

FERN INTERMEDIATE VERSION

VOICE	IMAGES	REELS	SOUND
1. Since the earliest of times, ferns have been appreciated for their beauty and have provided shelter and sometimes, food.	BUSH SCENE Pan down from bridge to the tree ferns below and to the stream Reel 2 04:01:04 to 01:14	LJ002 04:01:03:19- 04:01:13:23	
2. The birth of their young, coiled fronds.....	TREE FERN Top of fern with opening fronds. <u>Reel 2 04:05:49</u> Fern leaflets opening <u>Reel 6/7 06:30:22</u>	LJ002 04:05:48:19 04:05:53:03 LJ006 06:30:21:24 06:30:25:20	
3.has often been used in art work such as the Koru..	KORU: two korus simple koru <u>Reel 6/7 07:00:22</u> Double koru <u>Reel 6/7 07:01:02</u>	LJ007 07:00:22:22 07:00:26:07 LJ007 07:01:01:20 07:01:05:10	
4. Ferns are popular in our parks and gardens.....	WINTERGARDEN <u>Reel 6/7 06: 20:50 (outside)</u>	LJ006 06:20:50:22 06:20:56:04	
5.and even brought indoors to enhance our living spaces.	HENDERSON MALL <u>Reel 6/7 06:30:05 to 30:15</u>	LJ006 06:30:07:18- 06:30:16:07	
6. . There are as many as 12,000 species of ferns throughout the world. Some are the size of your finger nail while others are as tall as a tree.	CASCADES Very 'arty' view of fern climber <u>Reel 3 03:21:34 to 21:54</u>	LJ002 04:04:17:15- 04:04:29:00	
7. In the wild, ferns are successful at reproducing and spreading throughout the forest. They do this by producing spores			
8			

	Spores and spore cases		
VOICE	IMAGES	REELS	SOUND EFFECTS
9. The familiar fern is known as a spore plant . If a fern frond, is turned over.....	MATURE FERN LEAVES, TOP Focus now swings up from the rhizome to the leaves above. <u>Reel 1 04 18:50 to 19:07</u>	LJ002 04:18:51:10- 04:19:04:15	
10. small circular areas may be seen.	MATURE FERN LEAVES, BOTTOM Focus is on the spots on the lower leaf surface.		
11. Each of these	ANIMATION: IMMATURE LEAF FROM BELOW	FAM 01:01:07:00 01:02:37:00	
12.contains a group of small spore cases.	INSIDE THE SORUS: GROUP OF YOUNG SPORANGIA		
13. In some ferns,these are exposed.	NAKED GROUP OF SPORANGIA		
14. In others, the spore cases are protected by a cap.	AROUND THE SORUS: A PELTATE INDUSIUM Covering shown first, then taken away to show attachment, then returned.		
15. In some ferns this covering is bowl-shaped.	BOWL SHAPED INDUSIUM		
16. Each group contains as many as 100 spore cases. Each of these will produce several dozen spores.	FERN LEAF: SORUS Entire circular area (sorus), moving closer and closer		
17. Each is attached to the leaf by a stalk.	SINGLE SPORANGIUM Single sac with stalk		
18. The jacket cells protect the fertile tissue within.	SPORANGIUM STRUCTURE A single sporangium to show jacket cells		
19. A band of jacket cells with very thin outer walls forms around the spore case.	ANNULUS A row of jacket cells expands and acquires thick inner walls.		

20. The function of this band is to open the case and release the spores.	LIP CELLS Moving around to see the other side of the sporangium.	crossfade	
21. Below the jacket there are two layers of cells. These cells nourish the fertile tissue inside.	YOUNG SPORANGIUM, TAPETUM Removing jacket cells Two layers of coloured tapetal cells	FAM 01:13:40:00 01:15:24:00	
22. The cells of the fertile tissue each contain two sets of chromosomes.	IMMATURE LEAF: YOUNG SPORANGIUM, SPOROCTE CELLS Removing tapetal cells Move in closer to sporocyte cells, ending up on a single cell.		
23. As each cell matures, its nucleus divides twice by the process of meiosis . Each nucleus now contains one set of chromosomes.	SPOROCTE DIVISION Meiosis: a single sporocyte nucleus dividing to yield 4 nuclei within one parent cell.		
24. Thin walls now form around each nucleus.....	CLEAVAGE Cleavage: cytoplasmic partitioning around each haploid nucleus to create four cells.		
25.resulting in a cluster of four new cells.	TETRAD		
26. A further deposit of wall material produces cells with thick, resistant walls that are called spores .	FINAL WALL FORMATION The four cells move apart. Particles move from the collapsing tapetal cells to the spore cells. The tapetal cells break down. Pullback sequence: from single sporangium to a group of sporangia.		
SUMMARY • Groups of spore cases are located on the underside of a fern frond.	SORUS	FAM 01:01:19:00 01:01:26:00	
• A band of cells forms around each spore case.	ANNULUS	FAM 01:02:07:00 01:02:15:00	
• The fertile tissue divides by meiosis to produce spores.	MEIOSIS	FAM 01:14:09:00 01:14:15:00	
• Spores are thick-walled cells with one set of chromosomes.	TAPETUM ADDING SPOROPLENIN	FAM 01:14:30:00 01:14:36:00	

