1	Stru	icture a	and Composition	1
	1.1	Introd	uction	1
	1.2	Seed S	Structure	2
		1.2.1	Embryo	3
		1.2.2	Non-embryonic Storage Tissues	5
		1.2.3	Testa (Seed Coat)	6
	1.3	Seed S	Storage Reserves	7
		1.3.1	Carbohydrates	9
		1.3.2	Oils (Neutral Lipids)	14
		1.3.3	Proteins	16
		1.3.4	Phytin	22
		1.3.5	Other Constituents	23
	Usef	ful Liter	rature References	24
2	Dev	elopme	nt and Maturation	27
	2.1	Fertili	zation	27
	2.2	Embry	yogeny and Storage Tissue Formation	28
		2.2.1	Embryonic Tissues	29
		2.2.2	Endosperm	30
		2.2.3	Testa (Seed Coat)	34
	2.3	Regul	ation of Seed Development	36
		2.3.1	Plant Hormones	36
		2.3.2	Embryo Polarity and Patterning	38
		2.3.3	ABA Content and Sensitivity to ABA	
			During Development	41
		2.3.4	Regulation of the Seed Maturation Program	43
		2.3.5	Epigenetic Control of Endosperm Development	46
		2.3.6	Testa Development and Its Interaction with the	
			Endosperm and Embryo	48
		2.3.7	Somatic Embryogenesis and Apomixis	50

	2.4	Germi	inability During Development	52
		2.4.1	Ability to Germinate During Development	52
		2.4.2	Precocious Germination: Vivipary	
			and Preharvest Sprouting	55
		2.4.3	Role of Preharvest Drying in	
			Development of Germinability	57
	2.5	Matur	ation Drying and the "Switch" to Germination	60
		2.5.1	The Acquisition of Desiccation Tolerance	60
		2.5.2	Protective Mechanisms Associated with Drying	61
		2.5.3	Gene Expression Changes Upon Rehydration	67
	2.6	Late N	Auturation Events and Seed Drying	69
		2.6.1	Physiological Maturity Versus Harvest Maturity	71
		2.6.2	Seed Development and Seed Quality	73
		2.6.3	Maturation Drying and Biophysical	
			Aspects of Dry Seeds	75
	Usef	ful Liter	rature References	81
3	Syn	thesis a	of Storage Reserves	85
	3.1	Assim	ilates for Grain and Seed Filling	85
		3.1.1	Sources of Nutrients for Storage Reserve Synthesis	86
		3.1.2	Import of Nutrients into the Developing Seed	88
		3.1.3	Factors Affecting Seed Production and Quality	92
	3.2	Depos	ition of Reserves Within Storage Tissues	96
		3.2.1	Starch Synthesis	100
		3.2.2	Synthesis of Polymeric Carbohydrates Other than Starch	105
		3.2.3	Oil (Triacylglycerol) Synthesis	106
		3.2.4	Storage Protein Synthesis	114
		3.2.5	Phytin Synthesis	125
		3.2.6	Modifications of Non-storage Compounds	
			to Improve Nutritional Quality	128
	Useful Literature References			
4	Ger	minatio	on	133
	4.1	Seed (Germination: Definition and General Features	133
	4.2	Measu	rement of Germination	136
	4.3	Imbibi	ition	141
			Uptake of Water from the Soil	141
		4.3.2	Phase I, Imbibition and Imbibitional Damage	143
		4.3.3	Phase II, The Lag Phase	149
		4.3.4	Phase III, Completion of Germination	150
		4.3.5	Kinetics of Imbibition	151
	4.4		ation: Oxygen Consumption and Mitochondrial	
			opment	153
		4.4.1	Pathways and Products	153
		4.4.2	Respiration During Imbibition and Germination	153

