

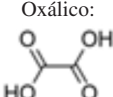
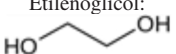
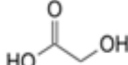
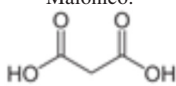

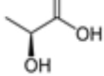
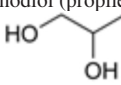
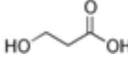
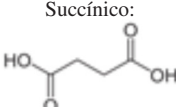
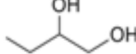
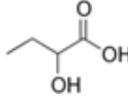
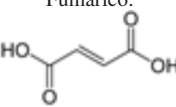
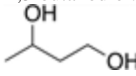
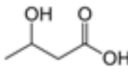
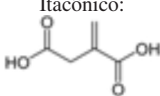

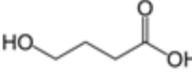
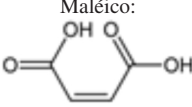
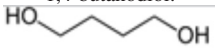
APLICAÇÕES DE ENZIMAS NA SÍNTESE E NA MODIFICAÇÃO DE POLÍMEROS

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Tabela 1S. Monômeros que podem ser utilizados na síntese de poliésteres por reações de policondensação

Nº de Carbonos	Diácidos	Dióis	Hidroxiácidos
1			
2	Oxálico: 	Etilenoglicol: 	Glicólico: 
3	Malônico: 	1,3-propanodiol: 	L-lático: 
		1,2-propanodiol (propilenoglicol): 	3-hidroxiopropiônico: 
	Succínico: 	1,2-butanodiol: 	α-hidroxiбутírico: 
4	Fumárico: 	1,3-butanodiol: 	β-hidroxiбутírico: 
	Itacônico: 	2,3-butanodiol: 	γ-hidroxiбутírico: 
	Maléico: 	1,4-butanodiol: 	

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Tabela 1S. continuação

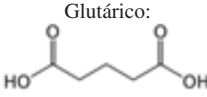
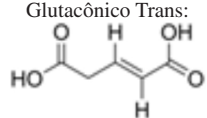
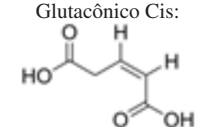
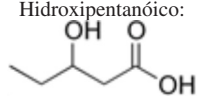
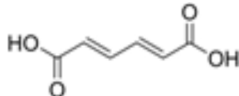
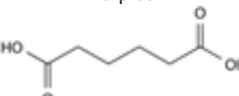
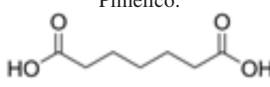
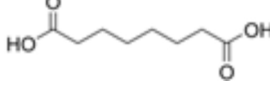
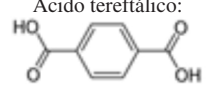
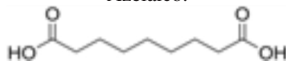
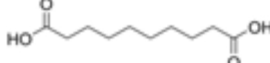
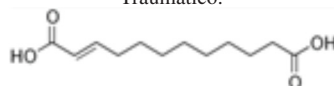
Nº de Carbonos	Diácidos	Dióis	Hidroxiácidos
5	<p>Glutárico:</p>  <p>Glutacônico Trans:</p>  <p>Glutacônico Cis:</p> 		<p>Hidroxipentanóico:</p> 
6	<p>Mucônico:</p>  <p>Adípico:</p> 		
7	<p>Pimélico:</p> 		
8	<p>Subérico:</p>  <p>Ácido tereftálico:</p> 		
9	<p>Azeláico:</p> 		
10	<p>Sebáico:</p> 		
12	<p>Traumático:</p> 		

Tabela 2S. Síntese de poliésteres via reações de policondensação catalisada por enzimas (Elaborado a partir de Gross *et al.*)¹

