

## Glossary Cell Cycle Module

The table below summarizes some of the key cell-cycle players, their main function, and their regulation.

Name	Function	Time of function	Activated by	Inhibited by	Degraded by
S.cervisiae					
APC/c	Anaphase Promoting Complex (or Cyclosome), an E3 ligase required to ubiquitinate substrates and thereby induce their degradation by the 26S Proteasome	anaphase onset, mitotic exit	---	---	never
APCCdc20	Cdc20 is the substrate-specific adaptor, phosphorylation of APC is required for APCCdc20 activity, small number of substrates	anaphase onset	Clb-Cdk	Mad2	never
APCCdh1	Cdh1 is the substrate-specific adaptor, large number of substrates (including most substrates of APCCdc20)	mitotic exit	Cdc14	Clb-Cdk	SCF
Aurora B (Ipl1 in S. cerevisiae)	forms the chromosome passenger complex together with INCENP and Survivin (Sli15 and Bir1 in S. cerevisiae), required to ensure bipolar attachment of the chromosomes by breaking up incorrect attachments	M	absent or monopolar microtubule attachment	bipolar microtubule attachment	at the end of mitosis, machinery unknown
Bfa1/Bub2	a bipartite GTPase activating protein (GAP) for Tem1	mitotic exit	Kin4	absence of Kin4 in the bud	---
CAK	Cdk activating kinase; Cak1 in S. cerevisiae and Cdk7/CyclinH/Mat1 in higher eukaryotes	always	---	---	---
Cdc6	recruits the MCM complex to pre-replication origins, and inhibits its activity	G1 + G1/S	Cdc14	Clb5/6-Cdk	SCFcdc4
Cdc14	phosphatase, recognising Cdk consensus phosphorylation sequences: S/T-P-X-K/R	anaphase and mitotic exit	release from nucleolus by Net1 phosphorylation	dephosphorylated Net1	---
Cdc15	kinase, activates Dbf2 in the MEN pathway	mitotic exit	Tem1, Cdc14	Clb-Cdk	---
Cdc28	major cyclin dependant kinase (Cdk) in yeast required for cell cycle regulation, also called Cdk1	G1/S, G2/M	CAK, Cdc25, Cln's/Clb's	Wee1 (Swe1 in S. cerevisiae), Sic1, Far1	stable

Clb1/2	B-type cyclins required for cell cycle progression, in particular entry into and progression through mitosis	M	CAK, Ndd1	Sic1	APCcdc20 and APCcdh1
Clb3/4	B-type cyclins required for cell cycle progression, in particular for spindle assembly and positioning	M	CAK, Ndd1	Sic1	APCcdc20 and APCcdh1
Clb5,6	B-type cyclins required for cell cycle progression, in particular for DNA replication	S	CAK, Ndd1, SBF/MBF	Sic1	APCcdc20 and APCcdh1
Cln1/2	cyclins required for progression through START	START	CAK, SBF/MBF (positive feedback loop)	Far1, Clb-Cdk repressing SBF/MBF, Cln1/2-Cdk	SCFGrr1
Cln3	cyclin required for progression through START (acting upstream of Cln1/2)	START	Ste12 (during mating)	---	unstable, machinery unknown
Cohesin	a complex required for sister chromatid cohesion composed of Smc1/3 (coiled coil and ATPase domain), Scc1 (contains proteolytic cleavage site for separase) and Scc3	S, G2 + M (until anaphase onset)	loading during DNA replication	cleavage of Scc1 by separase, phosphorylation by Polo kinase	---
Dbf2	kinase, phosphorylates Net1 in the MEN pathway	mitotic exit	Cdc15	---	---
Far1	a Cyclin-dependent Kinase Inhibitor (CKI) for Cln1/2-Cdk	G1	Ste12 (during mating)	Cln1/2-Cdk	SCFcdc4
Fob1	component of the replication fork barrier present in the rDNA repeats, localises Net1 to the nucleolus	S	---	---	never
Kin4	a kinase, required to maintain active Bfa1/Bub2, present only in the mother cell	always	---	---	---
Lte1	a Guanine nucleotide Exchange Factor (GEF) for Tem1, present only in the bud	mitotic exit	---	---	---
Mad2	component of the spindle assembly checkpoint, inactivates APCCdc20 by binding to Cdc20	G2, M (until anaphase onset)	unattached kinetochore, active Mad2 (positive feedback loop)	all kinetochores attached	never
Mbp1/Swi6	a transcription factor, also called MBF, activates expression of Cln1/2 and Clb5/6	START	phosphorylation of Whi5 by Cln-Cdk	Whi5, Clb-Cdk	never
Mcm2-7	a helicase complex, part of the pre-replication complex, required to unwind the DNA during replication	S	Cdc6 (required for loading onto DNA)	Cdc6, Clb-Cdk	never