Spore release			
VOICE	IMAGES	REEL	SOUND EFFECTS
<p>27. The spore cases in a group are now ready to open.</p> <p>Opening is accomplished by the band of jacket cells that encircles the spore case.</p> <p>These cells begin to dry out as water evaporates from their surface.</p> <p>Water remaining in the cells now pulls strongly on the cell walls.</p>	<p>MATURE SPORANGIUM Sorus, moving in gradually to a single sporangium.</p> <p>Entire sporangium, moving in closer and closer as it rotates.</p> <p>Trace of water leaving annulus cells via their outer walls</p>	<p>FAM 01:15:35:00 01:17:04:00</p>	
<p>28. The thick inner and side walls resist this pull but.....</p>	<p>X-RAY VIEW OF ANNULUS: THICK WALLS</p>		
<p>29.the thin outer walls are.....</p>	<p>X-RAY VIEW OF ANNULUS: THIN WALLS</p>		
<p>30.easily pulled inward.</p>	<p>SPORANGIUM: WATER LOSS Close up: outer walls pulling inwards as water evaporates.</p>		
<p>31. As a result, the band shortens much like an accordion and</p>	<p>SPORANGIUM: ANNULUS MOVING Annulus band beginning to shorten</p>		
<p>32.tears the jacket cells apart.</p>	<p>TEARING APART OF THE SPORANGIUM WALL Water molecules continue to leave. Sporangium jacket cells slowly begin to rip. Blue water pulling on outer walls</p>		

33. As the tear enlarges the spore case opens.	ANNULUS MOVES BACKWARD SLOWLY Water molecules continue to leave Jacket cells slowly complete ripping. Sporangium halves fully separated. A small amount of water pulling on the outer walls.		
34. When all the water has evaporated, the pull on the band cell walls is suddenly released. The thin outer walls then spring back.	WATER TENSION OVERCOME: VAPORISATION Close up of an annulus cell wall: water molecules departing, outer wall pulling inward.. Outer wall springs back in place		
35. This snaps the band forward, throwing out the spores.	TOP OF SPORANGIUM MOVES FORWARD FAST Outer walls of annulus cells spring outward to their original location.		
	SPORES SAILING THROUGH THE AIR! Annulus straightening out		
36. This process is repeated in thousands of spore cases on a leaf, releasing large quantities of spores.	LEAF: SPORES BEING RELEASED		
SUMMARY • A band of jacket cells shortens, opening the spore case.	SPORANGIUM: ANNULUS FROM SIDE. SPORANGIUM OPENING BACKWARDS	FAM 01:15:53:00 01:15:57:00FAM 01:16:29:00 01:16:37:00	
• The band then springs forward throwing out the spores.	SPORANGIUM CLOSING FORWARDS	FAM 01:16:45:00 01:16:53:00	

	The gamete plant		
VOICE	IMAGES	REEL	SOUND EFFECTS
37. Carried by the wind, some spores will land on a moist surface and absorb water.	MANY SPORES GERMINATING Many spores landing on a surface together.	FAM 01:17:10:00 01:19:50:00	
38.	ABSORPTION OF WATER SPORE Close up of one spore Water particles entering spore walls		
39.			
40. A filament emerges and attaches the spore to the soil.	FIRST RHIZOID Focusing on the trilete ridge Ridge un-zips A long rhizoid emerges and grows .		
41. This is followed by a sheet of cells which.....	BEGINNING OF PROTHALLUS Emergence of a finger of tissue Growth at the margins A gradually broadening sheet of cells forming		
42.rapidly expands to form a small heart-shaped gamete plant .	FORMING THE HEART- SHAPED PROTHALLUS Growth localised in the notch. Cells flowing out of notch left and right. Gradual formation of two wings.		
43. This simple plant absorbs water and is photosynthetic.	MATURE HEART-SHAPED PROTHALLUS From above [growing sequence can be cut out...begin with view from above].		