Enzima	Monômero	Condição	Rendimento (%)	Referência
Novozym 435	PDL, glicol, AA	60 °C, 24h	>95	2
Novozym 435	MCH, MUA, PDL	90 °C, 24h	87	3
Novozym 435	MCH, VA, PDL	90 °C, 6,5h	57	3
Novozym 435	EGDMA, PDL	90 °C, 24h	71	3
Novozym 435	AA, OD, glicerol	70 °C, 42h	90	4
Novozym 435	TMP, OD, AA	70 °C, 42h	40-94	5
Novozym 435	HD, DMMS	70 °C, 48h	92	6
Novozym 435	PEG-1500, 5-DMAIP	90 °C, 48h	93.5	7
Novozym 435	PHB; PHO; Divinil adipato	70 °C, 8h	55	8
Novozym 435	DXO; CL;	60 °C, 4h	63-92,6	9
Novozym 435	α,ω -diácido insaturado/epoxidado (C18, C22), dióis	90 °C, 48h	60-89	10
PPL	SA; GPE	80 °C, 72h	100	11
Lipase PC	PDL, DVS, BD	60 °C, 72h	80	12
Lipase CA	DVS, glicerol, ácido graxo epoxidado	60 °C, 24h	66-83	13
Lipase CS 99-125	BD, DES	70 °C, 24h-48h	100	14

AA, ácido adípico; BD, 1,4-butanodiol; β -BL, β -butirolactona; C12- ω HA, ácido 12-hidróxi-dodecanóico; CL, caprolactona; DES, dietil sebacato; DMAIP, dimetil 5-aminoisofalato; DMDA, metil éster de ácido α,ω -dicarboxílico; DMMS, dimetil 2-mercaptosuccinato; DVS, divinil sebacato; DXO, 1,5-dioxepan-2-ona; EGDMA, etileno glicol dimetacrilato; GPE, glicidil-fenil-éter; HD, 1,6-hexanodiol; Lipase CA, lipase de *Candida antarctica*; Lipase CS, lipase *Candida sp.* 99-125; Lipase PC, lipase de *Pseudomonas cepacia*; MCH, 6-mercaptop-1-hexanol; MUA, ácido 11-mercaptop-1-undecanóico; OD, 1,8-octenodiol; PDL, ω -pentadecalactona; PEG-1500, poli(etileno-glicol) com Mw de 1500; PHB, poli(hidroxi-butirato); PHO, poli(hidroxi-octanoato); PPL, lipase de pâncreas suíno; AS, anidrido succínico; TMP, trimetilolpropano; VA, acrilato de vinila.

Tabela 3S. Enzimas hidrolíticas que catalisam a hidrólise superficial de alguns polímeros (modificado de Guebitz e Cavaco-Paulo)¹⁵

Polímero	Enzima	Numero EC	Micro-organismos produtores
PAN	Nitrila hidratase	4.2.1.84	<i>Rhodococcus rhodochrous</i> , <i>Arthrobacter sp.</i> , <i>Brevibacterium imperial</i> , <i>Corynebacterium nitrilophilus</i>
	Nitrilase	3.5.5.1	<i>Agrobacterium tumefaciens</i> , <i>Micrococcus luteus</i>
	Amidase	3.5.1.4	<i>Rhodococcus rhodochrous</i> , <i>Agrobacterium tumefaciens</i>
	Cutinase	3.1.1.74	<i>Fusarium solani</i>
	Lipase	3.1.1.3	<i>Thermomyces lanuginosus</i>
PET	Cutinase	3.1.1.74	<i>Thermobifida fusca</i> , <i>Penicillium citrinum</i> , <i>Fusarium oxysporum</i> ; <i>Fusarium solani</i>
	Lipase	3.1.1.3	<i>Candida Antarctica</i> , <i>Humicola sp.</i> , <i>Candida sp.</i> , <i>Pseudomonas sp.</i>
	Esterase	3.1.1.1	<i>Pseudomonas spp.</i>
PA	Protease	3.4.21.62	<i>Bacillus subtilis</i> , <i>Beauveria sp.</i>
	Cutinase	3.1.1.74	<i>Fusarium solani pisi</i>
	Amidase	3.5.1.4	<i>Nocardia sp.</i>
PEG	Lipase	3.1.1.3	<i>Candida antarctica</i> (Novozym 435), <i>Mucor miehei</i> (Amano Lipase M)
PBO	Peroxidase de Raiz forte	1.11.1.7	<i>Armoracia rusticana</i>
PHS	Tirosinase	1.10.3.1	<i>Agaricus bisporus</i>

PA: Poliamida; PAN: Poli(acrilonitrila); PBO, poli-*p*-fenileno-2,6-benzobistiazol; PEG: Poli(etileno glicol); PET: Poli(Tereftalato de metila); PHS, poli(4-hidroxiestireno).

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