Ndd1	a transcription factor, works together with Mcm1 and Fkh1/2 to activate expression of Clb1-4	G2 + M	phosphorylation of Ndd1 by Clb-Cdk (positive feedback loop)	---	---
Net1	localises to the nucleolus, sequesters and inactivates Cdc14	always except during FEAR and MEN activation	PP2Acdc55	Clb-Cdk, Polo kinase, Dbf2	never
ORC	binds to origin recognition element (ORE), required for initiation of DNA replication	always	---	---	---
Polo kinase (Cdc5 in <i>S. cerevisiae</i> )	a kinase, phosphorylates Net1 which has been primed by Clb-Cdk	M	---	---	APCCdh1
PP2Acdc55	Protein Phosphatase 2A (PP2A), dephosphorylates Net1 (only the phosphates added by Clb-Cdk)	always except during FEAR and MEN activation	---	separase	never
SCF	Skip1/Cdc53/F-box complex, an E3 ligase required to ubiquitinate (mostly) phosphorylated substrates and thereby induce their degradation by the 26S Proteasome	always	phosphorylation of substrates	---	autoubiquitination
Securin (Pds1 in <i>S. cerevisiae</i> )	required for proper folding of separase, an inhibitor of separase	G1 + S + G2 + M (until anaphase onset)	stabilization by Mad2-dependent inhibition of APCCdc20	---	APCcdc20
Separase (Esp1 in <i>S. cerevisiae</i> )	a protease, cleaves cohesin and inactivates PP2Acdc55	anaphase onset, mitotic exit	degradation of securin, phosphorylation of cohesin	securin	autocleavage
Sic 1	a Cyclin-dependent Kinase Inhibitor (CKI) for Clb-Cdk	G1	Cdc14, Swi5	Cln/Clb-Cdk	SCFcdc4
Ste 12	a transcription factor induced during mating, activates the expression of Far1 and Cln3	G1 (during mating)	pheromones	Cln-Cdk	machinery unknown
Swi4/Swi6	a transcription factor, also called SBF, activates expression of Cln1/2 and Clb5/6	START + S	phosphorylation of Whi5 by Cln-Cdk	Whi5, Clb-Cdk	never

Swi 5	a transcription factor, works together with Ace2 to activate expression of Sic1	M + G1	Cdc14	Clb-Cdk	never
Tem 1	a small GTP-binding protein, required to activate MEN (active when GTP bound, inactive when GDP is bound)	mitotic exit	Lte1	Bfa1/Bub2	never
Tub 1	encodes for an $\alpha$ -tubulin, some particular mutants only affect cytoplasmic (astral) microtubules but not the mitotic spindle	always	---	---	---
Whi 5	a transcriptional repressor, binds to SBF and MBF	always except during START	Cdc14	Cln-Cdk	---
Mammalian Cells					
Cyclin A	similar to Clb5/6, forms a complex with Cdk2	S	---	---	APCCdc20
Cyclin B	similar to Clb1-4, forms a complex with Cdk1	M	---	---	APCCdc20, APCCdh1
Cyclin D	similar to Cln3, forms a complex with Cdk4/6, activated by growth factors	G1	cyclinD,E/Cdk	---	SCF
Cyclin E	similar to Cln1/2, forms a complex with Cdk2	G1/S	cyclinD,E/Cdk	---	SCF
E2F/DP	a transcription factor, required to activate expression of Cyclin E	always	hyperphosphorylation of Rb/p130 by CyclinD-Cdk4/6, and Cyclin E-Cdk2 (positive feedback loop)	Rb, p130	---
p130	a transcriptional repressor, expressed mainly in quiescent cells	G1	---	cyclinD,E/Cdk	---
Rb	a transcriptional repressor, expressed mainly in dividing cells	G1	---	cyclinD,E/Cdk	---