44. Numerous filaments attach it firmly to the soil surface. .	SIDE VIEW OF PROTHALLUS From side to show rhizoids at posterior end		
45. Male reproductive structures or sperm cases, are formed at one end of the gamete plant.	ANTHERIDIA: MOVING IN TO RHIZOID AREA Several antheridia are seen amongst the rhizoids		
46. Inside the outer protective jacket there are sperm cells.	ANTHERIDIUM : JACKET Focus on a single antheridium. [do not show parts of jacket....remove this sequence)	cross at 01:18:42:00 to 01:18:54:00 01:18:57 to 01:18:54:00 01:18:57	
47.	ANTHERIDIUM: SPERM Show sperm cells to the inside.	cross to 01:18:49:00 01:19:20:00	
48. At the other end of the plant..... there are female reproductive structures or egg cases.	ANTHERIDIA CLOSE TO THE NOTCH Underside of prothallus, moving to anterior end of prothallus. View of notch with many archegonia hanging down.		
49. Each has a protective jacket. Inside, there is an egg cell . .	ARCHEGONIUM STRUCTURE Focus on a single archegonium. Show the exterior with only the neck protruding. Move inside : the neck canal Move up: the venter Move in: the egg cell	use cutaway to cover the neck cannel cell archcells FAM 01:19:55:00 01:20:10 Cross to 01:19:32:00 01:19:50:00	
50. Although these plants are bisexual, they pass through separate female and male phases to avoid self-fertilisation..	NURSERY: SINGLE PROTHALLUS Close up of isolated prothallus with finger. <u>Reel 5a 05:34 to 06:11</u> (will have to select a portion of this.	LJ005 05:05:56:03 05:06:07:17	

51. If a plant is flooded with water while it is in the female phase, it releases a hormone.	BISEXUAL INDIVIDUAL RELEASING ANTHERIDIOGEN View from above of bisexual prothallus: water film spreading across field of view. Antheridiogen diffusing from a mature bisexual gametophyte to germinating spores nearby	FAM 01:20:15:00 01:20:55:00	
52. This hormone stimulates adjacent plants to stop growing and only form male structures.	GERMINATING IN THE PRESENCE OF ANTHERIDIOGEN Early stage of germination, rhizoid forming and beginning of thallus formation.		
	MALE PROTHALLUS FORMING Early stages of prothallus formation		
53.	MALE PROTHALLUS Underside, showing numerous antheridia on margins and all over Rhizoids.		
54. A plant in the female phase may therefore be surrounded by several male plants at the time of fertilisation.	BISEXUAL AND MALE PLANTS A bisexual prothallus surrounded by several male prothalli [Stop growth of male to the right!!]		
SUMMARY • Spores form small bisexual gamete plants.	PROTHALLUS From above, heart shaped.	FAM ??	
• Sperm are formed within sacs located at one end of the gamete plant.	UNDERSIDE: Antheridium	??	
• Eggs are formed within sacs located at the opposite end of the gamete plant.	UNDERSIDE: Archegonium		
• Sperm and eggs are formed at different times to avoid self fertilisation.	PROTHALLUS	??	
• In some ferns, a hormone is released that stimulates plants to be male.	MALE PLANT Males enlarging around a female, with hormone being released.	??	

Fertilisation			
VOICE	IMAGES	REEL	SOUND EFFECTS
55. Being close to the soil, the tiny gamete plants are easily flooded when it rains.	NURSERY: RAIN FALLING Rain falling on a group of prothalli. <u>Reel 5a 31:19 to 31:40</u>	LJ005 05:31:24:19 05:31:32:21	
56. This water plays an important role in fertilisation.	MODEL: PROTHALLUS FROM ABOVE Bisexual and male plants; camera then goes down and into water film.	FAM 01:09:55:00 01:10:22:00	
57. Water stimulates the male structure to open and release sperm cells.	ANTHERIDIUM OPENING Cap cell comes off Sperm emerge.		
58. Sperm are now able to move within the water film in search of an egg cell.	GROUP OF PROTHALLI FROM ABOVE Sperm trafficking between plants.		
	REPEAT: HATCHING OF BABY SPERM (3) ABOVE.		
59. A sperm cell consists of a spiral cell body bearing numerous flagella that move it forward.	DETAIL OF SWIMMING SPERM Multiflagellate sperm swimming across field of view	insert hatching FAM 01:10:10:00 01:10:13:00 cut to 01:10:22:00- 01:10:33:00	
60. Water also stimulates the egg case to open.	ARCHEGONIUM OPENING Cells at tip of archegonium peeling backwards on themselves.	chop part of shot FAM 01:10:49:00- 01:11:40:00	
61. A chemical is then released into the surrounding water.....	DIFFUSION OF SPERM ATTRACTANT Spread outwards of attractant from archegonium mouth.		
62.where it attracts sperm to the open egg case.	ATTRACTING SPERM Sperm coming from adjacent prothallus Sperm coming from same prothallus Sperm being 'caught' by attractant field. Sperm swimming towards mouth of an archegonium		

