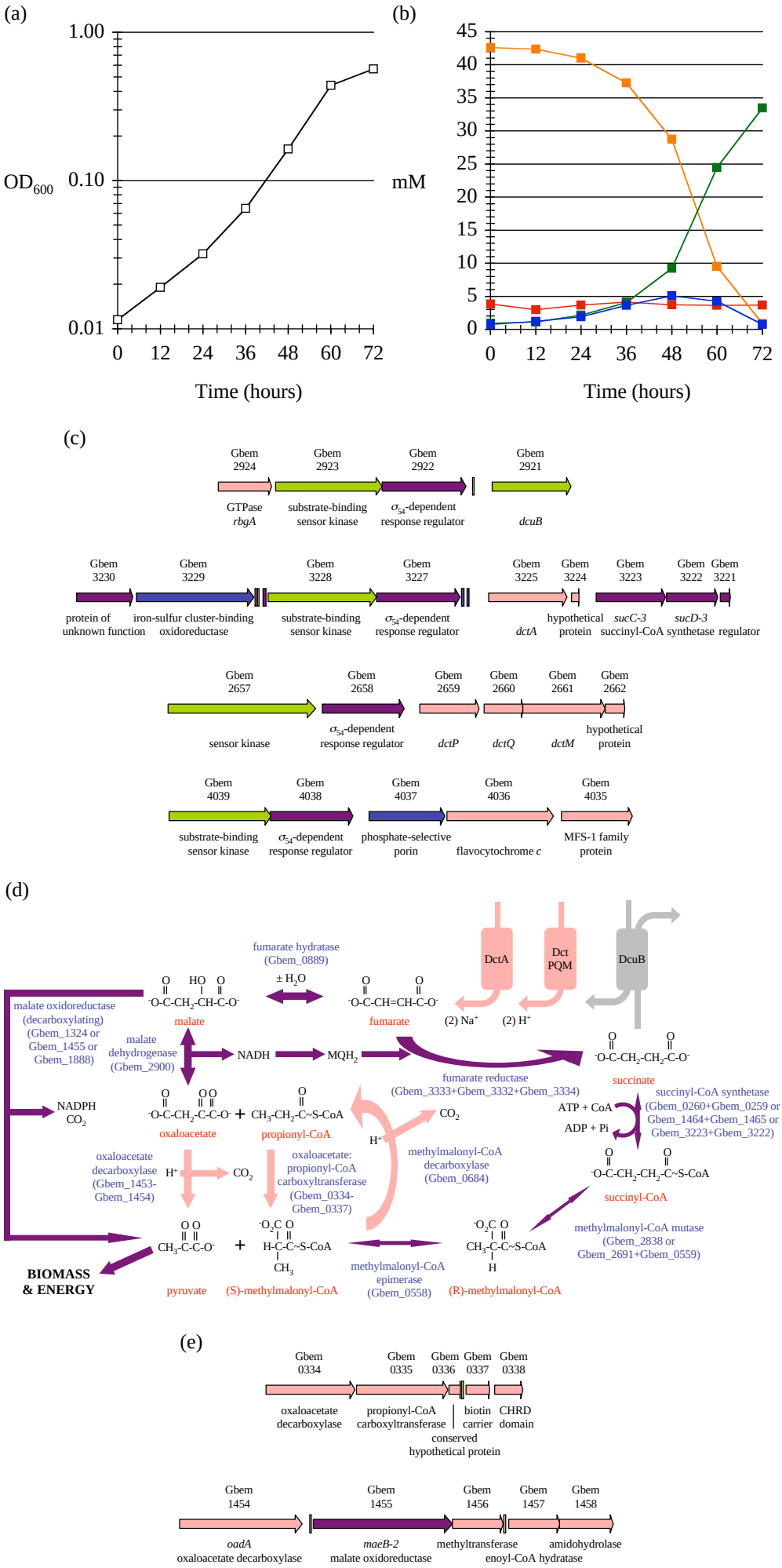
(a)
1.00
0.10
0.01
OD600
0
12
24
36
48
60
72
Time (hours)
(b)
45
40
35
30
25
20
15
10
5
0
mM
0
12
24
36
48
60
72
Time (hours)
(c)
Gbem 2924
Gbem 2923
Gbem 2922
Gbem 2921
GTPase rbgA
substrate-binding sensor kinase
σ54-dependent response regulator
dcuB
Gbem 3230
Gbem 3229
Gbem 3228
Gbem 3227
Gbem 3225
Gbem 3224
Gbem 3223
Gbem 3222
Gbem 3221
protein of unknown function
iron-sulfur cluster-binding oxidoreductase
substrate-binding sensor kinase
σ54-dependent response regulator
dctA
hypothetical protein
sucC-3 succinyl-CoA synthetase
sucD-3 regulator
Gbem 2657
Gbem 2658
Gbem 2659
Gbem 2660
Gbem 2661
Gbem 2662
sensor kinase
σ54-dependent response regulator
dctP
dctQ
dctM
hypothetical protein
Gbem 4039
Gbem 4038
Gbem 4037
Gbem 4036
Gbem 4035
substrate-binding sensor kinase
σ54-dependent response regulator
phosphate-selective porin
flavocytochrome c
MFS-1 family protein
(d)
fumarate hydratase (Gbem_0889)
± H2O
malate
fumarate
DctA
Dct PQM
DcuB
(2) Na+
(2) H+
malate oxidoreductase (decarboxylating) (Gbem_1324 or Gbem_1455 or Gbem_1888)
malate dehydrogenase (Gbem_2900)
NADH
MQH2
NADPH
CO2
oxaloacetate
propionyl-CoA
fumarate reductase (Gbem_3333+Gbem_3332+Gbem_3334)
CO2
H+
succinate
succinyl-CoA synthetase (Gbem_0260+Gbem_0259 or Gbem_1464+Gbem_1465 or Gbem_3223+Gbem_3222)
ATP + CoA
ADP + Pi
succinyl-CoA
oxaloacetate decarboxylase (Gbem_1453-Gbem_1454)
H+
CO2
oxaloacetate: propionyl-CoA carboxyltransferase (Gbem_0334-Gbem_0337)
methylmalonyl-CoA decarboxylase (Gbem_0684)
methylmalonyl-CoA mutase (Gbem_2838 or Gbem_2691+Gbem_0559)
BIOMASS & ENERGY
pyruvate
(S)-methylmalonyl-CoA
methylmalonyl-CoA epimerase (Gbem_0558)
(R)-methylmalonyl-CoA
(e)
Gbem 0334
Gbem 0335
Gbem 0336
Gbem 0337
Gbem 0338
oxaloacetate decarboxylase
propionyl-CoA carboxyltransferase
biotin carrier
CHRD domain
conserved hypothetical protein
Gbem 1454
Gbem 1455
Gbem 1456
Gbem 1457
Gbem 1458
oadA oxaloacetate decarboxylase
maeB-2 malate oxidoreductase
methyltransferase
amidohydrolase
enoyl-CoA hydratase