		4.4.3	Mitochondrial Development and Oxidative Phosphorylation	155
		4.4.4	Respiration Under Low Oxygen Conditions	157
	4.5	RNA a	nd Protein Synthesis	160
		4.5.1	Transcriptomes of Dry and Germinating Seeds	161
		4.5.2	Proteomes of Germinating Seeds	164
	4.6	The Co	ompletion of Germination	166
		4.6.1	Embryo Growth Potential Versus Enclosing	
			Tissue Constraints in Radicle Emergence	166
		4.6.2	DNA Synthesis and Cell Division (Cell Cycle)	173
	4.7	Primin	g and the Enhancement of Germination	175
	Usef	ul Liter	ature References	179
5	Mot	oilizatio	n of Stored Reserves	183
	5.1	Seedlin	ng Growth Patterns	183
	5.2		zation of Stored Reserves	
	5.3	Stored	Oligosaccharide Catabolism	188
	5.4	Pathwa	ays of Starch Catabolism	189
		5.4.1	Synthesis of Sucrose	191
	5.5	Mobili	ization of Stored Starch in Cereal Grains	192
		5.5.1	Synthesis and Release of α -Amylase and Other	
		Ну	/drolases from the Aleurone Layer	192
		5.5.2	Starch Breakdown and the Fate of the Products	
		of	Hydrolysis	
		5.5.3		196
		5.5.4	Programmed Cell Death of the Aleurone Layer	
			d Other Tissues	
	5.6		ilization of Stored Carbohydrate Reserves in Dicots	
		5.6.1	Starch-Storing Non-endospermic Legumes	
		5.6.2		
		5.6.3	0 0	
	5.7		d Triacylglycerol Mobilization	
		5.7.1	Mobilization of TAGs from Oil Bodies	
		5.7.2	5 5	
		5.7.3		
	5.8		ge Protein Mobilization	
		5.8.1	Protein Mobilization During Germination	
		5.8.2	Protein Mobilization Following Germination of Cereals	
		5.8.3	Protein Mobilization Following Germination of Dicots	
		5.8.4	Protease Inhibitors	
		5.8.5	Utilization of Liberated Amino Acids in Dicot Seedlings	
	5.9	-	n Mobilization	
	5.10		ol of Reserve Mobilization in Dicots	
		5.10.1		
		5.10.2	0 1	
	Usef	ul Litera	ature References	244

6	Dor	mancy	and the Control of Germination	247	
	6.1	Dorma	ancy: Its Biological Role	248 249	
	6.2	2 Categories of Dormancy			
	6.3	Mechanisms of Dormancy		251	
		6.3.1	Blocks to Germination Within the Embryo	251	
		6.3.2	Blocks to Germination by the Covering Layers	254	
	6.4	Embry	yonic Inadequacy: The Causes	259	
		6.4.1	Energy Metabolism of Dormant Seeds	259	
		6.4.2	Genetic Aspects of Dormancy	261	
	6.5	The E	nvironment in Dormancy Inception	262	
	6.6	The Release from Dormancy			
		6.6.1	Perception, Signaling, and Role of Hormones		
			with Respect to Dormancy and Germination	266	
		6.6.2	After-Ripening	276	
		6.6.3	Low Temperatures (Chilling)	278	
		6.6.4	Other Effects of Temperature on Dormancy	281	
		6.6.5	Light	282	
		6.6.6	Dormancy Release of Seeds with Impermeable Coats	288	
		6.6.7	Breaking of Dormancy by Chemicals	290	
	Usei	Useful Literature References			
7	Env	ironme	ental Regulation of Dormancy and Germination	299	
	7.1		Dispersal and Burial	300	
		7.1.1	The Soil Seed Bank	300	
	7.2	Enviro	onmental Control of Germination	302	
		7.2.1	Water	303	
		7.2.2	Temperature	311	
		7.2.3	Light	317	
		7.2.4	Nitrate	323	
		7.2.5	Oxygen and Other Gases	324	
		7.2.6	Other Chemicals	326	
	7.3	Secon	dary Dormancy and Seasonal Variation	330	
		7.3.1	Dormancy Cycling	330	
		7.3.2	Dormancy Cycling: Mechanisms and Modeling	332	
	7.4		nces of Plant Life Cycle, Distribution		
			rigin on Germination	335	
		7.4.1	Plant Distribution	335	
		7.4.2	Seasonal and Flowering Interactions		
			Affecting Dormancy	336	
	Use	ful Lite	rature References	338	
8	Lon	gevity.	Storage, and Deterioration	341	
			nt Seeds	342	

Contents

	8.2	Longe	vity of Seeds in Storage	346
		8.2.1	Patterns of Seed Viability Loss During Storage	347
		8.2.2	Temperature, Moisture Content, and Seed Longevity	351
		8.2.3	Other Factors that Affect Seed Viability During Storage	354
	8.3	Seed S	Storage and Conservation	356
		8.3.1	Short-Term Storage	357
		8.3.2	Long-Term Genetic Conservation:	
			Ex Situ Seed Gene Banks	358
		8.3.3	Long-Term Genetic Conservation:	
			In Situ Centers of Diversity	362
	8.4	Mecha	anisms and Consequences of Deterioration in Seeds	363
		8.4.1	Deterioration Mechanisms in Stored Seeds	364
		8.4.2	Consequences of Storage on Germination	367
	8.5	Mecha	anisms of After-Ripening in Dry Seeds	368
	8.6	Recald	citrant Seeds	370
	Useful Literature References			374
Gle	ossar	y of Sp	ecies Names and their Nomenclature	377
Inc	Index			