63. Reaching the opening, the sperm makes its way towards the egg.	SPERM AT ENTRANCE TO THE NECK CANAL Sperm enter archegonium mouth and loosen their helix, being not so tightly coiled. Flagella still attached.		
	SPERM MOVING UP NECK CANAL Sperm wiggling their way up the neck canal		
64. Fertilisation is completed when the egg and sperm nuclei fuse.	SPERM IN THE VENTER		
	SPERM ENTER EGG CYTOPLASM Sperm enters egg cytoplasm. Flagella are now shed.		
	FUSION OF ONE SPERM WITH THE EGG NUCLEUS Sperm nucleus moves to and joins with, the egg nucleus.		
65. Two sets of chromosomes are now present and the fertilised egg is ready to grow into an embryo.	ZYGOTE CELL. Hold frame with nucleus showing then go to surface view.		

SUMMARY • Water stimulates the male structure to open and release sperm.	CAP CELL COMING OFF	FAM 01:10:05:00 01:10:13:00	
• Water stimulates the egg case to open and release a sperm attractant	ARCHEGONIUM RELEASING ATTRACTANT.	FAM 01:10:49:00 01:10:55:00	
• Sperm swim through the surrounding water by beating their flagella.	DETAIL OF SPERM SWIMMING	FAM 01:10:22:00 01:10:29:00	
• Fertilisation is completed when the sperm and egg nuclei fuse.	FERTILISATION	FAM 01:11:21:00 01:11:29:00	

	The embryo and young spore plant.		
VOICE	IMAGES	REEL	SOUND EFFECTS
66. The fertilised egg remains attached to the gamete plant .	GREENHOUSE: Fern prothallus on soil, close up <u>Reel 5a 05:34 to 06:03</u>	LJ005 05:05:56:03 05:06:02:04	
67. Here, it begins to divide and form an embryo.	ANIMATION: Fly in and cut away to reveal the Embryo growing	FAM 01:21:00:00 01:22:04:00	
68. The growing embryo gets nutrients from the surrounding tissue and increases in size.	NUTRIENTS GOING INTO EMBRYO Cut showing the nutrients going into the foot		
69. The egg case around the embryo stretches and	VENTER STRETCHING external shot showing stretching of venter.		
70.eventually breaks.	VENTER BREAKING Venter ruptures and the root enters the soil (downward). (copy root of pine animation)		
71. A root now grows out into the soil where it supports the young spore plant and absorbs water.	EMERGENCE OF ROOT Root growing out of venter.		
72. Other parts of the embryo form the first leaf and a stem .	EMERGENCE OF LEAF, SHOOT Camera pans around to show leaf bursting out and then rhizome.		
73.	UNCURLING, EXPANSION OF LEAF leaf grows out and through the notch, bending upwards and expanding.		
74. In this way a new spore plant is formed.....	GREENHOUSE young sporophytes of progressively older ages.	LJ005 05:08:25:21 05:08:29:14 LJ005 05:33:53:21 05:33:56:21	

<p>75.that will mature into another spore producing fern continuing the reproductive cycle.</p>	<p>LOWER LECTURE THEATRE WALL Hound's tongue fern</p> <p><u>Reel 2 03 34:49 ----</u> (ground level, zoom in)</p>	<p>LJ002 04:18:51:10 04:18:57:14</p>	
<p>SUMMARY</p> <ul style="list-style-type: none"> The developing embryo remains attached to the gamete plant.. 	<p>PROTHALLUS WITH EMBRYO Low power shot showing gametophyte with zygote.</p>	<p>???</p>	
<ul style="list-style-type: none"> The embryo develops into a small spore plant with root, leaf and stem. 	<p>ROOT, LEAF AND STEM BREAKING OUT OF ARCHEGONIUM</p>	<p>???</p>	
<ul style="list-style-type: none"> Further growth produces a large spore plant. 	<p>REAL MATURE FERN PLANT</p>	<p>???</p>	
<p>GRAND FINALE</p> <p>While ferns do not form a major part of the earth's vegetation, they have been on this planet for over 370 million years.</p> <p>Perhaps the secret to their success is to be found in the clever ways in which they form and release spores and gametes.</p> <p>Perhaps it is their ability to specialise and adapt to a wide variety of habitats</p> <p>One thing that is certain, these attractive plants will continue to thrive and spread.</p>	<p>REAL FERNS</p> <p>Bush shot</p> <p>Hound's tongue leaf</p> <p>Finger at prothallus??</p> <p>Along stream In scoria or dirt bank On tree trunk</p> <p>-----</p>	<p>LJ002 04:18:52:17 04:18:57:16 LJ005 05:01:59:15 05:02:04:06 LJ003 03:21:41:00 03:21:45:13 LJ002 04:07:08:05 04:07:12:14</p> <p>-----</p>	