i>	-	+	-	-	-	+	+	-	-	-	-	-	+	+	-	-	-	-	+	NA			

+, positive reaction; -, negative reaction; V, variable reaction; +^W, weak positive; NA, data not available; BE agar, bile esculin agar; LAP, leucine aminopeptidase; PYR, pyridoxyl aminylase; MOT, motility; PIGM, pigment; ADH, arginine dihydrolase; HIP, hippurate hydrolase; GLU, glucose; MNTL, mannitol; SOR, sorbose; ARAB, arabinose; SRTL, sorbitol; RAFF, raffinose; SUC, sucrose; PYRV, pyruvate; MGP, methyl α-D-glucosaminide.

+, positive reaction; -, negative reaction; V, variable reaction; +, weak positive; NA, data not available; BE agar, bile esculin agar; LAP, leucine aminopeptidase; PYR, pyridoxal aminylase; MDT, motility; PIGM, pigment; ADH, arginine dihydrolase; HIP, hippurate hydrolysis; GLU, glucose; MNTL, mannitol; SOR, sorbose; ARAB, arabinose; SRTL, sorbitol; RAFF, raffinose; SUC, sucrose; PYRV, pyruvate; MGP, methyl α-D-glucopyranoside.

References:

1. Textbook of Diagnostic Microbiology, Fourth Edition; Connie R. Mahon, Donald C. Lehman, George Manuselis.
2. Koneman's Color Atlas & Textbook of Diagnostic Microbiology, Seventh Edition; Cary W. Procop, Deirdre L. Church, Geraldine S. Hall, William M. Janda, Elmer W. Koneman, Paul C. Schreckenberger, Gail L. Woods.